A TREATISE

ON THE

DIATOMACEÆ

CONTAINING

Introductory Remarks on the Structure, Life History, Collection, Cultivation and Preparation of Diatoms,

AND

A Description and Figure typical of every known Genus, as well as a Description and Figure of every Species found in the North Sea and Countries bordering it, including Great Britain, Belgium, &c.

BY

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Illustrated by about 2,000 Figures.

TRANSLATED BY

WYNNE E. BAXTER, F.R.M.S., F.G.S.

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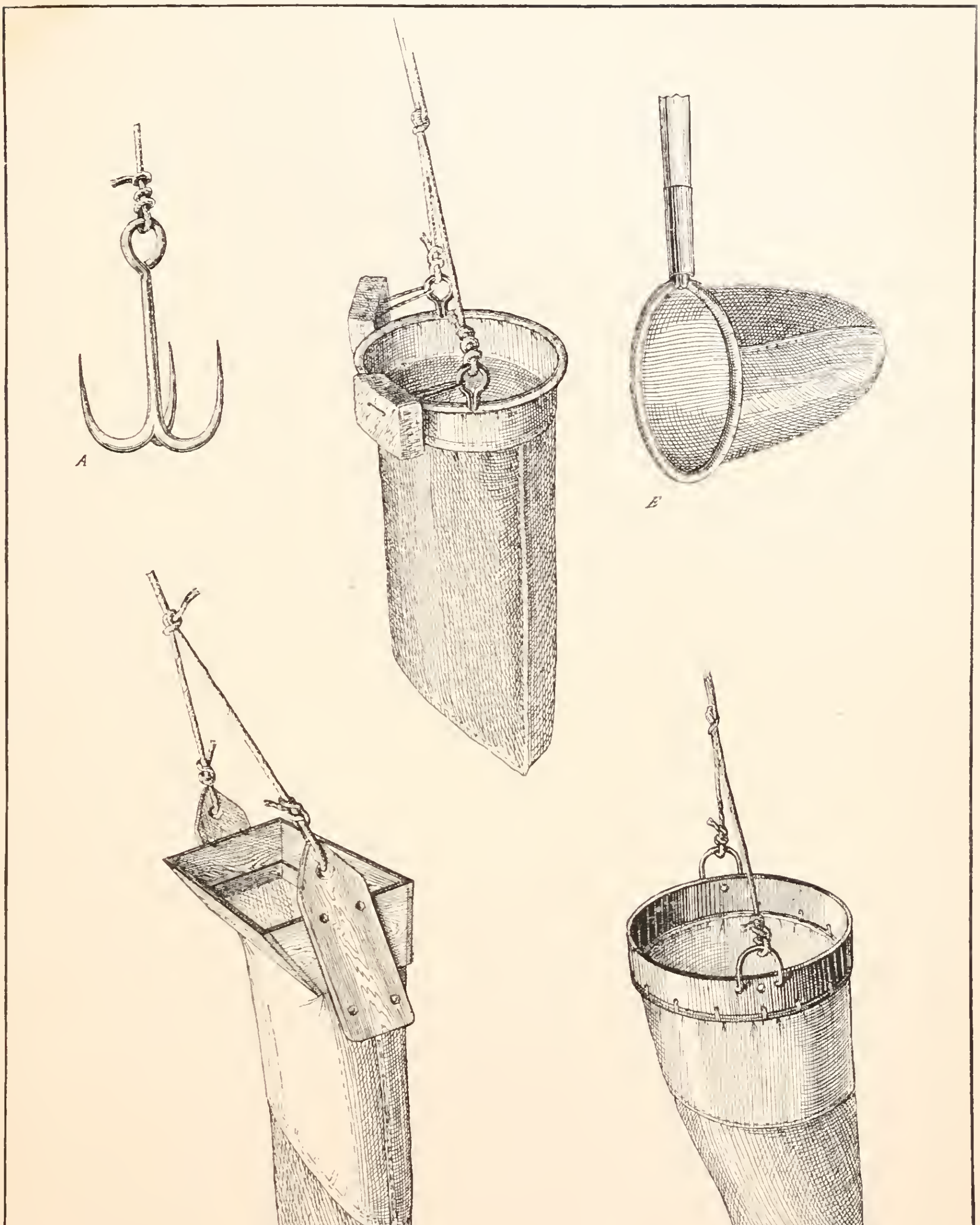
1896.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Author's Preface.

The Synopsis, the last part of which was published in 1885, had the good fortune to meet with so favourable a reception by diatomphiles that the work was promptly subscribed, and, in consequence, its selling price increased considerably.

Its present enhanced value, and the fact that only a few copies are now available, prevents all but those with considerable means from acquiring it.

Under these circumstances it has occurred to the Author that it would be useful to publish a work, in some respects more limited, and at such a price as to be within the reach of all persons of average means.

The scope of the present Treatise includes all the information of which we can be certain concerning the Life History and Structure of Diatoms.

It also comprises a description of every genus that can with reason be admitted at the present time, as well as of every species that has been hitherto found in the North Sea, and of those more commonly found in the countries abutting thereon, viz. :—Great Britain, the extreme north of France, Belgium, Holland, Denmark and Norway.

Under these conditions it is hoped that the Work will be found useful, not only to those who merely devote themselves to a general and summary examination of diatoms, but also to those who desire to determine the species found within this area.

It is essential that a book of this nature, to attain its object, should contain a large number of figures; and, consequently, although as many Synopsis-figures as possible have been made use of, several hundred others have been added. The fact that all these have been reproduced on a moderate scale by the process of phototypography, has enabled greater clearness to be attained than in the Synopsis, whilst keeping the price within moderate limits.

Every effort has been made that the work should present as faithful a conspectus as possible of all the forms found within the prescribed area; but, notwithstanding, it is greatly feared that a certain number of them has escaped the Author's notice. The Author requests the readers of this Volume to be good enough to inform him of any omissions they may discover, so as to enable him to insert them in the French Edition, which he hopes to publish shortly.

Mr. Wynne E. Baxter, who is himself a skilful Diatomist, has been good enough to translate this work, and publish it for the benefit of English diatomphiles. He has performed this task with every possible care, and with his usual ability. Both amateurs and the Author owe a debt of gratitude to Mr. Baxter for the great sacrifice at which he has published the Work.

H. V. H.

Botanical Gardens, Antwerp,
19*th September*, 1896.

Translator's Preface.

The last general work on the Diatomaceæ published in English is that by Mr. Ralfs as published in Pritchard's Infusoria in 1861, while that on the Diatomaceæ of Great Britain is the classical work of Professor Wm. Smith, which made its appearance more than 40 years ago.

Under such circumstances, the publication of the present work appeared to be opportune, aiming as it does at a complete figured classification of genera, bearing the stamp of the authority of the Author's great experience, together with a description and illustrated synopsis of all species found in Great Britain and the neighbouring shores; and this view has been corroborated in a most encouraging manner, by the fact that more than half the Edition has been subscribed previous to publication.

The geographical distribution of species described have been largely noted from published lists; and my own collection, amounting to upwards of 10,000 preparations (including the life-work of that versatile and indefatigable diatomist, the late Mr. Frederick Kitton), has enabled me to supplement the records of previous authors.

The Index of species and genera, which contains references to the Analytical Contents, and to the figures in the plates and text, has been compiled so as to render reference to any particular species as easy as possible, and at the same time to prevent readers from being confused by synonyms.

It was originally intended to have incorporated a full list of the Diatomaceous Deposits found in the British Isles, but the unexpected length of the Work has not only considerably delayed the date of publication, but has also rendered this object unattainable. My thanks, however, are due to many correspondents who have so readily assisted me in its compilation, and it is hoped that its publication is only deferred.

In spite of the fact that most of the leisure hours of a somewhat busy life have, during the last three years, been devoted to this work and that every care has been exercised in testing the many references, it is feared that errors, both of translation and reference, will be found, to which it is hoped readers will extend their generous indulgence.

The Author has referred to the Translator's work in terms of unjustifiable eulogy. The latter, however, feels that no English amateur, with any enthusiasm, will be able to refrain from admitting that this admirable work, with its elaborate tables and carefully conceived diagnoses, modified to meet the requirements of the student of our country, places us all under great obligations to the great Belgian Diatomist.

W. E. B.

170, CHURCH STREET, STOKE NEWINGTON, LONDON, N.

1st October, 1896.

CONTENTS.

A Treatise

ON

The Diatomaceæ.

INTRODUCTION.

CHAPTER I.

The Structure, Life History, Study, Collecting and Preparation of Diatoms.

§ 1. The Structure and Life History of Diatoms.

1. Structure of Diatoms.—Diatoms are microscopical algæ. Each individual diatom (called a *frustule*) consists of a single membranous cell, enclosing, in addition to the liquid of the cell, a nucleus surrounded by protoplasm, some oil globules, and a brownish matter called *endochrome*, which is composed of chlorophyl and phycoxanthin.

This cell is enclosed in a silicious covering or carapace, generally forming a kind of box, and consisting of (A) two *valves* and (B) a *zone* or *connecting band*, sometimes called a *cingulum* or *girdle*.

According to the assertions—now completely established—of Messrs. Wallich and Pfitzer, the two valves have each a rim, which overlaps like the two parts of a pill-box. These two rims form the connecting band, or the two rings of the girdle according to Prof. Pfitzer.

The two connecting parts are independent and not united to the valves, as some authors allege.

This independence of the connecting parts is now conclusively proved by the beautiful section of a *Navicula Dactylus* made by Mr. W. Prinz —an illustration of which will hereafter be given—(Chap. II. § 3. Raphe and nodules), and also by the same microscopist's successful sections of *Coscinodiscus*, which we have carefully examined.

Finally, the frustule is coated or enveloped with mucous, or sometimes muco-silicious matter, the existence of which can be demonstrated, as Prof. H. L. Smith has shewn, by means of fuchsine or ordinary methylene blue, either in simple solution or with a slight addition of borax (Miquel), which must be applied in very small quantities, so that the water shall be only just tinted. This investment (or *coleoderm* as it has been called by De Brebisson) is in some cases developed to such an extent that the diatoms, when united together, assume the appearance of higher-branched algæ, Ulvaceæ, &c. Such are the diatoms composing the genera *Schizonema*, *Dickieia*, &c.

Some of the various parts of a diatom require a more careful examination. (1)

The *nucleus* (fig. 1 A) is analogous to that of all vegetable cells; generally a *nucleole* can be distinctly seen. In many diatoms the nucleus is quasi-invisible, but Dr. Miquel has shewn that it can be made apparent by means of a weak aqueous solution of methylene blue; this colours the chromatine of the nucleus in living diatoms before the peri-nuclear protoplasm and the protoplasmic mass become coloured in their turn. The best mode of carrying out the operation is to place the living diatoms in a watch-glass, with a little water in it, and then to add the methylene blue solution drop by drop, which should be of the strength of one in a thousand.

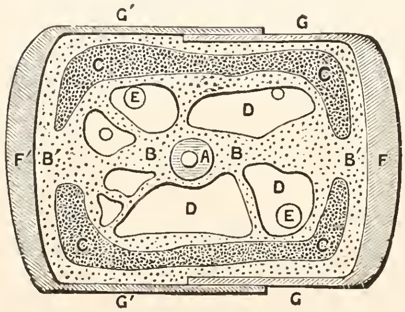

Fig. 1.

Ideal Section of a *Navicula*.

A. Nucleus and nucleole. BB. Protoplasm. B′B′. Membranous cell. CC. Endochrome. EE. Oil Globules. FF. Valves. GG, G′G′. Connecting parts. DD. Central cavity (after Mr. J. Deby).

The *protoplasmic mass* (fig. 1 BB) surrounds the nucleus; it is finely granulated and attached to the protoplasm of the cell wall, sometimes by two large bands and at other times by radiating or even anastomosed prolongations of different diameters. The liquid of the cell, enclosing the protoplasm, probably consists of almost pure water.

The cellular membrane or *primordial cell* (fig. 1 B′B′) is in contact with the inner surface of the valves. It is enclosed on all sides and of

(1) See Mr. Julien Deby's excellent paper: *Ce que c'est qu'une Diatomée* in the *Bulletins de la Société Belge de Microscopie* for the year 1877.

varying thickness, which is generally considerable at the ends of those diatoms whose axis is prolonged. The cellular membrane is transparent and, as in all vegetable cells, is formed at the expense of the primitive protoplasmic mass. It does not adhere intimately to the valves because the use of even the weakest re-agents suffices to make it contract by forcing its contents towards the centre of the frustule.

The *endochrome* (fig. 1 CC) is of a golden or brownish yellow and sometimes, but rarely, of a greenish colour, as in the case of *Navicula cuspidata*. The endochrome is arranged either in granules (as in the cylindrical and discoid forms) or else in plates, which are now sometimes called *chromatophores.*

The chromatophores do not always form continuous bands; they are occasionally jagged and perforated in a most peculiar way, and this is the case with many marine diatoms.

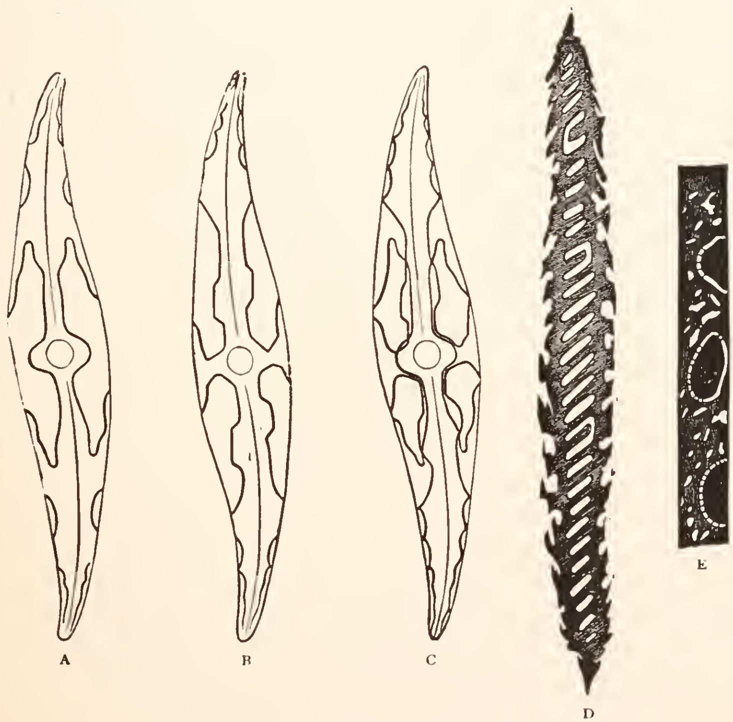

Fig. 2.

Chromatophores of Marine Diatoms.

A. Schematic figure of the portion of chromatophore resting on the superior valve of *Pl. angulatum.* B. The same of the inferior valve. C. The two parts combined, showing the appearance of the whole. D. Schematic figure of an exposed chromatophore of *Pl. Balticum.* E. Median portion of the chromatophore of *Nitzschia Sigma* (after Otto Müller).

Mr. Otto Müller, of Berlin, who has attempted to elucidate some of the most difficult points in the anatomy and physiology of diatoms, has published a very interesting note [1] on the chromatophores of *Pleurosigma angulatum* and *Balticum*, and also on those of *Nitzschia Sigma*.

In *Pleurosigma angulatum* the chromatophores consist of two comparatively narrow bands, at least twice the longitudinal diameter of the cell.

These bands are lobed and jagged but not perforated; they are placed symmetrically on each side of the cell and are applied to the cellular wall, from which they are only separated by a thin bed of protoplasm. The median portion of each chromatophore is undivided, and is applied to the superior valve (a name given by Otto Müller to the valve which contains the median portion of the chromatophore). Two pieces (together equal to the median portion) are placed separately on the inferior valve while the ends of the chromatophore which penetrate into the extremities of the valve are turned towards the connecting parts and there join the pieces proceeding from the superior and inferior valves.

The active part of the chromatophore is thus spread almost equally on each side of the surface of the protoplasm of the cell.

The median line of the chromatophores coincides, in the same way as in *Navicula*, with those of the connecting parts; but the parts which are thrown back on the valves are not placed symmetrically in relation to the plane of division. In the centre of the median part of each chromatophore, which is placed on the superior valve, on either side of the raphe there is a rounded opening giving rise to a nearly circular blank space round the raphe.

Pleurosigma Balticum also contains chromatophores, the median line of which coincides with that of the connecting parts and which spreads itself on both sides over the valves. These chromatophores are not long-folded bands, as in *Pleurosigma angulatum*, but are very jagged and perforated plates.

Pl. Hippocampus Sm. has similar plates to the last.

Otto Müller has in a similar manner investigated *Nitzschia Sigma*. In this species there is only a single chromatophore which is completely divided by the nucleus. This chromatophore is in the form of a plate, and is applied to the connecting part opposite the two keels.

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(1) Otto Müller: Die Chromatophoren mariner Bacillariaceen aus den Gattungen Pleurosigma und Nitzschia. — Vorläufige Mittheilung; Nov., 1883, in Berichte der Deutschen Botanischen Gesellschaft (1883) i. pp. 478-84; J.R.M.S. 1884, p. 274.

It contains a certain number of *pyrenoïds* (1) (five or more), which when the band is seen on the side, have the appearance of rounded elevations of lenticular form.

The endochrome, as already stated, consists of chlorophyl and phycoxanthin, and serves the same purpose in diatoms as chlorophyl in higher plants. Mr. P. Petit published in the "Brebissonia," of January, 1880, an interesting article on the chemical and spectroscopic properties of the endochrome. The result of this study can be summed up in a few lines as follows:—

The colour of the endochrome varies from pale yellow to deep brown. It loses it colour neither in cold nor boiling water, but it is completely decolourised by macerating it for a short time in cold alcohol, which latter acquires a fairly dark brownish green tint. The colouring matter of the endochrome is Diatomine. This may be split up into *phycoxanthine* the yellow, and *chlorophyl* or the green colouring element.

The proportion of these two colouring matters varies according to the species and the different tints of the endochrome. The darker the endochrome, the more chlorophyl is present. To separate the constituent elements of diatomine, Mr. P. Petit macerated diatoms in alcohol at 90°C, and diluted the product obtained with an equal volume of distilled water, so as to diminish the power of the alcohol; the solution is quite free from sediment. A quantity of chloroform, equal to one-third of the whole volume, is added to the mixture. After shaking it for a minute or two it is allowed to rest. Seven hours afterwards the separation is complete; the chloroform assimilates the green colouring element and sinks to the bottom of the flask, while the yellow colouring element, being more soluble in weak alcohol, remains in the supernatant liquid. After decanting, a second washing with chloroform is made, proceeding as before.

As a rule, the second washing is sufficient to get rid of all that remains of the green colouring element. If the supernatant liquid be not quite clear it can be rendered so by pouring into it a small quantity

(1) The words *chromatophore* and *pyrenoïd* were introduced as scientific terms by Fr. Schmitz (*Die Chromatophoren der Algen; Vergleichende Untersuchungen über Bau und Entwicklung der Chlorophyllkörper und der Analogen Farbstoffkörper der Algen*, 8vo, 180 pp., and one plate, Bonn, 1882).

According to Fr. Schmitz the term chromatophore includes chlorophyll-bodies, coloured pigments (other than green), and similar colourless bodies belonging to Algæ. Otto Müller was the first to apply this term to the endochrome of diatoms.

Pyrenoïds are inclosures (characteristic in certain groups of the algæ) of a colourless and very refractive substance, whose re-actions, especially with staining re-agents, are similar to those of the dense matter (the *chromatine* of Flemming and *nuclear substance* of Strasburger) which forms a part of the nucleus of vegetable cells.

Pyrenoïds are usually globular, and in the green algæ are frequently surrounded with starch. Chromatophores and pyrenoïds multiply by fission; sometimes, though rarely, pyrenoïds spring into existence spontaneously.

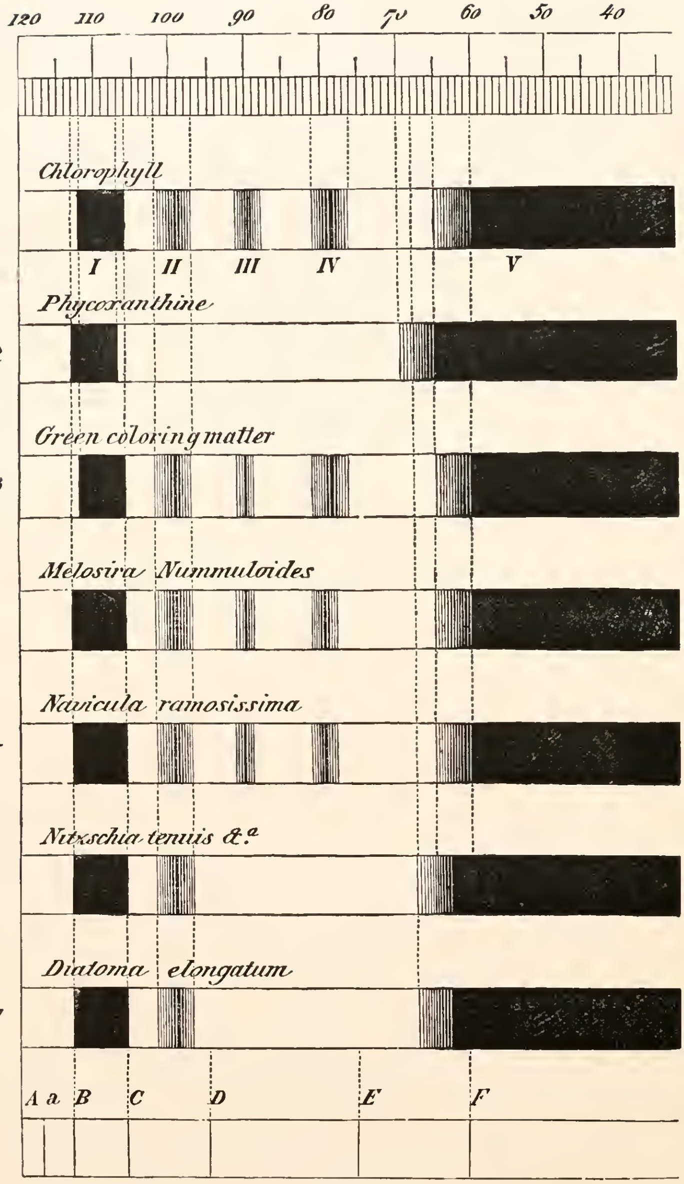

Fig. 3.

Spectra given by certain diatoms and by chlorophyl (after P. Petit. Copy Engraving belonging to R.M.S.)

1. Chlorophyl of higher plants.
2. Pxycoxanthin extracted from diatoms.
3. The green colouring matter (chlorophyl) of diatoms.

4, 5, 6, 7. Spectra of the endochrome of various diatoms.

of alcohol at 90°. Thus the two colouring elements are isolated, and it only remains to evaporate the solvents to obtain the elements in a solid state.

The plate on the preceding page represents the spectra of various kinds of endochrome which have been obtained by Mr. Petit in a pure state, compared with the spectra of chlorophyl.

Petit's researches are very important, but according to an anonymous critic, published in a note in the *English Mechanic*, they are incomplete. At the time when Petit published his work, says the critic, he was unacquainted with the long and important paper published by Sorby in 1873 on the colouring materials of the vegetable kingdom. (1)

It is shewn in Sorby's paper that certain colouring materials which had, till then, been considered simple, could be separated into many others.

Thus the phycoxanthine of Petit, which is identical with the phycoxanthine of Kraus, consists of the yellow xanthophyl of Sorby with the addition of chlorofuchsine, true fucoxanthine and lichnoxanthine, the whole being slightly stained by the presence of a little chlorophyl (which is itself a compound substance) (2) and of a very small quantity of phycoxanthine. We must refer the reader who desires to study these different substances to Sorby's paper, as this subject cannot here be exhaustively treated.

It will be sufficient for the diatom student to know that diatomine is extremely analogous to the chlorophyl of higher plants, and that like it, it decomposes the carbonic acid of the air under the influence of solar light, rejecting the oxygen, and assimilating the carbon. It is in consequence of this action that diatoms are able to perform the important function of purifying water.

The *valves* of diatoms assume every variety of shape and form ; they are, as a rule, mutually symmetrical, slightly convex on the outside and

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(1) On Comparative Vegetable Chromatology, by H. C. Sorby. Proceedings of Royal Society, N. 146, June, 1873, pp. 442-483.

(2) The green colouring matter of higher plants, according to Sorby (op. cit.), is of very complex composition and that in leaves taken from the shade differs from that in those exposed to the sun. In the leaves of *Aucuba Japonica*, for example, Sorby found what he called "blue chlorophyl," "yellow chlorophyl," "orange chlorophyl," and "mixed chlorophyl," in which latter again he detects "yellow xanthophyl" and "lichnoxanthine."

The latest researches of the French chemists, Messrs. Fremy and Arm. Gautier, have not pronounced it of so complex a composition ; Mr. Arm. Gautier has shewn that the chlorophyl is a distinct substance, crystallizing in intensely green flat needle-like crystals, which are slightly acid.

By oxidizing or deoxidising the chlorophyl a variety of derivative salts of yellow, green, red, and brown colours can be formed. When digested in warm concentrated hydrochloric acid, it divides into two substances ; the one which is insoluble in this liquid, but forming a brown solution in warm alcohol or ether, is the phylloxanthine of Fremy ; while the other, which is of a bluish green hue, has acid properties and is the phyllocyanic acid (which he formerly called phyllocyanine) of the same author.

concave on the inside. When examined with good objectives of sufficient resolving power and in media of high refractive index, all, or nearly all, appear ornamented with designs or striæ running in different directions. The best objectives, however, show that these striæ are illusory, and that in reality they are alveoles in the thickness of the valves (1), the regular arrangement of which gives the appearance of striæ.

Many diatoms show an increase in the thickness of the valves, either at the centre of figure alone, or, in addition to this, at the two extremities; this increase of thickness is called a *nodule* (fig. 4). These nodules are often connected together by a longitudinal line called a *raphe* or *median line*. When the nodule in the centre is considerably enlarged so as to spread laterally over all or part of the valve, the name of *stauros* is substituted for that of nodule.

The striæ do not always occupy the whole surface of the valve; they are very often absent near the median rib, and also round the central nodule, where their absence may give rise to the semblance of a stauros (*pseudo-stauros*).

The unstriated part of the valve is called by English diatomists the *white* or *blank space*, for which expressions Manoury has proposed to substitute that of *mesorhabde*. The mesorhabde, which is faint or absent in many diatoms, is highly developed in others, such as *Navicula cardinalis*, *lata*, &c.

In this work we have invariably used the terms *zone* or *hyaline area* when referring to this plain portion of the valve.

The surface of the valves is called the *valve* or *valvular face* or *side view* of the frustule or simply the valve; and the part of the frustule corresponding with the connecting zone is called the *frontal face*, *front*, *girdle* or *zonal view* or *principal face*.

Some authors (Rabenhorst, &c.) have reversed the terms principal face and lateral face, and we should greatly approve of their idea if it were not for the confusion which would necessarily result now that the previous terms having been used by such eminent authors as Kutzing, Smith, Gregory, Greville, &c., have been generally adopted.

It is preferable to select the expressions *valve face* and *girdle* or *zonal face*, which can leave no doubt in the reader's mind. These words which we proposed in the third edition of our work on the Microscope have been generally adopted, and we shall continue to employ them.

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(1) It was generally assumed, until recently, that the valves of diatoms were covered with hemispherical beads in relief. We shall show hereafter that these so-called beads are cells hollowed out of the thickness of the valve. We shall nevertheless continue to use the words beads, striæ, and costæ, after fixing their true meaning, as they have passed into common use, and to abandon them would introduce confusion in the descriptive part.

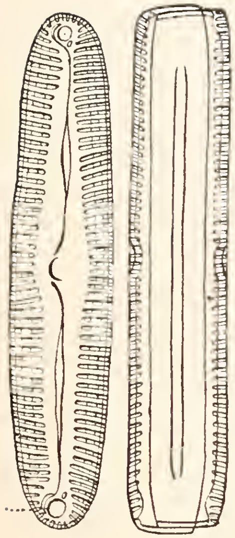

Fig. 4.
Navicula viridis.
A. Valve or valve face.
B. Girdle or zonal face.

2. Movement of Diatoms. — A large number of diatoms, especially those which have a naviculoid form, are endowed with the power of locomotion, the cause of which is not yet ascertained, and which has exercised the imagination of a large number of observers.

Of the numberless hypotheses which have been put forward to explain the motion of diatoms, that which has been advanced most frequently is the supposition of the existence of cilia; this is also the suggestion of Mr. Jacob D. Cox, of Cincinnati, one of the most learned diatomists of our age, in a small work (1) recently published by him. Mr. J. D. Cox believes that the raphe is the seat of a line of cilia, which act in the groove formed by the raphe, and which Prof. H. L. Smith declares to be a genuine cleft. The narrow line of epidermis at this spot being covered with active cilia, one can easily understand, says Mr. Cox, that the formation of silica on this line would be obstructed or hindered. Still more recently Mr. O. Bütschli, (2) Professor of Zoology at Heidelberg University, has revived the idea of a cilium or very fine flagellum, and thinks that by means of it the phenomenon under consideration can be explained. Unfortunately, up to the present no staining re-agent whatever has been discovered which will throw these filaments into relief so that their existence has never been demonstrated.

Professor H. L. Smith has for a long time studied the motion of diatoms with great care. We cite below a passage from a letter, in which this scientist describes some interesting phenomena which he was able to observe during the movement of certain diatoms.

"If a living *Pinnularia* is followed under the microscope after the field has been coloured blue by indigo, and when the valve side is in view, that is to say, with the median line turned towards the eye, small particles of indigo will be observed to move along the whole length of the median line, and then to accumulate near the centre in the form of a small ball or sphere.

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(1) Diatoms, their nutrition and locomotion, by Jacob D. Cox, in *The Microscope*, July, 1890.
(2) Mittheilung über die Bewegung der Diatomeen. Heidelberg, 1892.

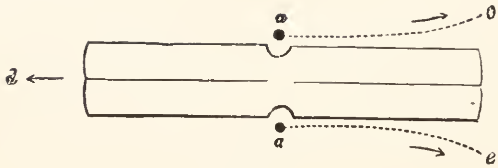

Fig. 5.

"If viewed on the girdle face (fig. 5) a ball is seen to form in the centre of each valve at *a* and *a'*, and it is remarkable that each of these small spheres spin round on its axis just as if a small jet of water was being whirled over it from a small opening situated at the central apex of the median line at the point *c* of figure 6.

"When the balls have attained a certain volume they suddenly burst, and the particles of indigo move off, following the direction of *e* and *c* (fig. 5). Immediately after the rupture of the ball, a new one commences to form in the same place. The particles follow the directions *e*, *c* (fig. 5), while the diatom itself moves in the opposite direction indicated by the arrow *d*. If the movement of the diatom be reversed, the particles of indigo follow a path opposite to that shewn in the figure. I have observed this curious phenomenon for hours together, and I can assure you that it is a glorious spectacle. I had in the field of the microscope some magnificent specimens of large *Pinnularia*, and the phenomenon showed itself very distinctly when the free movement of the frustule was arrested by a grain of sand or other obstacle. The colour used by me was an ordinary water colour, indigo blue paint, sufficient being used to make the water fairly dark. Another observation which I made at the same time established to my mind the existence of a hyaline gelatinous envelope, external to the frustule, which prevented the particles of indigo coming in contact with the silicious part. When the diatom moved, it pushed before it string of indigo particles which always remained at the same distance from the front portion of the frustule, as is indicated in figure 6 *d*, and which was pushed out of the way during the movements of the diatom.

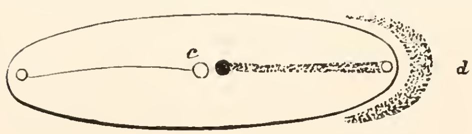

Fig. 6.

"A very slight application of red aniline (fuchsine) proved decisively the existence of this gelatinous and usually invisible envelope, for it coloured it distinctly, even before the tint had appeared in the field of the microscope. The aniline always instantly stopped all movement of the diatoms with which it came into contact."

Mr. Otto Müller also has for a long time carefully studied the movement of diatoms. We are convinced that we can give no better idea of the opinions of Mr. Müller than by translating a short resumé which our learned and skilful correspondent has been good enough to draw up for this work.

From his recent investigations on the mechanical causes of their motion Mr. Otto Müller concludes that the movements of diatoms must be regarded as produced by the resultant of motive forces which are generated on the surface of protoplasmic currents. His theory contains the mechanical basis of these movements, and clearly brings out its essential particulars in the following manner :—

Mr. O. Muller ([1]) in the first place proves the existence of a very complicated system of canaliculi and anastomosing fissures which run across the side of the valve of the largest species of *Pinnularia*, and must be regarded as designed to conduct a fluid medium from the interior towards the external side of the cell. The central and terminal nodules are sulcated by straight and curved canaliculi, which run towards the raphe and are lost in it. In addition to this Mr. Muller has shewn that the lithoplasm has a considerable internal pressure. According to him, in consequence of this pressure the living plasm starts out through the canaliculi of the central and terminal nodules, and runs into and courses down the whole length of the raphe against the external surface of the cellular wall, so as to return by the canaliculi of the terminal or central nodules into the interior of the cell. The re-action of the motive forces, at the surface of the living plasm, upon the surrounding medium is the cause of the movement of the frustules.

At the surface of the Pinnularia are seen four courses of currents (two on each valve). Each of them is independent in this sense, that of itself the current can proceed from a terminal to the central nodule or inversely, or can even momentarily stop. This gives rise to a great variety of force combinations, and consequently of directions of movements since the displacement is produced in the direction of the resultant of all the motive forces which simultaneously act in the courses of the currents. The particulars of their displacement, their backward and forward motion, their deviations from the straight line, &c., are easily explained by basing them on the preceding considerations.

As a rule, a plasmatic current starts from each side of the polar cleft of the anterior terminal nodule (the notions of back and front being derived from the direction of the movement) moves towards the central nodule and returns by the anterior opening of the central nodule into the interior of the cell. Outside of the posterior opening of the central nodule, there starts on

([1]) Otto Müller: Durchbrechungen der Zellwand in ihren Beziehungen zur Ortsbewegung der Bacillariaceen. Berichte d. Deutsch. Bot. Gesellsch, 1889, Bd. VII., pp. 169—180.

either side, a second current, which returns by the polar cleft of the posterior nodule. In this case the motive forces act in the same direction, and the cell moves forward in a direction opposite to the current.

If, on the other hand, the currents issue at the same time from the polar clefts towards the openings of the central nodule, then the motive forces equilibrate and the frustule remains stationary. In this way an explanation is given of the extraordinary movements of foreign corpuscles down the length of the raphe, which movements have been described by Max Schultze ([1]).

On the other hand O. Bütschli ([2]) and R. Lauterborn ([3]) explain the movement of the large Pinnularia (*major*, *nobilis*, *viridis*) by an abundant production of coleoderm. They placed the frustules in an emulsion of Chinese ink and observed a current of isolated corpuscles which were directed towards the central nodule down the whole length of an envelope of coleoderm. This envelope was interrupted near the central nodule, and there brought together the ink corpuscles which, as they came together, ended by forming a kind of filament which lengthened out backwards. They also assume that in this spot there is a filament of coleoderm projected, which, by its re-action against the moving water, brings it to a standstill.

Mr. Otto Müller ([4]) ([5]) confirms, it is true, these observations but rejects the conclusions they would draw from it. Often, and notwithstanding a rapid movement, the presence of a filament cannot be demonstrated, so that for this reason the movement cannot be attributed to the projection of a filament.

According to Mr. Müller, the filament is only formed by the momentary stopping of the protoplasm when animated by a backward movement in front of the aperture of the central nodule. Moreover, by introducing oxygen into his cultures those individuals which are without coleoderm can be made to move. Mr. Müller believes that the protoplasm of the three species of Pinnularia (namely, *major*, *nobilis*, *viridis*) secretes a glaireous matter, which is fairly consistent and vibratory, possessing analogous qualities to that of the jelly of the conjugatæ described by Klebs. The minute and light granules of Chinese ink do not succeed in penetrating into the glaireous bed. Conse-

(1) Max Schultze: Die Bewëgung der Diatomeen. Archit. f. Mikrosk. Anatomie Bd. 1, Sep., p. 376, taf xxiii. Bonn, 1865.

(2) O. Bütschli: Bewëgung der Diatomeen Verh. d. Natur. Hist. Med. Ver. zu Heidelberg, N.F., Bd. iv., Heft 5.

(3) Robert Lauterborn: Zur Frage nach der Ortsbewëgung der Diatomeen Berichte d. Deutsch Botan. Gesellsch (1894) Bd. xii., p. 73.

(4) Otto Müller: Die Ortsbewëgung der Bacillariaceen betreffend. Berichte d. Deutsch. Bot. Gesellsch. (1893) xi., p. 571.

(5) Otto Müller: Die Ortsbewëgung II. Berichte d. Deutsch Bot. Gesellsch (1894) xii., p. 136.

quently they are displaced the whole length of the perimeter of the protoplasmic current, which is enveloped in a glaireous bed so as finally to come together in front of the anterior opening of the central nodule. There they collect together so as to form a filament by the plasm, which is stopped from time to time, and this filament is drawn out by the plasm as it continues to ooze out.

The smaller Pinnularia and other Navicula show no signs either of a glair or filament. Nevertheless, their movement acts in the same way as in the case of the three species enumerated above. And even their anatomical structure, the system of canaliculi and fissures, as well as the arrangement of the currents which are observed in them, are in all respects identical.

Consequently one is forced to conclude that the emission of the gelatinous matter is the motive agent. Muller's theory of the mechanical causes of their motion explains the displacement of these smaller species in the same manner as that of the larger, with this unique and subsidiary difference only, that the plasm of the larger species generally secretes during its movement a glaireous matter, which is not the case with the smaller species.

3. Multiplication and Reproduction of Diatoms.—Diatoms multiply by self-division and are reproduced by conjugation.

When multiplying by self-division the nucleus commences by splitting up, and the division of the internal membrane takes place at exactly the same period that this phenomenon does in the cells of higher plants; the act of deduplication of the primordial utricle is brought about with very great rapidity. It commences to show itself at the two ends of the frustule at the points *a* and *b* (fig. 7); the membrane there forms a fold which gradually lengthens so as to reach the nucleolated mass in the centre about six minutes after the commencement of the phenomenon.

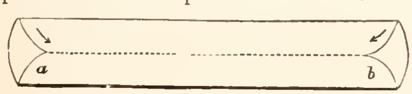

Fig. 7.
Deduplication of the primordial utricle of a *Pinnularia* (H. L. Smith).

According to Mr. Robert Lauterborn the division of the nucleus is always caryokinetic. Dr. Miquel on his part has seen in some Nitzschia the single primitive nucleus dividing into two coloured areas, each spread out like a fan, together assuming the shape of a spindle. Consequently he admits that phenomena of caryokinesis are possible in the case of diatoms.

According to Dr. Miquel the division of this primordial utricle would not be brought about in the way Professor H. L. Smith indicates, but that it only commences when the nucleus is completely deduplicated, and when the nuclei which are being formed are completely separated from one another.

While this sub-division is proceeding the connecting zone is correspondingly enlarged, and the internal membrane afterwards secretes a new silicious valve over each divided surface ; in the place of the primitive original frustule we therefore now find two frustules, each composed of a new and an old valve.

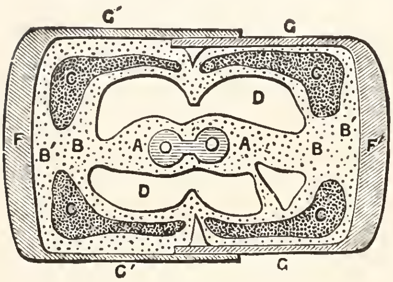

Fig. 8.

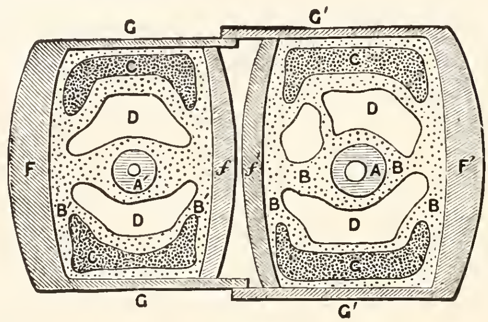

Fig. 9.

Fig. 8' Section of a diatom at the commencement of deduplication. A. Nucleus commencing to divide, showing distinct nucleoles. B. Protoplasm. B.' Primordial utricle. C. Endochrome. D. Central cavities. FF.' Valves. GG.' Connecting parts.

Fig. 9.—Section of a diatom in process of deduplication. AA.' New nucleus and nucleoles. BB.' Protoplasm. BB.', Double primordial utricles. CC. Divided endochrome. DD.' Central cavities. F.' External mother valve. F. Internal mother valve. ff.' New daughter valves. GG.' Connecting parts. (J. Deby).

"While the new valves are being formed," writes Mr. Deby, "They thicken and are covered with the markings peculiar to the species, and rapidly take the form and appearance of the external valves ; this secretion appears to take place from the centre towards the periphery (fig. 9). These new valves inside the original frustule occupy a more or less central position in it and face one another.

"We now see the diatom made up of four valves, of which two are external and old, and two internal, close together, new and attached to the entire inside circumference of the old connecting parts ; at this period the young valves are as yet without any connecting part.

"Soon afterwards, sometimes in fact before the division of the primordial utricle, it may be noticed that the connecting parts become considerably enlarged and that at the same time the interior has slid into the exterior so as to cause a greater space between the two external valves and to increase the internal cavity of the frustule. The connecting parts of the young valves are only developed later, either before or after their liberation, according to the genera and species of the diatoms. A little later, in species whose frustules are solitary, the sliding of the connecting parts attains its maximum, and the narrower frustule liberates itself entirely from the other which before was acting as a sheath to it.

"From what has just been stated it follows that in the same species of diatom, according to its stage of development, individuals may be met with possessing—

1. Two valves, a connecting part and a necleus (fig. 11) 2. Two valves, two connecting parts and a necleus (fig. 1)	early stage.
3. Two valves, two connecting parts, and two nuclei (fig. 8) 4. Four valves, two connecting parts, and two nuclei (fig. 10) 5. Four valves, four connecting parts and two nuclei (fig. 9)	More or less advanced stage of deduplication.

"The external connecting part of frustules is often caducous and detaches itself spontaneously; this is a fact which must be taken into account.

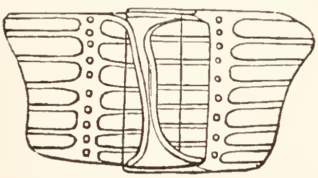

Fig. 10.

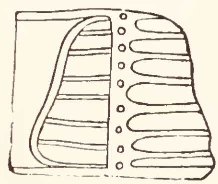

Fig. 11.

Fig. 10. Diatom (*Isthmia*) formed of four valves and two connecting parts.
Fig. 11. The same with two valves and one connecting part.

"It is well also to notice that the protoplasm of the primordial utricle generally travels into the interior of the silicious envelope both previously to the commencement of the sub-division of the utricle and again after the termination of the phenomenon, drawing along with it the endochrome; and also that the migrations of the colouring matter vary in their nature according to the genera and families of diatoms. While a diatom divides by binary sub-division, the endochrome also separates into two parts in order to apportion half of it to each of the two new utricles.

"Every diatom frustule, it will be noticed, consists of an old valve (fig. 1 F′, fig. 8 F) from the original frustule and a younger valve (fig. 1 F and fig. 8 F′) of subsequent creation, whose connecting part, when it is developed, slides in the inside of the connecting part of the old valve. It follows from this that in the large majority of diatom genera where the connecting parts are of the exact breadth of the valves and are even of smaller diameter to them, every sub-division must effect a diminution in the dimensions of the new frustule equivalent to double the thickness of the connecting part. The thickness of the latter being known, it can, even a priori, be determined what will be the size of any descendant after any given number of sub-divisions."

The above opinion expressed by Mr. Deby is that held by Diatomphiles for a long time, but it does not completely account for all the facts. If the matter is as simple as Mr. Deby has made it out to be, sexual reproduction would be very frequently observed, which, however, is not the case.

Some causes not yet known must therefore occur to retard sexual reproduction. Otto Muller has tried to investigate what are the causes of this phenomenon being so rare, and for that purpose has attentively studied a filamentous diatom, *Melosira arenaria*, Moore. As the frustules in this species remain united, it is possible to verify how the decrease in size comes about. (1) The following is the result of his researches :—

Considered singly, individual frustules (or individual cells, if preferred) which compose a filament of *Melosira arenaria*, Moore, have an unequal biological value. Beyond this fact it may be remarked that in many individuals the edge of one or both valves (to the edge of which the connecting membrane is attached) is thickened in a peculiar manner; this thickening is absent in other individuals. The *younger valve* of each frustule, up to the moment when the division commences, is without any connecting membrane, and is surrounded by the connecting membrane of the *older valve.*

The structure of the connecting membrane, differing from that of the membrane of the valve at the lateral limits of the filament, allows a certain microscopical distinction between the *free* valve (older and not covered over by a connecting zone), and the younger valve covered by the connecting zone of the older valve of the same cell. The succession, relative position and anatomical structure before mentioned of the *free valves* and covered valves enables a distinction to be made in the filament between groups of twin and triplet cells arranged in regular order.

It can be proved in the strictest manner that the cells, the enveloped valves of which have their rims thickened, are produced by their particular ancestors as *larger daughter cells*; those, on the other hand, in which this thickness is absent, are produced as *smaller daughter cells.*

As soon as the large cells and the smaller daughter cells can be distinguished with certainty, by eliminating the elements of the last formation (of the covered valves), groups of twins and triplets can be traced to their ancestor cells of the $(N-1)^{th}$ or the $(N-2)^{th}$ divisional period, and their special anatomical arrangement, and their relative situation in the filament of each period, can be depicted.

If in this manner the geneological tree of the filament be reconstructed, it is then found that the smallest daughter cells, which can be easily recognized morphologically by the absence of the thickness in the edge of the younger

(1) Otto Müller: Die Zellhaut und des Gesetz der Zelltheilungs folge von Melosira arenaria Moore. Berlin, 1883, in 8vo, with 5 plates.

valves, exactly oversteps a divisional period (generation); and in this way the duration of division is retarded.

As a result of what has preceded, the following law can be formulated :—

"The largest daughter cell divides during the $(N+1)^{th}$ consecutive divisional period; the smallest daughter cell, on the other hand, first divides during the $(N+2)^{th}$ period exactly."

This law not only requires that there should be a considerable delay in multiplication by division, but it also arrests the constant diminution of the cells in a marked manner; it follows from this that the diminution in size is not carried on simultaneously with the multiplication by division, and that this diminution is only produced in a limited degree.

For as far as the birth of *Auxospores* can be attributed to the diminution of the size of the frustules, so can the rarity of their production be explained by the phenomenon just described.

The effect of the law is comprehensive; if, for example, the diminution of size after forty-three divisions in the cells of *Melosira arenaria* is such that the production of auxospores becomes necessary, as must be admitted in the face of known facts, then it follows from the law enunciated that a *single* auxospore will be produced in the present case; while on the other hand, if the division is effected according to the generally received rule, and as enunciated above by Mr. Deby, 1,052,100,000,000 auxospores ought to have been brought into existence.

The general application of Otto Müller's law can scarcely ever be verified in solitary species, and it can only be verified in filamentous species when the smallest daughter cells of twin groups are morphologically distinguishable from the larger daughter cells, as is the case with the *Melosira* we have been considering.

In every case each species will probably follow its own peculiar law, which we shall probably never know, because the conditions under which they have to be studied are so unfavourable. For this reason then an exhaustive knowledge of the facts which prevent the too rapid diminution of size in any given species is of special importance, and Otto Muller has rendered a signal service to science in discovering and elucidating phenomena, the existence of which had not even been suspected.

One of the principal originators of Bacteriological Science, Dr. P. Miquel, Director of the Microscopical Department of the City of Paris (Montsouris Observatory), has lately turned his attention to Diatoms.

Dr. Miquel has introduced into the study of these Algæ the same methods of cultivation which he has employed with such marked success in the study of Bacteria. For the future much time will have to be devoted to these cultivations, though Dr. Miquel has also studied the return of the reduced frustule to its largest (Sporangial) form which he has been able to bring about artificially by successive special cultivations.

Dr. Miquel presented to the Academy of Sciences of Paris (24th October, 1892) a paper on this subject, which, on account of its importance, is here reproduced in its entirety :—

" It is ascertained that when a single frustule of a living diatom in a free state is propagated in a sterilised and suitably nutrient maceration the daughter cells produced from the mother cell vary greatly in size. In measuring frustules of a similar cultivation it is found that the figures which represent diatoms of the same size, are approximately related to one another as the terms of the binomial expansion $(1 + 1)^n$ in which n denotes the number of generations which have occurred.

By taking certain diatoms of medium size from a first cultivation and transferring them to a second maceration, a second cultivation is obtained in which the size of the medium cells differs in length from that of the same diatom from some tenths to several μ, according to their species. By continually producing cultivations in this way, the diatoms are made to assume very reduced dimensions, and the phenomena which accompany the re-establishment of the so-called *Sporangial* form are quickly observed. If the silicious Pheophyceæ are associated in chains of joints the filaments, as they become smaller and smaller, should be transferred into fresh sterilised macerations, and in the same way the formation of auxosporial cells is easily promoted.

" I have myself followed the re-establishment of the maximum form in Melosira and Nitzschia.

" In *Melosira nummuloides* the protoplasm of the joint which gives birth to the so-called *Sporangial* frustule increases in volume, forces back the cylindro-spherical valves which contain it, slowly abandons them, and forms on their exterior an almost spherical mass, the outer covering of which immediately silicifies. This newly-formed cell soon generates by division individuals like itself, and produces a string of joints of a diameter about double that of the cylindro-spherical generating frustule.

"The cells of *Melosira varians* when they have reached a sufficiently reduced size, also produce a large number of spheres, but these have diameters more than double the size of those of the generating frustules.

" When these large cells have reached maturity they free themselves from the filaments and are enveloped in a thick membrane, and then the vitality of the diatom is relaxed. To all appearances these spheres constitute the spores or sporanges of *Melosira varians*. Hitherto I have not been able to observe them during their evolution.

"In the case of *Cyclotella comta* the protoplasm, whilst increasing in volume, separates the two cylindrical valves fitting into one another, and oozes out on to the exterior in the form of a fairly regular discoid mass, the axis of which is perpendicular to that of the small frustule. The membrane containing the protoplasm then silicifies, and after deduplicating several times the newly formed *Cyclotella* becomes perfectly circular.

"*Nitzschia palea* is even more adapted than the preceding species for studying the re-establishment of the maximum form of diatoms.

"When the naviculoid frustules of this species have decreased in size to from 28μ to 30μ, the protoplasm which they enclose is considerably distended, especially in the neighbourhood of the nucleus; under the action of this increase of volume the valves are forced open, nearly always at one end only, and the external thalle of the diatom is rent to make way for the contents of the cell, which increases in bulk and is lengthened in the direction of the major axis of the *Nitzschia* and on both sides opposite the nucleus (fig. 12). This yellowish body from 65μ to 70μ in length, containing oil globules and possessing the endochrome plates of a Nitzschia, is very irregular in form; it has the appearance of a cylinder rounded at the ends and inflated in the centre; it may be torous, constricted, arcuate, extremely sigmoid, etc., (fig. 13) but curiously enough it is animated, and from the time of its maturity

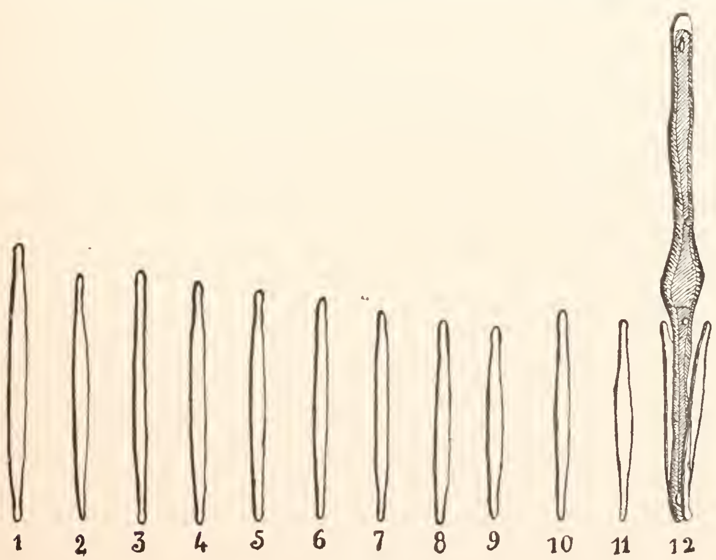

Fig. 12.

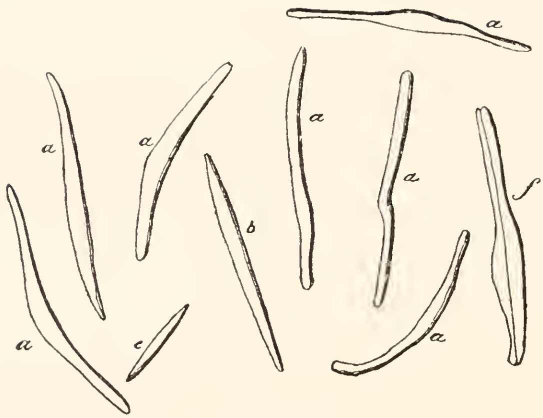

Fig. 13.

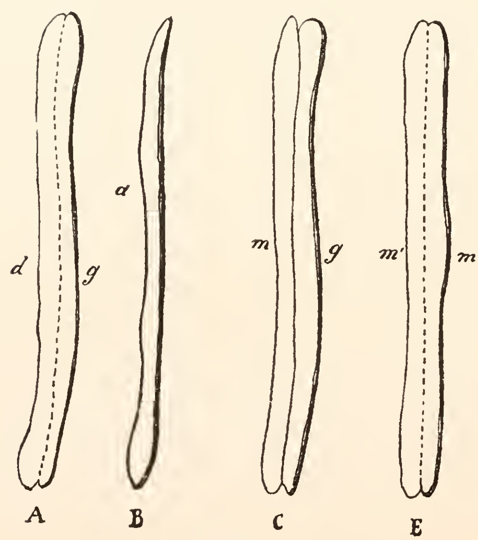

Fig. 14

it moves about in the maceration, often drawing in its train the two small valves of the diatom which has given it birth. The outside covering of these newly-born, large-sized Nitzschia is very soon charged with silica and covered with the striæ and carinate puncta which characterise this species; lastly, the form of this more or less abnormal species is determined by its forming increasingly rectilinear septa and by bipartition (fig. 14).

"In a cultivation which is 10 c.c. (2.81525 fl. drachms) in volume many millions of cells similar to those just mentioned may often be counted.

"In short, the re-establishment of the maximum form of diatoms is usually accomplished in the simplest manner; the protoplasm of each cell of smallest size swells, forces open the frustule, and escapes to the exterior enveloped in a membrane of cellulose, the presence of which may be revealed at any stage by means of reagents. Frequently the cell thus formed presents but a remote likeness to the diatom which has given birth to it; its envelope silicifies very rapidly and becomes ornamented with the designs which characterise the genus and species; and then, by subsequently dividing, the frustules of maximum size are rectified and regain their regularity and elegance.

"The phenomenon of the re-establishment of the maximum form does not appear to be preceded by any act of fecundation; nor is it usually the effect of conjugation. If certain diatoms do produce spores, auxospores or sporanges, this is not the case universally, for the establishment of their maximum form is usually effected without their undergoing this special modification of vegetable growth. But after all the microscope does not enable us easily to distinguish this glutinous or gelatinous matter in the midst of which, according to certain observers, diatoms germinate.

"The method of cultivation which I have just described gives observers the opportunity of obtaining diatoms in their re-established form at any time, and in as large a quantity as they desire, and of witnessing under the microscope the different phases which precede this re-establishment."

Thanks to the kindness of Dr. Miquel, who has been good enough to send me a 13th cultivation of *Nitzschia palea*, I have been able to examine the auxospores described, and to follow in all their phases the curious phenomenon pointed out by him.

We shall now examine the various methods of reproduction which have been described by different authors. They are four in number:—

1. The reproduction takes place in a single frustule. The diatom secretes a mass of gelatinous matter with which it surrounds itself, the valves are pushed apart, the cellular contents assume a globular form and are hardened into a *sporange*, which itself gives birth to an *auxospore*.

This auxospore is a body of variable form, and is enclosed in a silicious envelope; it continues to increase and ultimately bursts the sporange and becomes free. Shortly afterwards fresh frustules, which differ slightly from ordinary frustules (particularly in their size), are observed to come into existence in the interior of this auxospore. These frustules, which are called *sporangial*, in their turn reproduce the primitive frustule by division.

As regards this method of reproduction it is evident that authors have have either inaccurately observed or described their observations. What has been described as a method of reproduction is nothing more or less than the return to the primitive form as observed and described by Dr. Miquel.

"I have never seen," writes this skilled observer ([1]) "the gelatinous matter produced, nor the protoplasm form the spore any more than I have seen the protoplasm escape *naked* from the valves; on the contrary I have always seen the protoplasm surrounded by an extremely thick and resisting membrane." In the following words he sums up in all its simplicity the phenomenon of the re-establishment of the form of diatoms as follows: —

"*The contents of the micro-frustule hardens, and is surrounded by a strong membrane; then without other visible phenomena this quasi-spore germinates and produces what is nothing less than the diatom of re-established form.*"

Professor H. L. Smith has on his part observed the return to the sporongial form in *Cymbella cuspidata*, and describes and figures it ([2]) exactly as Dr. Miquel has done *Nitzschia palea*.

2. Two different frustules approach one another and pour out their cellular contents; from this mixture is borne a single sporonge, which gives rise to the production of a sporongial frustule.

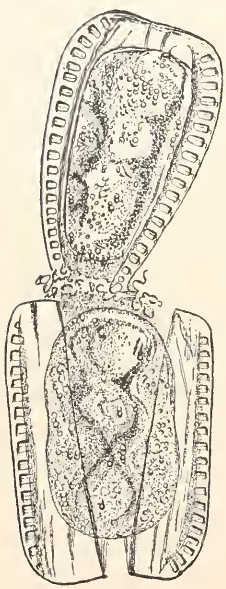

Fig. 15.

Professor H. L. Smith has personally observed this method of reproduction in *Surirella splendida*. The union takes place at the narrow extremities of the two frustules, the cellular contents mix and soon there remains only an enormous sporange, which the free valves of the two original frustules enclose.

The Rev. Wm. Smith has described something analogous in *Himantidium*, but a careful examination of his plates shows that what he has seen is in reality merely the rejuvenescence or return to the maximum form without fecundation.

3. In the third method the conjugation of two frustules results in the production of two sporanges, of two auxospores, and of two sporangial frustules (fig. 16).

This is the most frequent and best known method of reproduction. It has been most carefully observed by a large number of diatomists: W. Smith, Pfitzer, H. L. Smith, Ad. Schmidt and myself, &c.

It has been observed in Epithemia, Cocconema, Gomphonema, Encyonema, Colletonema, Navicula, &c.

([1]) Le Diatomiste (1894) ii., p. 95.

([2]) Proceedings of Amer. Soc. of Microscopists, 1887.

4. Lastly the Rev. Wm. Smith has described a fourth method of reproduction, in which a single frustule gives birth to two sporanges. This phenomenon has been recorded in Achnanthes and Rhabdonema, but as it has never been since observed it is thought that it must have been an error in observation on the part of the illustrious English diatomist.

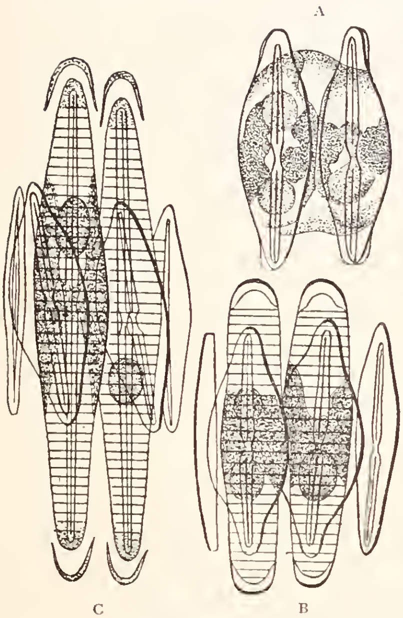

Fig. 16.

Fig. 16 Reproduction of *Van Heurckia rhomboides Breb.*

A. Two mother cells fusing their protoplasmic contents in order to form two sporanges.

B. Two auxospores larger than the four empty valves, between which they are formed, arrived at their complete development and at the point where the terminal hoods detach themselves to enable the sporangial frustules to pass.

C. Sporangial frustules arrived at their complete development and still covered with the hoods which they have drawn along on leaving the auxospores.

To sum up it seems probable that diatoms most frequently return to the sporangial form by an act of rejuvenescence without actual reproduction, but that when it really does take place it is produced by the union of two frustules, which give birth sometimes to a single sporange, but generally to two sporanges.

We shall here draw attention to a very remarkable idea ventilated by Dr. Ad. Schmidt. "I observed," said he, "in 1871 the regeneration of *Gomphonema mustella Ehr* in thousands of cases, and what I have just said has not been invalidated by a single exception. When these Gomphonema reproduce they have their stipes, and unite with their venters turned towards each other, but in an inverted position, that is to say, so that the anterior apex of one frustule rests against the posterior apex of the other." "This fact," he concluded, "in my opinion disposes of the vegetable nature of diatoms." (! ?)

In concluding this section it may be noticed that, according to Kitton (1) and Professor Samuel Lockwood, (2) diatoms may possess microspores so small that they can pass through filter papers. Lockwood appears to

(1) Kitton: On the Mysterious Appearance of a Diatom, J.Q.M.C., Ser. II., Vol. II. (1885), pp. 178-9; 206. J.R.M.S (1885), p. 1,041.

(2) Lockwood, Prof. Samuel: Raising Diatoms in the Laboratory. Journal New York Mic. Soc. (1886) II., p. 153, two plates; J.R.M.S. (1887), p. 626.

have undertaken his experiments with the most minute precautions, and the curious nature of the results which he has obtained render it advisable that diatomists should make fresh researches in this direction, more especially as Dr. Miquel asserts that his own experiments are not in accordance with Messrs. Lockwood and Kitton's opinions.

§ 2. Study of Diatoms.

In my treatise on the microscope [1] I have given all the necessary information about that instrument from the point of view of general microscopy. For any details which do not specially concern diatoms reference should be made to that work, and so I shall only give a few notes here specially intended to assist diatomists.

Workroom.—The diatomist's workroom should not be very large; the essential is that it should, as far as possible, be free from dust; it will therefore be well not to encumber it with furniture or books in open shelves, but to furnish it with glazed cases, where books, instruments, and preparations may be kept.

The study of diatoms sometimes requires the use of sunlight, and in that case the room should be facing east or west. Professor Harting recommends a southern situation. Although some authors condemn the latter direction, we have found it excellent, and use it almost exclusively, although we have windows with other aspects.

The principal furniture of the workroom is the table. It should be heavy, massive, and of such a height as to render it possible to work conveniently when standing up. An easy position can be assumed with a high chair, but this should only be used exceptionally.

In addition to the workroom, the diatomist should have a room or kind of laboratory where he can do all his dirty work, such as cleaning diatoms, boiling in acids (which latter is best effected in a glass stink-chamber, such as are used in chemical laboratories), developing photographic plates, &c.

Artificial Illumination.—In our climate the diatomist is frequently compelled to employ artificial light. Nothing surpasses incandescent electric light [2] which can be obtained at the present day in sufficient quantity for microscopical research without much trouble and at small cost. In

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(1) The Microscope: its Construction and Management, by Dr. Henri Van Heurck. English edition, translated by Wynne E. Baxter. London: Crosby Lockwood and Son, 1893.

(2) See H. Van Heurck—L'Eclairage electrique appliqué aux recherches de la micrographie, 2nd Edition in Pelletan's Journal de Micrographie; Van Heurck's Microscope English Edition, pp. 109-117.

default of this, a mineral oil lamp can be used. An excellent little lamp of this kind is supplied by Messrs. Watson and Sons for 16s.

Instruments.—Microscope.—Excellent instruments are made in England, Germany, France, and the United States; but all these instruments are not equally convenient for diatom work. An instrument will not be suitable unless it is furnished with an excellent condenser, enabling us to change from axial to ultra-oblique illumination instantly and without difficulty. We know of two condensers which perfectly fulfil these conditions, viz., Abbe's condenser and Powell and Lealand's *oil condenser.* The first of these apparatus is in more general use than the second, and satisfies all the requirements of the microscopist; the second, made specially for examining diatoms, enables the diatomist to work more rapidly and with greater exactness; the light having previously been arranged a lever has only to be pressed in order to change immediately from axial to any degree of oblique illumination. For some years Powell and Lealand have constructed an optical system, the lower lens of which has the middle part stopped, and the whole can be substituted for the ordinary optical system. It is used to obtain extreme obliquity, and is useful, for instance, for resolving the longitudinal striæ of an *Amphipleura.*

Achromatic condensers, especially for photo-micrography, are to be preferred to those that are not achromatised. Of achromatic condensers Powell and Lealand's *apochromatic oil condenser* is the best for resolving diatoms, on account of the largeness of its aperture, which is nearly as much as 1.4 N.A. The microscope of a diatomist who wishes to exhaustively investigate the organisms which form the subject of this work should be a first-class one; it should be quite firm and its coarse and fine adjustments as perfect as possible.

A sliding movement, used as a coarse adjustment, would prevent the correct centering of the condenser to be maintained; the adjustment must therefore be effected with a rack and pinion.

It is an advantage for the stage of the microscope to be fitted with a mechanical stage, by which diatoms can be easily found again and the entire preparation easily examined with the certainty that nothing has been lost sight of.

The large and medium sized microscopes of Zeiss are excellent, when furnished with Abbe condensers; but we always prefer to use the large English forms made by Ross and Powell and Lealand. The Van Heurck microscope, which is constructed by Messrs. Watson and Sons according to our specifications, realizes all that a diatomist can desire, for both the purposes of observation and photo-micrography. It is constructed

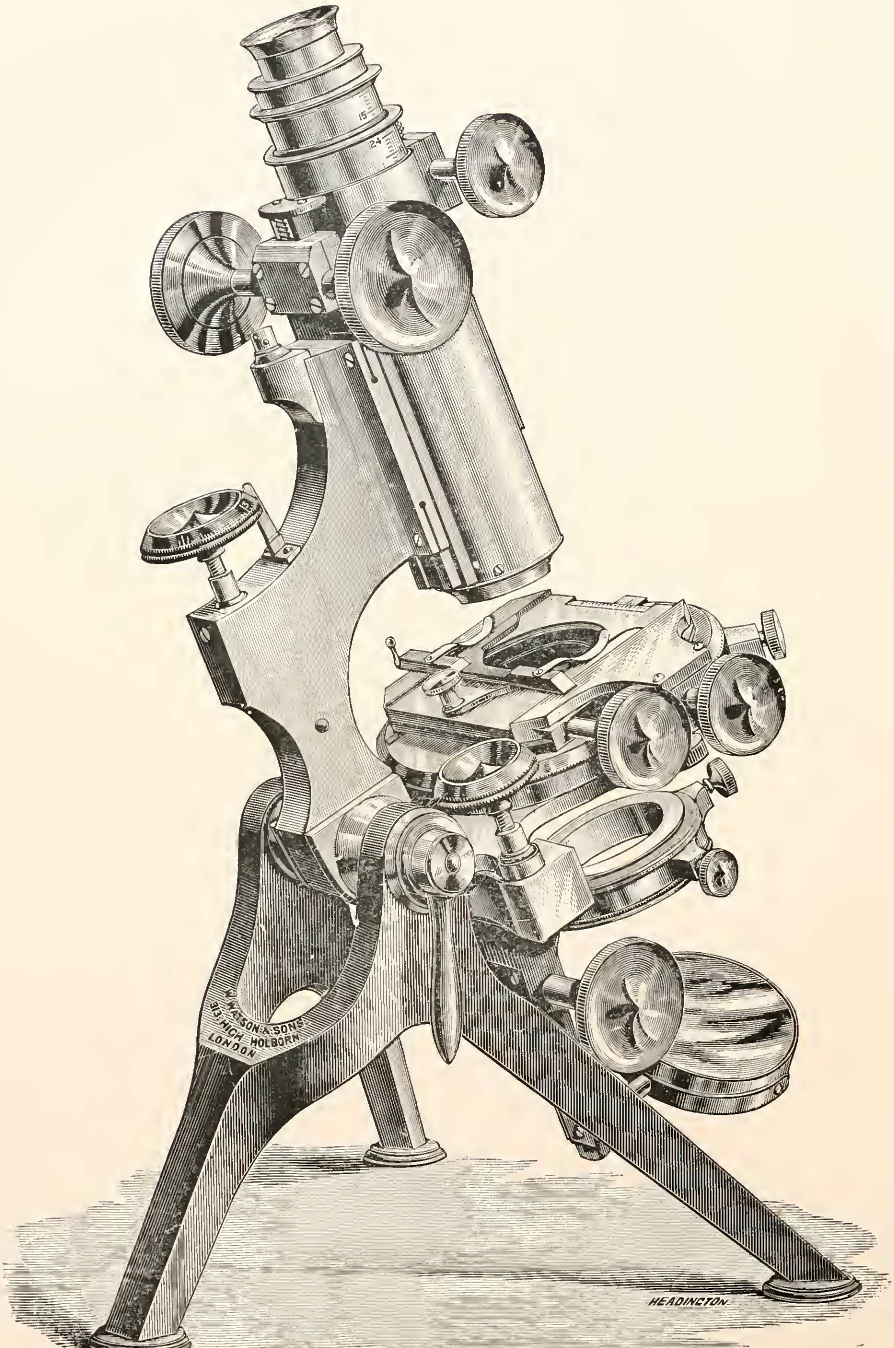

Fig. 17.—The Van Heurck Microscope.

either with the continental foot or a tripod; the former is more adapted for photographing difficult objects in a nearly vertical position, the latter is more suitable and stable in the inclined position in which finished preparations have to be examined.

The stereoscopic binocular microscope, almost unknown on the continent and so important in histological research, is not indispensable for observing diatoms. With high powers the *Wenham Prism* and *High-power Prism* are of no use, so also Abbe's stereoscopic apparatus, though fine detail can still be seen with high-power objectives, fails nevertheless to give a sharp image, which thus renders details less visible than with a monocular microscope.

The ordinary binocular, giving a moderate magnification (*i.e.*, 200 diameters at least), is however remarkably useful for resolving the often complicated structure of Crypto-raphideæ, and I venture to assert that it is impossible to form so good an idea of a diatom as when it is observed through a binocular microscope.

The objectives which a diatomist requires are not numerous. Every difficulty can be met with four objectives of graduated power. In order to avoid any loss of time it is best that these objectives should be attached to a well-constructed nose-piece permanently fitted to the microscope. However the piece of apparatus invented by Dr. R. Zeiss called a "Sliding objective changer," is even preferable, because it enables each separate objective to be perfectly centered.

The objectives which I now use for ordinary research are all apochromatic. They are the 8mm. (1-3rd inch), 3mm. dry (1-8th inch), and 2·5mm. (1-10th inch) N.A. 1.25 water immersion. When they are insufficient, *e.g.*, for observing certain minute details, I have recourse to the 3·0 or 2·0 mm. (1-8th or 1-12th inch) homogeneous. But these cases are rare, for they never occur when making *ordinary* observations for determining species, but only when elucidating structure, when all the resources of optics have to be utilised, and even Zeiss' famous objective of N.A. 1·6 is by no means too much. Nine-tenths of the observations for determining species can be made with an 8mm. objective in combination with a series of compensating eye-pieces, particularly No. 8 and 18. We consider that this objective is the best that modern optics have produced for all kinds of ordinary work. An experienced eye can easily, with its aid, detect the bacillus tuberculosis.

My work on the Microscope ([1]) affords all necessary information on the subject.

([1]) English Edition, London, 1893, pp. 101-102, 44-57, etc.

Accessory Apparatus.—There is little that need be said about accessory apparatus, as it is such as is generally employed by microscopists. A heliostat is sometimes useful for observation in monochromatic light and for photo-micrography. Reference will hereafter be made to the camera lucida and also to microscopical preparations.

§ 3. Drawing and Determining the Species of Diatoms.

A careful determination of any diatom is impossible without previously making a good drawing of it. It is only by comparing this drawing with those published by various authors that any given form can be studied. The diatomist therefore ought to have at all times the camera lucida ready at his side. I have tried every apparatus of this kind, but for working with ease I know of none which can compare with the camera lucida for an inclined microscope as constructed some years ago by Mr. A. Nachet (1). This apparatus resolves the most delicate details without any part becoming deformed, but the plane of the paper on which the drawing is made should be parallel to the surface of the prism to which the eye is applied. In drawing diatoms, hard pencils (such as Gilbert's No. 5) should be used, and they should be very finely pointed, otherwise it would be quite impossible to represent very close striæ sufficiently near to one another without confusion.

It is essential that all drawings should be of the same magnification, which should be sufficiently large to reproduce delicate details. All the drawings in the Atlas to my *Synopsis des Diatomées de Belgique* were drawn to 900 diameters and reduced by photography to 600. This magnification was not chosen at random. I fixed upon it in order that my drawings should bear comparison with those of previous good authors, such as William Smith, Greville, Gregory, &c., whose figures were made at 400 diameters; mine are therefore half as large again as the figures of W. Smith and the other authors previously mentioned.

It is to be regretted that Dr. Adolph Schmidt has used so arbitrary a magnification as 660 for his Diatom Atlas.

In the present state of the science a magnification of 400 diameters is no longer sufficient for an original drawing, and as far as possible all drawings should be 900 diameters, while certain details even require double that amplification.

In the present work the drawings of Genera have been made at 900 diameters, and wherever possible have been reduced to 600. With regard

(1) The Microscope: English Edition, London, 1893, pp. 92-93.

to the drawing of Species the original designs have in the same way been made at 900 diameters, and have been reduced by phototype to 400 diameters in order to diminish the expense and so render the work available for a very large number of observers. The figures of this work will therefore often be improved by the use of a magnifying glass.

§ 4. Collecting Diatoms.

A.—Collecting Inland.

Diatoms are to be found distributed everywhere; whatever water-course may be explored our researches are almost certain to be rewarded; the smallest ditch, the smallest pool, provided the water is not stagnant, contains diatoms in greater or less numbers. Moreover they accumulate in prodigious manner. It is by reason of this fact that at different times I have found the bottom of the immense harbour basin of Blankenberge entirely covered over with a thick deposit of diatoms, principally consisting of *Pleurosigma*.

When starting in search of diatoms, certain necessary collecting instruments and appropriate vessels to contain the gatherings must naturally be got ready. The following is a list of the articles which a diatomist may take with advantage on his excursions :—

The principal article is a leather bag fitted with a strap; this is carried over the shoulder and under the arm. The bag should contain a sufficient number of pockets to carry a dozen wide necked bottles of say 2oz. capacity, a smaller leather case containing six large phials with wide necks, holding about 1 oz. a piece, each phial fitting into a pocket; in the country this case is carried in the pocket of the overcoat.

Next comes a box containing some small tubes and a camel's hair pencil for painting off pure gatherings, or avoiding the inconvenience of bringing home a larger quantity of material.

In addition to the bottles and the tubes, some pieces of gutta-percha paper or waterproof macintosh cloth, nine inches square, are very useful to wrap up algæ, masses of confervæ, and other diatom-yielding plants; these are made up into bundles, after slightly pressing out part of the water. These bundles are kept from unfolding by an elastic ring, and are put at once into the bag. For scraping the surface of mud, such as alluvia, the sides of jetties, &c., the writer uses a copper spoon with a screw clamp to fasten to the end of a walking-stick when used. On one side of the neck of the spoon is rivetted a small knife blade, which forms a convenient means of cutting away portions of aquatic plants covered with diatoms and lifting them out of the water.

The only lens necessary to a diatomist when out collecting is a Coddington, but the writer has found a small compound hand microscope very useful occasionally. This, with some slips of glass, are carried in a separate compartment in the leather sachel.

For some time past we have used with advantage a small pocket microscope, sold by E. Thum, of Leipzig, and which he has named an *Algensucher*.

This instrument is in the form of a tube, 5 or 6 centimetres (2 inches) in length by 3 centimetres broad. This tube carries at the upper end the magnifying apparatus, which consists of a doublet, under which can be placed two glass slips sliding in a groove and held in position by a spiral spring. The diatoms are placed on one of the slips and can be covered over by the other.

This little apparatus, which is very convenient, can be furnished with interchangeable doublets, so as to give different magnifications varying from 50 to 200 diameters.

Now that we are equipped and ready to start, the question arises, where shall we go in search of diatoms?

In 1872 there was published in the *Lens* of Chicago (1) an article copied from the *Intellectual Observer*, (2) entitled "Where to search for Diatoms."

This article gives very valuable information to the young diatomist, and we believe that we cannot do better than reproduce the greater part of it:—

"A knowledge of the most likely places to look for Diatomaceæ is only to be gained after some experience, and it is the wish of the writer to give the result of his experience in the matter, which has induced him to pen these lines. In mentioning the various species of Diatomaceæ in connection with given habitats and localities, it may be as well to say that the writer has, in most cases, found the species named in such localities; not necessarily in one particular district, but at various times and in different parts of the country.

"We will now suppose the collectors are commencing their imaginary collecting tour, and, before leaving the town, let us take a stroll round the docks, for here we may meet with material in places where such might be the least expected. For instance, let us examine the logs of Baltic or American timber as they come from the vessels. If the

(1) The Lens (1872), i., pp. 106-116.

(2) Intellectual Observer (1872), i., pp. 190-199.

timber has remained for any length of time afloat before shipping, the logs are almost sure to have traces of Confervæ, either fresh water or marine, growing on them, and these, on being carefully scraped off, will, in all probability, yield diatoms to reward the collector. Some of the logs from the St. Lawrence or the Ottawa will yield us American forms, while logs from Dantzig will give us interesting gatherings from the Vistula and the interior of Poland.

"Should a vessel be unloading "Kaurie spars" from New Zealand, or some of those gigantic "sticks" which have lately been imported from Vancouver's Island, we may probably be rewarded by finding beautiful Antipodean forms of Diatomaceæ on the former, and the exquisite *Arachnoidiscus* or *Triceratium Wilkesii* from the latter—perhaps even *Aulacodiscus Oregonus*.

"Let us not go past these mahogany logs landing from Mexico or Honduras, as the case may be, without casting an eye over them, for these may have been rafted for some time in the sea before shipment, or may have brought down new or little known forms from the interior of Central America. Here, on the first log we examine, is a copious incrustation of a form either identical with or closely allied to *Melosira nummuloides*, abundant likewise in our docks. The gathering is so copious that it fairly glistens in the sun.

"Let us also scrape away some of the shelly incrustation of *Balanus*, which completely covers some of the logs, for possibly among this we may find that exquisite American form *Terpsinoë musica*, so called, I suppose, from the costæ appearing like so many musical notes.

"Here are some fishermen just coming in. Let us examine their nets, for these men are trawlers, and have been fishing in deep water, and the meshes of their nets may still have diatom-bearing Algæ attached to them. On such Algæ we may probably find *Rhabdonema arcuatum* or *Adriaticum*, *Grammatophora serpentina* and *marina*, with species of parasitic *Synedras;* possibly the singular *Synedra undulata* may reward our search.

"Some of the oyster shells from deep water are worth examining for marine Algæ, or, what is even better, the greenish, leathery-looking ascidians attached to them. The ascidians are regular feeders on diatoms, and their stomach contents often yield a rich harvest of deep-water forms difficult to obtain in any other way. Perhaps we may be securing the rare *Biddulphia regina*, at any rate *Biddulphia Baileyii* and *aurita*. We will take some for future examination, for the curious *Rhizosolenia styliformis* is almost sure to be there.

"Let us step into a boat and examine that ship's bottom and sides, which look so brown with a growth of conferva and barnacles. Here the spoon becomes of use. Scrape very gently where the deposit is the darkest in color, and let us see what we have got—*Achnanthes longipes* and *brevipes* in abundance. These are common enough elsewhere in the timber ponds, so we will only secure the little thing in zigzag filaments, for this is probably *Diatoma hyalinum*, or, perhaps, the rare *Hyalosira delicatula.*

"Is it not singular that such delicate filaments, hanging together by the angles of the frustules, should be able to withstand the rushing of the vessel through the water during the long voyage she has just completed?

"The ballast-heap must not be passed without examining. Here are stones densely covered with marine Algæ and Corallines, which we will scrape off and store away for after-examination. *Biddulphia pulchella*, *Amphitetras*, *Grammatophora serpentina*, or possibly some of the beautiful foreign species of *Aulacodiscus*, may reward our trouble, for this ballast is brought from all parts of the world. The only matter of regret is the difficulty in ascertaining the exact localities.

"Let us now take some of the *Zostera* which is being landed on the quay in large bales; it is extensively imported from the Baltic as *Ulva marina*, for stuffing chairs and mattresses. *Cocconeis scutellum* and *diaphana*, with *Epithemia* and a medley of other forms, are generally found parasitic on the *Zostera*, and may be easily separated by maceration in weak acid.

"But what are those brown bundles landing from the steamer? These are "Dutch rushes," for coopers' purposes and chair-bottoms, and are well worth examining, for, growing as they do in brackish water in Holland, the sheath at the base is often completely coated with diatoms, *Coscinodiscus subtilis*, for instance, with other good things, such as *Eupodiscus argus* and *Triceratium favus.*

"Nor must we pass these cargoes of bones discharging into lighters. See, some of the larger bones have evidently been lying in the water some time, for they are covered with a green incrustation. Let us scrape away the incrustation, for we may find among it the fine *Synedra crystallina* or *undulata*, together with valves of *Coscinodiscus* and *Eupodiscus.* Many good gatherings have been procured from this source, especially from cargoes coming from Constantinople, Smyrna, and the Black Sea.

"Ask this sailor if he has any foreign shells still in the rough state; if he has any for sale, they are certainly worth securing for the small

Algæ and Corallines found growing on them. These, on being cleaned, often yield splendid results. Many of the most beautiful and rare species of *Campylodiscus* have been obtained from this source. The Californian *Haliotus* shell is almost certain to yield the fine *Aulacodiscus Oregonus*, *Arachnoidiscus*, *Hyalodiscus cervinus*, and *Biddulphia Roperi*; while the *Haliotus* from New Zealand will probably furnish the rare *Aulacodiscus Beeveriæ* and *Macraeanus*.

"The West Indian *Strombus* shells invariably yield beautiful forms, such as *Campylodiscus ecclesianus*, *ambiguus* and *imperialis*.

"Vessels with guano are worth visiting. The Peruvian guano, when properly prepared, yields the magnificent *Asterolampras* and *Aulacodiscus scaber;* while the Bolivian is even richer in fine things, such as the superb *Aulacodiscus formosus* and *Comberi*. Californian guano yields, among an infinite variety of forms, many of great beauty and rarity, such as *Aulacodiscus margaritaceus* and *Biddulphia Tuomeyii*. Algoa Bay is frequently rich in *Aulacodiscus Petersii*; and finally, the Ichaboe guano, *Eupodiscus Ehrenbergii*, and other good things.

"The old mooring anchors and cables, which are now lying on the quay, are covered with a marine incrustation, which, on examination, will be found deserving of notice.

"We will now take a stroll towards the timber ponds, where the timber often remains afloat for years. Here we see ample traces of the objects of our search. The sides of the logs seem quite covered with a tangled mass of the filamentous forms ; but before we bottle up any of them, let us collect with the spoon some of the brown pellicle which covers the surface of the water. This proves to be a very pure gathering of *Amphiprora constricta*. Then let us collect some of the green *Ulva* and *Enteromorpha*, growing on the sides of the timber, which seems so brown and furry. With the Coddington lens we find the brown tint is owing to a dense parasitic growth of *Achnanthes longipes* and *brevipes*. The long brown filaments are principally *Melosira nummuloides* and *Borrerii*, with *Schizonema crucigerum* and *Dillwynii*, mixed with *Bacillaria paradoxa*, shooting into long filaments, then suddenly retreating until the filament is closed again, one frustule sliding past the other in a most marvellous manner. By the way, this species will live, and even thrive, quite well in perfectly fresh water. Mixed with the *Bacillaria*, we find *Nitzschia Sigma*, and other free forms.

"The wooden piers running out into the river are brown, with a covering of *Homœocladia sigmoidia*, *Pinnularia Johnsonii*, and *Navicula* *ellipsis*. On another wooden breakwater we find *Pleurosigma scalprum* and *Navicula mutica*.

"Leaving the immediate vicinity of the docks, we come to a maze of ditches, to which the salt water has access during spring tides, and these ditches are often very rich in Diatomaceæ. Let us commence operations here by collecting this brown covering from the mud. Here we have *Pleurosigma angulatum*, *fasciola*, *Strigilis*, *Hippocampus*, *Nitzschia sigma*, and *Surirella gemma*. Such gatherings may afterwards be entirely cleaned from the mud by covering the outside of the bottle with black cloth, and letting it stand for some days in the sun. The diatoms by this time will have worked themselves to the surface, and the thick brown layer will be found quite free from impurities. This plan, if carefully carried out, rarely fails. The brown floating scum must by no means be neglected, for on bottling some we find we have secured a good gathering of *Pleurosigma fasciola*, *macrum*, and *delicatulum*, with, perhaps, *Navicula ambigua*, and other good things.

"Proceeding to another ditch, we will take a dip from the mass of brownish stuff which coats the weeds. Well, here indeed is a capital haul, for we have *Nitschia bilobata*, *Brebissonii*, *vivax*, with *Tryblionella gracilis*, *Navicula amphisbæna*, *Pinnularia peregrina*, and *Cyprinus*.

"Further on we pull out some of the weeds which are covered with brown furriness, and we have a gathering of *Synedra fulgens* and *Amphipleura Danica*; while on the mud we obtain a copious one of *Stauroneis salina*, *Nitzschia dubia* β, with *Navicula minutula*.

"But what can this brown hairlike mass be, growing parasitically on the reeds and floating pieces of stick? On examination it will prove to be pure *Melosira Borrerii*, which we will bottle up with great satisfaction.

"Further on we come to a large lagoon, and find therein some plants very promising in appearance, and well worth gathering. These yield us afterwards a fine mass of *Amphiprora alata* and *paludosa*, *Pleurosigma strigilis*, *Amphora salina* with *Surirella Brightwellii*.

"Mind how you step over this boggy ground, with the ink-black mud, smelling so unpleasantly of sulphuretted hydrogen. In spite of the smell, we shall probably get something to reward us. Collect carefully the brown covering from the mud, and you may find *Navicula elegans*, *tumens*, *Nitzschia dubia*, *Epithemia musculus*, *Amphora affinis*, with *Pinnularia Cyprinus* and *peregrina*.

"We now approach the banks of a canal, into which the brackish water sometimes gains access. Let us hook out some of the

Potamogeton and other weeds. Well done! we have here something that will reward us for our fatigue. Examine it with the Coddington; the circular discs are valves of the rare *Cyclotella punctata.* Mixed with these we find *Campylodiscus cribrosus*, *Bacillaria paradoxa*, with a host of other both fresh and salt-water forms.

"With the tweezers let us now carefully pull off some of the brown tufts growing on the clay banks of the river. This looks like some stunted Conferva. On examination with the lens, the filaments are found crowded with rows of little sigmoid things, for all the world like miniature specimens of *Pleurosigma Balticum.* This is a prize again, being no other than the rare *Colletonema eximium.*

"Leaving this locality, let us proceed a few miles down the river towards its embouchure, and where the water is salter. Being low tide, we see for miles the mud is colored of a dark chocolate-brown tint, owing to the presence of millions of *Navicula Jennerii.* In the large lagoon formed by the salt water getting over the embankment during spring tides, we shall probably find an abundance of good things; among these many of the filamentous *Schizonemas*, *Rhipidiphoras*, and *Podosphenias*, and even *Licmophora flabellata.* Proceeding even further down the river, the mud gradually disappears, sand takes its place, and afterwards we come to the open sea where the coast is in places guarded by rocks. Here is a fine field for the purely marine forms. Let us gather some of the wiry green tufts of *Cladophora rupestris*, one of the best of the diatom-bearing Algæ. The tips of the *Cladophora* are quite brown with a parasitic growth of *Grammatophora marina* and *macilenta*, together with *Rhabdonema arcuatum*, *Cocconeis scutellum*, and *Gomphonema marina.* On the other Algæ, growing among the rocks, we find masses of *Podosphenia*, and perhaps the easily-overlooked *Hyalosira delicatula.* The brown hairlike mass floating about, but attached to the stones, is *Fragilaria striatula*, and some of the filamentous *Schizonemas.*

"In the rocky pools left by the tide are some masses of *Coralina officinalis*, growing in dense tufts. This Alga is an excellent diatom-trap, collecting the floating frustules among its tangled branches. We must, therefore, select a good stock of the Coralline, lifting it out of the water with as little violence as possible, for fear of washing off the diatoms.

"Washing afterwards in acidulated water will liberate the frustules, and then we have probably a fine gathering of the beautiful *Eupodiscus Ralfsii*, with *Eupodiscus subtilis;* perhaps also *Amphiprora lepidoptera*, and other good forms.

"The sand in sheltered places, you will observe, is brown in the hollows of the ripple-marks. This is caused by millions of diatomaceous frustules, and we must by all means take home a good store of the brown sand, which by washing easily yields up its riches.

"Having spent so much time on the marine and brackish-water gatherings, let us turn inland and proceed where the tide ceases to have any influence. To make sure of this, we will take the rails and go to the rocky hills some ten miles distant. Having arrived there, let us examine, in the first place, this rocky streamlet, for I see traces of a brownish covering on the stones, and also some pretty long streamers. Lift the filaments out gently, or you will get little into the bottle. On examination at home you will probably detect *Odontidium mesodon*, *Himantidium undulatum* and *Arcus*, with *Tabellaria fenestrata* and *flocculosa*.

"Proceeding a little further, we come to a little water-fall trickling down the surface of the rock and gradually finding its way to the stream. The brown, velvety covering on the stones looks very promising for our purpose, and, if I mistake not, we shall be well rewarded for our trouble in carefully collecting a bottleful of the material, for we have a good gathering of the beautiful *Gomphonema geminatum* and *ventricosum* mixed with the minute *Acnanthidium lineare*. The brown mass completely covering the stones in the bed of the stream is *Cocconema lanceolatum*, not often found so pure.

"Let us see what causes the green colour on the surface of the mud in the roadside puddle. Ah, this is indeed a treasure! for it is seldom that *Navicula cuspidata* occurs as perfectly free from mixtures. The green colour is also remarkable, being so different from the usual brown endochrome of most diatoms.

"Here is another roadside puddle left by the recent rain; and see what a brown coating has grown at the bottom in so short a time. At any rate, we have here *Diatomaceæ* in abundance, though small in size, probably *Nitzschia palea* and *Pinnularia pygmæa*.

"Proceeding further inland, we are supposed to be passing a water-mill; and, as the mill-race is covered with confervoid growths, let us examine some of the coating from the wooden aqueduct. The brown streamers are in all probability *Diatoma vulgare* and *elongatum*, and the beautiful stellate form is the local *Asterionella formosa*, which, by the way, seems to select its habitat always in some out-of-the-way place, such as the present one in the mill aqueduct, water tanks and reservoirs.

"Having climbed up some distance on the hillsides, let us collect some of the weeds from the sides of the boggy pool, for in such localities we may expect to find some of the rarer alpine forms, *Navicula rhomboides*, *obtusa*, *Pinnularia divergens*, *lata*, and *Alpina*, for instance. The pale-green flocculent mass growing in quantities like a conferva is well worth collecting, for it is a pure gathering of *Tabellaria flocculosa* and *Jenestrata.*

"In tramping over this quaking bog, it is well to roll up a bundle of the *Sphagnum*, for on afterwards squeezing out the water we may be rewarded by finding some of the rarer species of *Pinnularia* such as *hemiptera* and *Alpina.*

"Before leaving this rocky part of the country for the flat country below, let us scrape some of the brown mucus from the face of the dripping rocks, for it will probably yield such forms as *Epithemia*, *Cocconeis Thwaitsii*, *Navicula trinodis*, *Denticula sinuata*, &c.

"The weather being warm, we will quench our thirst at the little spring in the cavern-like hollow in the rocky roadside. Observe, the roof of the little cavern is quite covered with a chocolate-brown mass, which feels rough and gritty to the fingers. Here is a splendid and pure gathering of *Orthosira arenaria*, and I recommend you to take a good store of it away with you, for it is seldom one finds this fine form so pure and unmixed.

"Proceeding towards the low country, let us take a scrape from the side of this horse-trough, for it is quite brown. It is well we have done so, for it is a nice pure gathering of *Cyclotella operculata* and *Pinnularia pygmæa.*

"Passing a little further on, we come to a clump of ash trees, with a crop of moss growing on their trunks. Perhaps you may smile when I proceed to peel off this moss and store it away in a bundle in my satchel. On washing the moss afterwards, however, I may be rewarded with some of our most local and rare species, viz., *Orthosira mirabilis*, mixed with *Navicula tumida*, *Pinnularia borealis*, and *Orthosira spinosa.*

"Having secured a bundle of moss from the tree-trunks, we will take another from the roof of this old thatched cottage, the north side of which is quite carpeted with beautiful green moss. This will probably yield *Nitzschia Amphioxys* and *Pinnularia borealis.*

"The white-colored stratum of earth exposed in the cutting on the roadside must now be examined, for it is probably a deposit of fossil diatomaceous earth; in which case a large piece must be secured.

"These fossil deposits are generally composed of a compact mass of Diatomaceæ of recent as well as extinct species. The deposit we are at present examining is several feet thick, and has at some remote period formed the bed of a lake, the diatoms accumulating at the bottom until the present thickness was attained. You will observe that the endochrome has been removed by long rotting, and the entire mass is now composed of the pure white siliceous valves. Pray also observe that this richness in silex suits the cereal crops growing over it, but does not seem to furnish much nutriment to the potatoes and turnips.

"The adjacent peat-beds may also be examined, for frequently rare Diatomaceæ are found in the turf which is cut for fuel.

"The dark, hairlike mass growing on the wood-work of this sluice-gate is a nice pure gathering of *Schizonema neglectum*, the frustules arranged in regular rows in the interior of the long filaments.

"Before leaving this pond, let us pull out a mass of the *Myriophyllum*, which seems rusty in color. Well! here is a medley of forms, but the gathering is worth bottling up, owing to the abundance of *Amphipleura pellucida*.

"The clear ditch by the roadside is a likely place for such forms as *Pleurosigma attenuatum*, *Spencerii*, and *lacustre*, *Nitzschia linearis* and *tenuis*, *Surirella ovata*, *Navicula elliptica* and *Cymbella maculata*.

"The yellow mass attached to plants a little further on is *Cyclotella operculata*, *Amphora ovalis*, and *Nitzschia sigmoidea*, while the brown covering on the *Anacharis* is *Gomphonema tenellum*, *dichotomum*, and *curvatum*. The stones in the running beck, issuing from the clear spring close by, are covered with long, yellowish-brown streamers, which are well worth collecting. Take them out very gently, for they are very fragile, and likely to drop again into the water. The species is the beautiful *Meridion circulare*, with *Melosira varians*.

At the bubbling spring itself, which forms the head of the streamlet, the sand, which is tossed and heaved about by the ascending water, seems tinted of a brown color. Let us secure some of the sand, when we shall find the brown color is caused by a dense parasitic growth of *Odontidium Harrisonii* quite pure.

"Farther on the dark brown streamers must be collected, for here are two species of *Fragilaria*, *capucina* and *virescens* mixed with *Diatoma elongatum*. The stones and aquatic plants are likewise covered with a dense brown coating of *Synedra radians* and *ulna*, species found in almost every clear water ditch.

"The boggy place where the plants are coated with a yellow coating of the oxide of iron, is not to be passed without collecting a little of this light flocculent surface mud. This will be almost sure to yield some fine diatoms, such as *Campylodiscus spiralis*, *Pinnularia nobilis* *Stauroneis Phœnicenteron*, *Surirella splendida*, and *Cymatopleura solea*.

"Here we must finish our day's work, having arrived at the railway station, from whence we proceed home with our treasures. The work of collecting has been finished, yet much remains to be done before the material is cleansed and mounted on slides for microscopical investigation.

"Let us hope our fatigue has not been in vain, but that the store of riches we have collected together will furnish us with ample material for much interesting study and instruction."

B.—Marine and Pelagic Collections.

To obtain an exhaustive knowledge of diatoms, it will not be sufficient to study those forms only which are met with in streams, on the banks of rivers, and on the sea shore, for in that case our knowledge of them would be very incomplete indeed; but we must also examine all fossil deposits as well as marine and pelagic diatoms.

It is in fact, just as important to obtain forms which are found at the bottom of the sea as those which float just under water or on the surface of the ocean and the mouths of large rivers. It is only of late years that it has been discovered how numerous are these floating forms to which the name *Pelagic diatoms* (1) has been given, and how much they vary according to the seasons and under the influence of currents and other causes which have not yet been completely ascertained.

For the last eight years I have specially devoted myself to the study of marine and pelagic forms, and have made hundreds of gatherings of them, and for this purpose I have used my steam yachts "Nautilus" and "Suzon." The former is specially constructed for exploring the upper Scheldt; it is a flat-bottomed paddle-boat, and by reason of its small draught and the special form of its keel it can navigate shallow water with impunity. I have used this yacht most frequently in making gatherings in the upper Scheldt between Ghent and Saftingen, while the "Suzon" (2) has been used for the lower part of the river and the North Sea.

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(1) It would be better to describe these diatoms as *Floating*, or *Wandering*. The Germans use the word "Plankton" (from πλαγκτός—wandering, roaming) to denote all living organisms which are displaced in this way under the influence of currents, &c.

(2) The "Suzon" comes from the shipyard of Messrs. Watkins and Co., of London, who are considered among the most skilful yacht-builders in England. The "Suzon" is constructed entirely of teak wood, having a draught of 6ft. Its length is 60ft., and breadth 11½ft. Being very narrow and fitted with powerful machinery it can, when running with the tide, make nearly 11 knots, and can carry coal to last eight days.

Special apparatus is required for collecting marine and pelagic forms. My own is very simple, but in spite of its extreme simplicity it has, nevertheless, proved hitherto sufficient in all my expeditions, and I do not think that anything further is necessary.

My apparatus consists essentially of a grapnel hook and a series of nets (Frontispiece, figs. A—E).

The hook has three barbed ends, and is attached to a long cord. This is used to secure or draw in any algæ which may be seen floating about, or which may be found on the banks of rivers or shallow bottoms. It is also trailed behind the boat, and so drags along the algæ and other bodies which it happens to catch hold of at the bottom of the sea or river.

The nets are of four kinds :—

1. *A bottom net or drag* (Frontispiece, fig. B).—The net is attached to a heavy ring of tinned iron ; its weight is sufficient to make it scrape the bottom, so that it collects the sand and other bodies over which it trails.

2. *A sub-surface net* (Frontispiece, fig. C).—In this the ring of tinned iron is rather lighter, and is, moreover, sustained by a piece of cork on either side ; the whole is balanced so as to be suspended at about 1ft. to 2ft. below the surface of the water.

3. *A surface net* (Frontispiece, fig. D).—The upper end of the net consists of a wooden frame of square section, which is very long. This frame as it is drawn along by the launch floats just at the surface, so as to collect any diatoms which may happen to be there. This kind of net, as a rule, gathers the most interesting kinds of diatoms.

To the framework of each of these nets is attached a cylindrical bag made of very stout cloth, to which again is attached the real net, which should be made of silk gauze of the best quality, such as is used for making fine silk strainers.

4. *An ordinary fishing net.*—This net is square and rather large, with fairly close meshes, and is useful for collecting algæ and shells at the bottom of the sea, which are so frequently covered with interesting diatoms.

All the nets, except the surface one, should have long stout cords attached to them, so that they may work well and overcome a fair amount of resistance.

It need scarcely be pointed out that all gatherings should be made against the current, and with the engines eased down to the minimum, *i.e.*, so as only just to counteract the current and so remain stationary, or, at all events, only make the slightest headway. Any attempt to go quicker is useless, for it will be quite impossible to obtain gatherings, owing to the fact that there would not be time for the water to filter through the net, and there is also a risk of tearing or even of altogether losing the net by the cords getting broken.

From time to time the nets are drawn in on to the deck of the vessel, and are carefully washed in a pail of water, which is left standing for a considerable time. After decanting the supernatant liquid, the sediment in the bucket is put into bottles, which are then carefully labelled, to avoid any subsequent confusion.

From pelagic gatherings many very rare forms may often be obtained in great abundance which are only met with exceptionally in shore mud. The following is a list of diatoms found in a pelagic gathering made at Hansweert, a maritime portion of the Scheldt, about 31 miles from Antwerp, on the 22nd May, 1892 :—

Rhizosolenia setigera.
„ Shrubsolii.
Plagiogramma Van Heurckii.
Synedra nitzschioides.
Eucampia Zodiacus.
Chætoceros Wighamii.
Ditylum Brightwellii.
Biddulphia lævis.
Coscinodiscus Oculus Iridis.
„ concinnus.
Lithodesmium undulatum.
Actinoptychus (Secondary valve = Debya insignis).
Triceratium Favus.
Campylosira cymbelliformis.
Skeletonema (Melosira) costatum (Grev.), Grun.

Up to the present time we have only incomplete data as to the origin, the rapidity of propagation, and the direction which these masses of floating diatoms take on our coasts. It will depend upon the littoral currents, of which we have no information, and on the sea currents which give rise to the "flow" ([1]), a current which sets out from the English Channel coast along the Belgian shore, bearing E.N.E. to N.E., and the ebb tide (reflux or descending sea), which comes down from N.N.E., and takes a

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([1]) Etude sur les courants de la Mer du Nord par. M. Petit, Directeur du service de l'hydrographie de Belgique. Anvers, Tessaro. 1892.

S.W.½W. or S.S.W.½W. direction, and which is in part dependent on the sea wave coming from the north, and in part on waters of the English Channel returning again. ([1])

The pelagic gathering mentioned above, made during the flowing tide, also shows its southern origin by the diatoms of which it is composed.

C.—Collecting from Fossil Deposits.

Fossil deposits may be divided into marine and fluvial deposits.

Marine deposits.—"Gather all earths," writes our friend Dr. Arthur M. Edwards, "of light colour, varying from a pure white, through different shades of grey, cream, and fawn to an iron-rust tint. The texture is often friable, and then looks somewhat like clay, especially when it is wet; at other times it is of a hard and stony character, although always more or less porous, and when soft, of little weight. Collect enough to make up three or four pounds weight, or, say, a block six or eight inches square, and, if possible, at various depths, because often these deposits vary in character according to the depths at which the gatherings are made. Everything that can be ascertained with regard to their position and their relation to other beds should be noted. Also any fossils contained in them or in the strata above or below them; if they are not known they should be taken in order to fix their species later. All specimens should be kept carefully separate (not even permitting them to come in contact) by wrapping each one in paper, placing within a label having written upon it *in ink* the exact locality, date of collection, and name of collector. It is also desirable that note should be made of the depth from the surface at which the specimen was taken, together with any other information that may be deemed of interest, as supposed extent of stratum, slope-upwards towards north, south, east, or west, and thickness."

Guanos.—In conjunction with marine diatoms we ought here to mention guanos which (as is well known) consist of the excrements of web-footed birds found in warm regions of the globe, especially Peru, the Chincha Island, Bolivia, &c. The birds which produce guano feed on fish and various marine products, all of which contain diatoms or have them on their surface, and consequently diatoms may often be found in these guanos in large quantities; by properly treating such guanos, many rare forms can be obtained, which would elsewhere be sought for in vain. Unfortunately, the best guano deposits are rare, or becoming so, and commercial guanos are so often adulterated.

([1]) Petit, op. cit., p. 54.

Lacustrine Deposits.—These deposits are produced in lakes, ponds, and rivers. Strictly speaking, they are not fossils but rather recent deposits, since the greater part of the diatom forms contained in them are identical with living species. They, however, sometimes belong to the tertiary and also quarternary periods.

These deposits are pulverulent, and when dry they are remarkably light. They are either quite white or grey, according to the quantity of organic matter which they contain, and have been said to resemble powdered starch. Their dampness when fresh usually deepens their colour which becomes lighter as they dry. These should be gathered in exactly the same way as marine deposits. As these beds are seldom of any great extent (they often become soon obliterated or covered up) it will be well to secure a good supply of the material whenever the opportunity presents itself. If any shell, wood, or other organic remains be found dispersed through the deposit, or overlying or beneath it, they should also be collected, and their position recorded on the label.

Deposits of fossil diatoms are numerous, and are found in very various localities. The most ancient is that found in 1878 by Mr. Shrubsole, of Sheerness-on-Sea, in the London clay, which belongs to the Lower Eocene (Tertiary period). Some of the diatoms found by Mr. Shrubsole are encrusted with pyrites, and some have even been transformed into pyrites. The number of species found is rather large, the most common being *Coscinodiscus perforatus* (?) and *Coscinodiscus minor.* (?) (1)

§ 5. Cultivation of Diatoms.

Every diatomist has at some time or another made diatom cultivations, that is to say, has tried to keep alive the species which he has collected on his excursions, or which may have been accidentally developed in the jars or aquariums of his laboratory. But the attempt to keep any species alive for a protracted period rarely succeeds, and then only under certain circumstances, which cannot be fully ascertained. The longest cultivation, we believe, which has hitherto succeeded is one which we have in our own laboratory, dating back to 1886, since which time some *Navicula didyma* and *Amphora duplex* have continued to multiply.

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(1) The Diatoms of the London clay, by W. H. Shrubsole, F.G.S., with a list of species and remarks by F. Kitton, Hon. F.R.M.S., J.R.M.S. (1881), p. 381.

Dr. Macchiati published a note ([1]) on the cultivation of diatoms on the 22nd March, 1892, but this little work only contained theoretical data, and gave no precise directions which could guide the worker.

On the other hand, Dr. P. Miquel, whose papers on the reproduction of the sporangial form have been previously mentioned, has published in *Le Diatomiste* and in the *Annales de Micrographie*, a series of articles in which all the questions relating to the cultivation of diatoms are examined in detail. The manuscript of the former of his articles was sent to *Le Diatomiste* on the 30th January, 1892. The French observer may therefore just claim priority in producing artificial cultivations of diatoms, which are destined to play so important a part in the future study of diatoms.

Dr. Miquel has laid before the Academy of Paris a paper in which he lays down general directions for cultivating diatoms ([2]). We shall now proceed to reproduce this paper, and then make a summary of the various publications by Dr. Miquel, on the subject under consideration :—

"The silicious phæophyceæ of the family of Diatomaceæ," says Dr. Miquel, "which hitherto have never been artificially cultivated, can nevertheless be cultivated in laboratories just like other microscopical plants.

"From a careful chemical analysis of the fluid media, in which these algæ are usually found growing in nature, I have drawn up a few instructions which have been invaluable in enabling me to ascertain the composition of the nutritive macerations which favour the multiplication of diatoms.

"Ordinary water when placed in glass jars, containing pieces of stalks of grass, husks of wheat, barley, oats, &c., and fragments of mosses, is rendered very favourable to the reproduction and multiplication of fresh water diatoms. The excrement of rodents and ruminants may also be used for the same purpose, but the latter are more inclined to favour the development of Chlorophyceæ than of Phæophyceæ. Fleshy muscle, washed and cooked, may also be used to charge the macerations with organic matter, but with much less success. The effect of adding to the cultivating media, soluble hydrates of carbon, albuminoid substances, white of egg, blood serum, gums, gelatines, &c., is either negative or else harmful, since a certain number of fungi are sown with the diatoms.

([1]) Dr. L. Macchiati : Communicazione preventiva sulla cultura della Diatomee. Extratto dagli atti della Societa dei naturisti di Modena. Ser. III., Vol. XI., 1892.

([2]) De la culture artificielle des Diatomées par M. P. Miquel, 28th March, 1892.

"Among the mineral elements whose fecundating action on diatoms is very remarkable, I shall quote the following salts of sodium, potassium, and calcium, viz.:—the chlorides, bromides, iodide, phosphates, and sulphates (1 to 5 parts dissolved in 1,000 parts of water, or more concentrated for certain frustular species). Sodium silicate (1 in 1,000) would seem to have no effect on these algæ, as they appear to more easily assimilate the silica, contained in vegetable matter and liberated by slow and progressive decomposition, than that of the silica contained in soluble chemical combinations. Lastly, a comparatively weak solution of the salts of ammonium, particularly the nitrate, impedes the growth of diatoms, but the phosphate of ammonium is an exception and favours it.

"There is no greater difficulty in producing cultivation of marine than of fresh water diatoms. Artificial salt water which has been obtained by adding to every litre of ordinary water 25 grammes of sodium chloride, 1 gr. of magnesium sulphate, 5 gr. of calcium chloride, and ·1 to ·2 gr. of potassium or sodium, bromide and iodide produces a mineral medium which is found to be very suited to the cultivation of marine Algæ, if a few straws and some fragments of Fucus and wrack be added.

"To obtain absolutely pure cultivations of diatoms the maceration should be prepared without applying heat 8 to 15 days before using and filtered with a Pasteur-Chamberland filter before planting.

"In the case of ordinary cultivations the planting may be done at once, but the entire maceration must have been previously sterilised at a temperature of 70°c., at which almost all microphytes except Bacteria are destroyed.

"Diatoms introduced into these various media produce at the end of eight days healthy cultivations consisting of magnificent deposits of a colour varying from golden yellow to dark brownish red and formed almost exclusively of the planted species.

"By varying the mineral and organic composition of these media, by increasing or diminishing their nutritive power any particular species can be made to predominate. As diatoms are unequally affected by heat and the toxic qualities of antisceptics it is easy by means of this physical and these chemical agents to separate the Algæ from one another by making use of a system of diluting.

"As diatoms cannot withstand the heat of direct solar rays, diatom-cultivations should be placed in a northern aspect either in the open air or behind windows of transparent glass. The light diffused from the sky is always sufficiently powerful to ensure the development of diatoms. Inside poorly-lighted rooms the cultivations are arrested; but even then three months after planting, these still unfertilised cultivations need only be exposed to the full light of day to spring into visible activity and to become a flourishing colony. From 0° (c.) to 10° (c.) the diatoms show perceptible signs of multiplying; from 5° to 10° the cultivations proceed slowly; from 10° to 20° they become luxuriant; and then at 45° the diatoms are utterly destroyed.

"Diatoms can be cultivated in a volume of liquid varying from several litres down to 1 c.c. or 2 c.c.; I have made use of this property to follow the development of these Algæ under the microscope and to witness various phases of their generation and multiplication which I shall describe in a future note."

Dr. Miquel draws a distinction between *Ordinary Cultivations* in which one or more species are cultivated together for the purpose of having them constantly at his disposal for any kind of research and *Pure Cultivations* where a single species is made to pass through all the phases of its existence in order to follow every modification which it would spontaneously undergo, or which can be artificially produced or again in order to cultivate them in such a manner as to be able to make a number of durable microscopical preparations.

The cultivations are again divided into *Cultivations of Fresh Water Diatoms* and *Cultivations of Marine Diatoms.*

A.—Ordinary Cultivations of Fresh Water Diatoms.

Diatoms are cultivated in water containing saline and organic nutriments. The saline nutriments are prepared in two solutions, A and B.

Formula for Solution A.

Magnesium Sulphate ...	10 gr.
Sodium Chloride	10 ,,
Sodium Sulphate	5 ,,
Ammonium Nitrate ...	1 ,,
Potassium Nitrate ..	2 ,,
Sodium Nitrate	2 ,,
Potassium Bromide ...	0·2 ,,
Potassium Iodide	0·1 ,,
Water	100 ,,

Formula for Solution B [1]

Sodium Phosphate	4 gr.
Calcium Chloride (dry) ...	4 ,,
Pure Hydrochloric acid at 22° (c)	2 c.c.
Hydrous Ferric Chloride at 45° (c)	2 ,,
Water	80 ,,

(1) The preparation of Solution A presents no difficulty; Solution B should be made up as follows: To the sodium phosphate dissolved in 40 c.c. of Water are added first the 2 c.c. of hydrochloric acid, then the 2 c.c. of hydrous ferric chloride and then the 4 gr. of calcium chloride dissolved in 40 c.c. of water, taking care to shake the mixture which I call Phospho-ferro-calcic solution. The addition of this last solution to the maceration throws down a slight brownish flocculent precipitate, formed for the most part of ferric oxide, which should be carefully separated from the liquid used for cultivations.

These solutions are kept separately; for use add 40 drops of A and 20 drops of B to a litre of ordinary water, in which has been previously placed 5 centigrs. of bran, 1 decigram of straw and a little quantity of ground moss previously washed in boiling water. When made in small quantities the cultivations are prepared in wide-necked flasks, stoppered with a plug of loose cotton wool. Large cultivations are made in crystallizing pans, &c. We have successfully employed square vessels which had been previously used as electric accumulators.

It is well to take the precaution of sterilising all liquids by heating them in a water bath for a quarter of an hour, at a temperature of about 70° (c.), so as to destroy any spores or fragments of Algæ or even foreign diatoms, which those liquids may happen to contain.

The cultivating liquid being ready it is fertilised by introducing into it a few healthy frustules.

The cultivations should be kept screened from the direct rays of the sun. The best results are obtained by exposing the flasks to a northern illumination, and keeping them at a temperature of 10° to 30° (c).

When green Algæ are produced their growth can be stayed by diminishing the light.

Diatoms will also flourish in artificial light, such as gaslight, &c. Every 10 or 15 days fresh sterilised water, such as has been previously mentioned, should be supplied in the place of any water which has evaporated.

If the cultivations "drag" (*i.e.*) develop slowly, this can often be remedied by adding a few drops of solutions A and B in the before-mentioned proportions.

B.—Artificial Cultivation of Marine Diatoms.

The Cultivation of Marine diatoms may be favourably effected in natural sea water. If this cannot be conveniently obtained, artificial water should be used and this can be made by dissolving :—

Sea salt	... ...	250 grammes.
Magnesium Sulphate	...	20 ,,
,, Chloride	...	40 ,,

which should be dissolved in a sufficient quantity of water to make up one litre of solution. The liquid thus obtained is subsequently mixed with 9 litres of water immediately before using.

The sea water is added to solutions A and B just as in the case of the fresh water, and similarly sterilised at a temperature of 70°c.

A short filament of Zostera is added to it for organic nutriment. The water which has evaporated should of course be made up by adding sterilised distilled or rain water.

Many diatoms, both marine and fresh water, require a special cultivation.

It is evident that in this summary we are unable to enter into these details and we therefore refer the reader to the original papers by Dr. Miquel, published both in Le Diatomiste and in the Annales de Micrographie.

C.—Pure Cultivation of Diatoms.

These cultivations are much more difficult than the preceding. In the first place a thoroughly healthy and fresh diatom should be isolated, which may be effected either by isolating it in the medium in which it is found by various artifices (capillary tube, pipette, hog's bristle, &c.), or by breaking up the said medium after the fashion of Bacteriologists. As a rule it is by this last method, which is unfortunately rather lengthy, that an ordinary gathering can be turned to the best account.

It is well known that this breaking up ([1]) is effected by mixing for example one drop of diatomiferous liquid with 100 c.c. of nutrient liquid and by again diluting 1 c.c. of the resulting liquid in 99 c.c. of fresh liquid. This last-mentioned liquid is then apportioned for example in 10 Frendenreich flasks and submitted to cultivation.

If the last liquid thus obtained be still too rich (*i.e.*, contains many kinds of diatoms) it should be diluted a third and, if necessary, a fourth time.

In this way cultivations in which not more than a single form occurs and from which subsequent cultivations can be made will eventually be obtained. These cultivations which we shall call *Research Cultivations*, can be made in various ways. One of the most interesting is cell cultivation originated by Dr. Miquel, and described by him in "L'Annuaire de l'Observatoire de Montsouris," 1892-1893.

The cells of Dr. Miquel are constructed as follows:—

"A cell is cemented, without solution of continuity, to a glass slip, near the upper edge of which is bored an aperture about 2mm. in diameter, and over this cell is similarly cemented a thin circular cover-glass. In this way an entirely new kind of cell is produced, having

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([1]) See Manuel d'analyse bactériologique des eaux par le Dr. P. Miquel. Paris, Gauthier Villars, 1892.

an aperture near its margin; it can be kept in a vertical position for the purposes of observation, and in a horizontal position during cultivation,

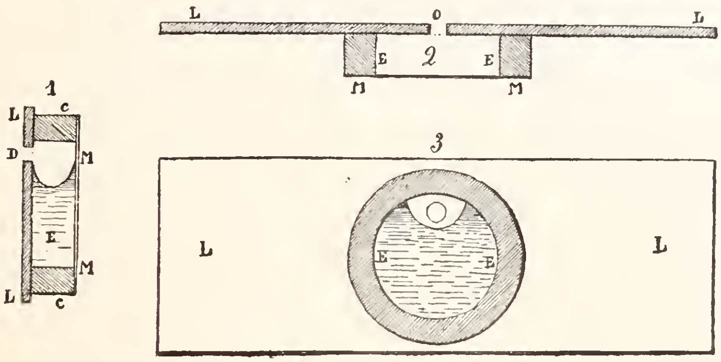

Fig. 18.—The Miquel Cell.

1. Tranverse section of the Miquel cell. LL. Glass slip. D. Aperture of 2 mm. cc. Cell. MM. Thin cover-glass. E. Liquid of cultivation.

2. Longtitudinal section. LL. Glass slip. O. Aperture. MM. Thin cover-glass. EE. Interior of cell.

3. Cell as seen on the stage of the Microscope. LL. Glass slip. EE. Cell.

in which latter case it is then laid flat on the surface of the thin cover-glass. Thus the deposits, instead of being formed on the bottom of the ring, rest and become incrusted on the thin cover-glass; the diatoms, that are planted in these little cells, grow and multiply on the inner surface of the cover-glass, which enables their evolution to be followed for many months with the most powerful immersion objectives. I have some cultivations of this kind which are eight months old, and which still exhibit healthy and vigorous frustular species.

"To replace the water which slowly evaporates through the apertures of the cells, the volume of liquid is made up to its original amount every eight days with a delicately-tapered pipette, filled with sterile distilled water.

"By means of this apparatus various re-agents can also be made to act on the Algæ by introducing them through the above-mentioned apertures without in any way deranging the position of the cultivation while under the microscope."

I have myself experimented with these cell cultivations and can testify to the good results obtainable. I will only add, that if the results obtained by Dr. Miquel's arrangements are excellent, still better ones can be obtained by using Mr. Nachet's large inverted microscope, as I am doing at present. By employing this instrument the cell can be left in position during an entire observation without the diatoms being

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deranged, and they can be observed with any kind of objective, provided that it has a correction sufficient for this length. As the instrument is admirably adapted for photography ([1]), photographs of high magnification can also be effected at any given moment. I have for several years used with this instrument a glass shade which covers up every optical part excepting the ocular; the culture cells can then rest in position, and the instrument be always ready for examination without any need of moving the shade.

D.—Mr. C. Haughton Gill's Cultivations.

Dr. Miquel has found in Mr. C. Haughton Gill (whose other ingenious researches I shall describe hereafter) a worthy rival in producing his cultivations. In short, this skilful chemist, who died of heart disease while still at his work and at an age when he might fairly have looked forward to many more years of life, commenced his cultivations in 1891, but he had not at that time discovered the best way of proceeding; moreover with the modesty which characterised the man, he attributed to Dr. Miquel all the success of his cultivations. "I have wasted," he wrote me, "half my time in preliminary researches and experiments, so that Dr. Miquel is in every way entitled to claim priority." I shall here summarily extract from his correspondence with me the information I possess concerning Mr. Gill's cultivations. I consider that I am only discharging a debt of honour by publishing this information, which my friend was prevented from giving to the world himself by his sudden death.

The liquid which appeared to Mr. Gill to be the best for cultivation was composed as follows:—

A.	Sodium chloride	10	parts by weight.
	Sodium sulphate	5	" "
	Potassium nitrate	2.5	" "
	Acid Potassium phosphate ...	2.5	" "
	Water	100	" "
B.	Filtered spring water	100	parts by volume.
	Solution A	0·5	" "

To this solution he added a sufficient quantity of slaked lime to neutralise the acidity of the liquid and a small quantity of well-washed precipitated silica. Then subsequently he also added a small quantity of either a sterilised infusion of grass or "Diatom-soup," which he obtained by boiling a large quantity of fresh diatoms for a long time in water.

([1]) See "The Microscope," by Dr. H. Van Heurck, English Edition, London, 1893, pp. 255, 256.

After filtration, this "soup" was preserved in sealed tubes. Later on again, he added to his solution some bone gratings, which he said dissolved rapidly in the liquid. At other times he added some well-washed grass roots.

Although the Gill-solution contains considerably less ingredients than that of Dr. Miquel, and more especially as the salts of magnesium and iron are absent from it, Mr. Gill found that it was quite as favourable to the growth of diatoms as that of the learned French bacteriologist. Still later on however, Mr. Gill, who made his cultivations on a very large scale, modified his liquids and made them more like the Miquel-solution. The liquid which he employed during the last year of his life was made up of a mixture of four distinct solutions, as follows:—

Solution 1.—	Crystallised Sodium phosphate (chemically pure)	2
	Calcium chloride (,, ,,)	4
	Syrup of Iron chloride (,, ,,)	0·5
	Strong solution of Hydro-chloric acid (,, ,,)	1·0
	Water	100
Solution 2.—	Crystallised Magnesium sulphate (chemically pure)	4
	,, Sodium sulphate (,, ,,)	4
	,, Potassium nitrate (,, ,,)	4
	Commercial salt (Sodium chloride)	8
	Potassium bromide	0·2
	,, iodide	0·2
	Water	100
Solution 3.—	Crystallised Sodium carbonate (chemically pure)	4
	Water	100
Solution 4.—	Well-washed precipitated Calcium silicate ...	25
	Water	75

Three cubic centimetres of these liquids are taken and a litre of drinking water or sea water (according to the circumstances of the case) is added to them; the mixture is well shaken and is portioned out in conical flasks (Erlenmayer's vessels) of 100 to 200 c.c., which are filled to a height of about three centimetres.

The flasks, stoppered with cotton wool, are sterilised either in the oven or by making the liquid boil. The flasks should be allowed to rest for a week at least before planting them with diatoms.

Solution No. 3 has a double action; in the first place, it destroys the acidity of the liquid and then precipitates half of the calcium in the form of useful carbonate, for Mr. Gill considered that it was advisable that the diatoms should have at their disposal some solid matter on which they could live and subsist.

The purity of the products employed in the solution is, according to Mr. Gill, essential. If one wishes to succeed, too much care cannot be taken to ensure the absence of every trace of arsenic, mercury or silver. The presence of arsenic which is so often found in ferric chloride, in consequence of its being frequently manufactured with impure hydrochloric acid, is one of the commonest causes of failure.

As Dr. Miquel also points out, Mr. Gill discovered that the direct rays of sunlight are absolutely harmful to the greater part of the cultivation. He exposed his flasks to the *direct* sunlight on a board close to some glass windows which were situated N.N.W., at the same time interposing between the glass and the flasks a plate of pale green glass of the height of the flask and a wooden board slightly higher than the liquid. All the cultivations had been planted with one or more frustules, transferred with a capillary tube. "This," said he, "is the simplest and quickest method and also ensures absolute certainty that there is no other diatom in the final drop which is to be used for the purpose of planting the flask.

The experiments of Mr. Gill were tried on a sufficiently large number of forms, among which we may mention *Pl. Angulatum*, *Cymatopleura solea* and *Elliptica*, various *Nitzschia*, *Cymbella* and *Navicula*. All these forms were made the subject of numerous successive cultivations, and he had about 100 in his possession at the time of his decease. Some of these cultivations are unfortunately dead, perhaps from want of assimilable matter or for other unknown causes; but a considerable number of them are still living. All of these, with voluminous notes by Mr. Gill, are in my possession. I hope to be able to follow these cultivations through a number of generations, and if the opportunity occur I intend to publish the results obtained from them.

E.—Results of Experiments with Cultivations.

Dr. Miquel has published in "Le Diatomiste" the technical methods of treating cultivations, and his experimental researches in the physiology, morphology, and the teratology of diatoms, which have resulted from the before-mentioned cultivations, have been published in the "Annales de Micrographie."

We shall in a few words summarise the results obtained by the learned observer, but we refer the reader who desires a detailed account to the above-mentioned publication in which the experiments are fully and minutely described.

1. Effect of Temperature.—A. *Damp heat.*—Diatoms flourish at a temperature between 15° and 30° C.

At 35° C. many species, especially the large forms, are considerably affected; after having been subjected to this temperature for two hours, free diatoms no longer move, and in the greater part of them the endochrome can be seen contracted, and showing signs of a large number of air-globules. At the end of 15 days to 2 months most species, if planted in a new maceration, are restored to life.

At 38° many species are absolutely destroyed.

At 40° life becomes extinct in the greater part of the diatoms belonging to our temperate climate. After being submitted to this temperature for two hours the protoplasm becomes perfectly glanular. At the end however of a few days *Navicula*, *Melosira*, *Fragilaria*, as well as *Surirella ovata*, and *Nitzschia thermalis* are restored to life, while large *Synedra*, *Nitzschia*, &c., are absolutely destroyed.

Between 40° and 45° all species are irrevocably destroyed.

Observations show that, in proportion as the temperature increases, the endochrome contracts from the walls of the valves and throws off a number of oil globules; if the temperature is further increased the protoplasm becomes green and then granular, and is detached from the wall of the valves, which is a sure sign of the death of the frustule.

B. *Cold.*—When the diatoms are submitted to a temperature of 0° C., to all appearances they scarcely appear to suffer at all, so long as the medium remains liquid, but should it happen to freeze the diatoms with very few exceptions succumb.

2. Effect of Dessication.—Experiments have shown that diatoms keep alive as long as they remain humid, but they die directly they are quite dessicated.

3. Effect of Light.—The rays which most favour the cultivation of fresh water diatoms are the yellow, blue, and green, arranged in order of merit. White rays are much less favourable. Semi-darkness is preferable to a flood of light, though the latter favours the prolific growth of green algæ.

4. Effect of Heat.—Cold considerably suspends or retards the progress of cultivations; at a temperature between 5° and 10° C. it takes from 10 to 12 days before the planted macerations show any well-pronounced traces of cultivation; between 10° and 15° C. it only requires eight days, and between 15° and 20° C. merely four to five days.

5. Effect of Chemical Reagents.—Chemical reagents may be nutritive, indifferent, or toxic. By a toxic reagent Dr. Miquel means every chemical body which, when added to the maceration in a less proportion than one part to 1,000 parts by weight of the total quantity of cultivation

liquid, suspends or checks the development of the diatoms. Chemical reagents have not the same toxic effect on all forms of diatoms. The following are the results which have been obtained by Dr. Miquel.

Mercury chloride kills diatoms in doses between 1 in 30,000 and 1 in 40,000.

Cupric sulphate acts like the former.

Zinc sulphate in a dose of 1 in 40,000 considerably impedes the development of diatoms.

Iron introduced in the form of ferric solutions is rapidly decomposed, and is thrown down as a flocculent precipitate of yellow hydrated ferric oxide, the presence of which obstructs the development of diatoms if too much is added; in a very weak dose (see solution B.) it may assist the growth of diatoms.

Arsenious acid acts very toxically on diatoms. It kills most of them even in so weak a dose as 1 in 30,000.

The Mineral acids in doses strong enough to produce a sensible reaction produce a very harmful effect.

Iodine produces the same toxic effect as zinc salts.

Boric acid and Carbolic acid are not prejudicial if weaker than 1 in 10,000.

Essential oils are opposed to the development of diatoms.

6. Effect of Anæsthetics.—*Chloroform* has a powerful toxic effect on diatoms; the vapours of *Bromoform and Iodine* also produce very harmful effects on them, but act more slowly. Lastly, the vapours of *sulphuric ether* and *iodoform* are less harmful, and *carbolic acid* has only a temporary effect.

7. Effect of Indifferent and Nutrient Substances.—Dr. Miquel has not yet published his experiments with these substances.

8. Forced Production of Auxospores in Cultivations. — Dr. Miquel, who has studied this phenomenon in connection with *Melosira varians* and *Nitzschia palea* has summarised his observations on this subject as follows:

"1st.—It is now unnecessary to rely on chance observations to observe the formation of auxospores in diatoms; the experimentalist, by means of successive artificial cultivations of these algæ in a pure condition, can most easily produce for himself millions of sporangial frustules of both filamentous and free diatoms.

"2ndly.—The size of diatoms is as a general rule established independently of the production of the spores or sporanges. The protoplasm of micro-frustules when near their size-limit increases in volume, escapes from the valves, and surrounded by a membrane which is primarily cellulose, passes out into the cultivations, usually assuming a very irregular form, but at the same time continuing to approach to that of normal mega-frustules. Many of these bodies, however, only complete their ultimate form when they begin to move.

"3rdly.—The primordial mega-frustules of bizarre and unsymmetrical shape acquire their elegant regularity by deduplication, a process to which they immediately submit.

"4thly.—Protoplasm which escapes from micro-frustules is not usually rendered effective in the glutinous or gelatinous substance, as recorded by various authors, and further, it is probable, as I have frequently observed, that the double auxospores placed side by side are due to the simultaneous germination of two micro-frustules on the point of dividing, the internal valves of which still adhere to another at certain points.

"5thly.—It is still uncertain whether micro-frustules before their germination are the subject of a special fecundation, the phenomena of conjugation therefore must be for the present withdrawn as the correct explanation of the cause of the re-establishment of form, in the case of the five or six species on which I have been able to make observations."

§ 6. Teratology of Diatoms.

Dr. Miquel in his articles on cultivations published in "*Le Diatomiste*," expresses himself as follows:—

"In addition to normal cultivations others can be produced, in which the predominence of certain physical and chemical elements can be intentionally exaggerated; then when the diatoms are able to grow in these media they acquire bizarre forms, which has induced me to call these cultivations *Teratological*. I have been able to follow these strange variations of form through three generations in certain *Nitzschia* and *Cyclotella*. Nothing is more curious than observing these original diatoms getting embossed, asymmetrically attenuated and becoming absolutely unrecognizable; in the case of *Cyclotella*, which are ordinarily in the shape of a regular box, the valvular surfaces are seen to lose their circular form become oval, triangular, quadrate, or assume the appearance of unangular but very irregular closed curves; at the same time the plane surfaces of the discs are warped and become undulated, the edges of the upper and lower surfaces of the cylinder begins, as it were, to form hills and valleys, while the markings of the *Cyclotella* are nevertheless persistent and manifest themselves with these marvellous modifications superadded; on the girdle face the alterations of shape which I record are very appreciable, and not unfrequently these box-shaped diatoms look somewhat like flexible accordions which are in the act of being pressed in. This bizarre morphology does not prevent these cell monstrosities from living and having a perfect endochrome.

"The results obtained with teratological cultivations strike me as very remarkable. They explain, in the first place, how it comes about that diatoms of abnormal form are met with in nature; it would seem that if only the growth of diatoms could be successfully arrested when they assumed the peculiar forms already indicated, not only could an infinite number of hybrid varieties cf the same species be created, but perhaps also the series of modifications could be followed, which slowly give rise to the transference from one species to another. So far I only feel confident on this one point, viz., that it is possible to produce very great deformities in the silicious carapaces of diatoms by means of cultivation."

Every diatomist has occasionally come across deformed or modified valves and many of them have collected curious forms. The collection of Mr. E. Weissflog includes a large number of them. Amongst the most curious are the three figured below.

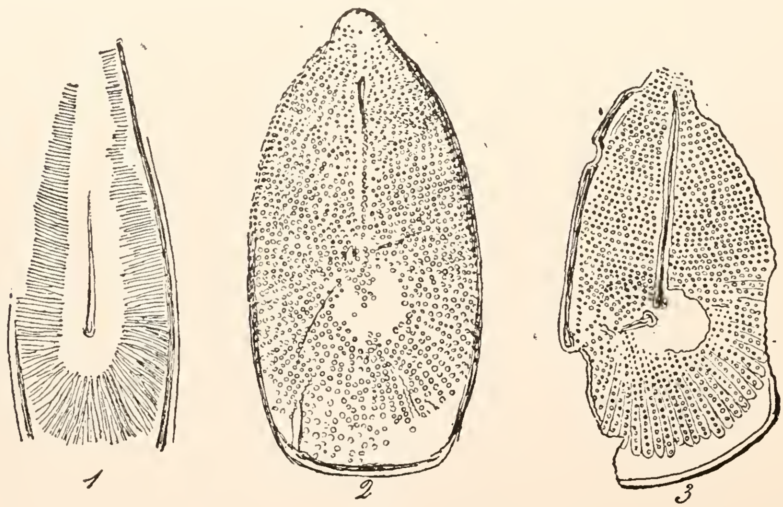

Fig. 19.—Deformed Diatoms.

No. 1 represents a *Navicula permagna*, the half of the raphe of which is wanting, whilst in the same part of the valve the striæ are radiant; No. 2 is a figure of an abnormal *Navicula maculata* in which the raphe is present only for a short distance, while the striæ become still more radiant and the valve assumes an almost oval outline. Lastly, in No. 3 the two raphes are placed nearly at right angles, and the puncta follow the same direction as the raphe.

I have found other valves in the same collection, which are all quite as peculiar and show that neither striation nor outline are invariable. A few examples will bear out these remarks:—

Navicula lyra affords us a series of monstrosities: the margin is excised or the outline becomes sub-hexagonal; the lyre is normal on one side of the raphe and inflexed towards the latter on the other side; in another example it is undefined and indistinct; on the two sides of the raphe the striæ are duplicated close to the central nodule; in another example there is a straight hyaline line, in addition to the lyre and between it and the margin; lastly, in a further example, quite close to the central nodule there is a kind of round spurious nodule surrounded by a short radiant striation.

Navicula Johnsoniana shows on the valve, spaces without striæ and placed asymmetrically on the two sides of the raphe.

In a *Cocconeis scutellum* the striation is regular on the lower portion of the valve, while it is undefined and takes all kinds of directions on the upper portion.

In a *Campylodiscus clypeus* the valve is broadly excised on one side and the costæ follow the outline of the excision. This does not always form a void space, the excision being filled up by a fine membrane showing an indefinite punctuation.

In a *Pyrgodiscus armatus* all the large spines, with one exception, are wanting.

A *Mastogloia rhombica* shows a sinuous raphe.

In a *Triceratium Favus* one of the margins is strongly concave, and a hexagonal *Triceratium dubium* has its six sides very concave. In another *Triceratium dubium* there are only five angles, one of which is more acute than the others.

An *Auliscus punctatus* has two false ocelli, while an *Auliscus cœlatus* has three equal and well-developed ocelli.

A *Biddulphia pulchella* displays a cuneiform frustule.

In conclusion, for space does not permit me to enumerate all the monstrosities in my possession, I will only mention further an *Aulacodiscus Comberi* having only three appendices, an oval *Eupodiscus radiatus*, and an almost perfectly triangular *Eupodiscus Jonesianus*.

All these modifications of form, these monstrosities of excess and defect will exemplify what has been above described.

The Honourable Jacob D. Cox, of Cincinnati, has made a special

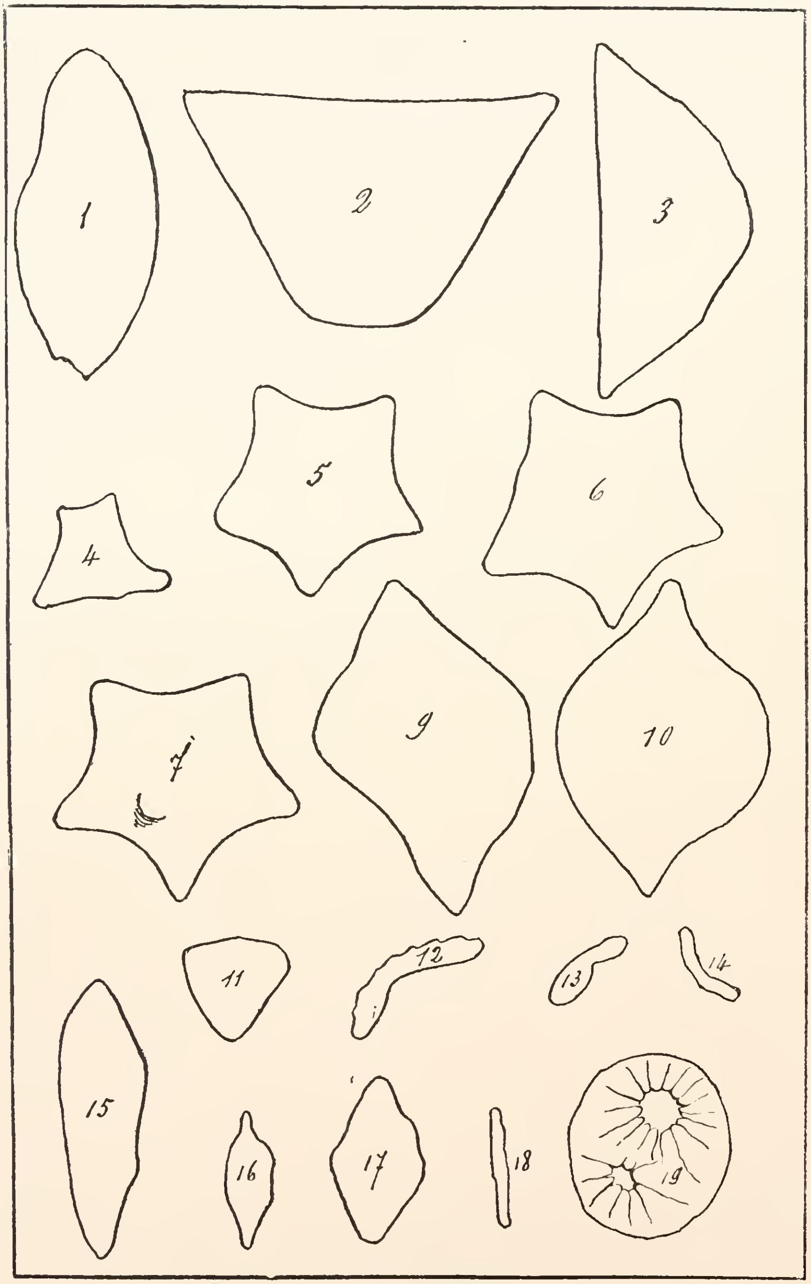

Fig. 20.

Deformed Diatoms. 700. This plate is traced from photographs and reduced one half, and the numbers of the figures correspond with the numbers of the paragraphs, all but No. 19 being in the first Class.

study of deformed diatom valves, and has published an excellent pamphlet ([1]) on this subject, a considerable portion of which I will proceed to give :—

"I have," says the eminent American Diatomist, "provisionally arranged them in three classes : 1. Those having indented or deformed outlines ; 2. Those having a double or multiple centre in the scheme of marking ; 3. Those having the marking unsymmetrically varied. [Fig. 20.]

I.—Indented or Deformed Outlines.

1. *Navicula lyra E.*—Santa Monica, Cal. ; fossil. One side boldly indented in a large, easy curve.

2. *Triceratium favus, E.*—Maranham Island, Pacific Ocean ; recent. One angle is wanting, two sides being joined by a curve, making one diameter, one-fourth less than the others. The process is present at the deformed angles, but is unsymmetrically placed.

3. *Same species,* from same gathering. A similar deformity carried further. The form almost semi-lunar, but the curve is not regular. The third process is wanting.

4. *Triceratium robustum, Grev. = T. Sculptum Shadbolt ?*—Calvert Co., Maryland ; fossil. One of the angles is replaced by two smaller ones, giving an irregular trapezoidal form to the shell.

5. *Triceratium formosum, Brightwell, var pentagonalis, Grun.*—Samoa Islands, Pacific Ocean ; recent. One of the indentations between the points of the star is nearly obliterated, and the two points connected by an irregular curve.

6. *Same species and variety*, from same gathering, similar deformity, but the line connecting two points of the star is more nearly straight, showing a tendency to revert to the triangular form of the type.

7. *Same species and variety*, from same gathering. The deformity here consists of a large umbonate protruberance in the centre of the shell, its surface covered by the irregular marking.

8. *Same species, typical.*—San Luis Obispo, Cal. ; fossil. A typical triangular form, but with the central protruberance noted in No. 7.

9. *Biddulphia rhombus, W. Sm.*—Cuxhaven, North Sea ; recent. One side deformed by a large, irregular indentation.

10. *Same species*, same gathering. Similar deformity, but less pronounced.

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(1) Deformed Diatoms by Jacob D. Cox in Proceedings of the American Society of Microscopists for 1890.

11. *Same species*, triangular form—*Triceratium striolatum*, *E.*—A group of three specimens, of which two are the triangular forms, with regular and moderately convex sides; the other specimen has one such side, but the other two curving into each other in a similar way to No. 2 above. The third process is wanting, but in its place are two spines, such as appear on the sides of the regular *Biddulphia* form. Variation in this species is so common that it would be easy to make a series of photographs showing the gradual passage of the *Biddulphia* into the triangular form.

12. *Eunotia diadema*, *E.*—Charleston, S.C.; recent. The concave side irregularly curved, making the width of the shell much less in one place than elsewhere. The convex side is regularly eight-toothed.

13. *Eunotia monodon*, *E.*—Loka Deposit, Sweden; fossil. A deep irregular indentation on concave side near one end, making the shell roughly comma-shaped.

14. *Eunotia arcus*, *E.*—Dolgelly Earth, Ireland (1); fossil. A similar (but less marked) irregularity. In a recent gathering at Cincinnati, Ohio, these *Eunotias* are found with so irregular reversed curves as to resemble wriggling earth-worms in outline. A specific distinction has been improperly based on this peculiarity.

15. *Licmophora ovata*, *E.*—Santa Monica, Cal.; fossil. A large, shallow indentation on one side, giving a gracefully varied outline.

16. *Rhaphoneis amphiceros*, *E.*—Savannah, Ga.; recent. One side of the shell a regular curve, the others very irregular.

17. *Cymatopleura elliptica*, *Bréb.*—France; recent. The outline of the shell on one side irregularly wavy.

18. *Grammatophora marina*, *Kg.*—Algoa Bay, Africa; recent. One side wavy, unsymmetrical.

II.—Double or multiple centre in the scheme of marking.

19. *Mastogonia actinoptychus*, *Ehr.*—Richmond, Va.; fossil. Elliptical form, with two distinct central spaces from which the costæ radiate.

20. *Stictodiscus Californicus*, *Grev.*—San Luis, Obispo, Cal.; fossil. A fine circular specimen with two centres, the radiating costæ approximately regular on the outer limbs, but anastomosing in the space between the two centres.

21. *Navicula Samoensis*, *Grun.* (=*Nav. palpebralis*, *Greg. ?*).—Samoa Islands, Pacific Ocean; recent. In one half the shell, longitudinally,

(1) Wales.—W.E.B.

a second medium nodule appears, with striæ radiating from it in all directions.

22. *Biddulphia balœna, Ehr.* = *Triceratium formosum, Brightwell.*—Spitzbergen, Arctic Sea ; recent. A large *Biddulphia* form, in which the delicate marking radiates from four or more distinct points as centres.

III.—Marking unsymmetrically varied.

23. *Coscinodiscus robustus, Grev.*—Pabellon de Pica, S.A. ; guano. The areolation is so irregular as to have lost all hexagonal form. Its strong margin, robust habit, and its occurrence among typical specimens of similar size, etc., fix the specific relation. A similar example in same species was found in the Santa Monica deposit.

24. *Arachnoidiscus Ehrenbergii, Bailey.*—Santa Monica, Cal. ; fossil. The radiating costæ, irregularly wavy, and anastomosing near the centre, where they also become fainter and hardly traceable.

25. *Actinoptychus Heliopelta, Grun.*—Nottingham, Maryland ; fossil. A specimen with five elevated rays. These are plainly distinguished at the central zone, but the undulations flatten out soon, and the outer part of the shell is quite flat and evenly areolated. The rim, with its irregularly scattered spines, is typical.

26. *Triceratium affine, Grun.*—Samoa Islands, Pacific Ocean ; recent. The areolation is so irregular as to lose entirely its hexagonal character ; this is the case all over the shell. Its size and outline, and its occurrence among numerous typical specimens show its relations. A second example has been noted on another slide from same locality.

27. *Amphitetras antediluviana, Ehr.*—Kiel, Baltic Sea ; recent. The central part of the shell is irregularly areolate, with a tendency to two centres. The typical forms, common in same gathering, have the central areolation evenly concentric.

28. *Navicula elliptica, Kg.*—Crane Pond, Mass ; recent. The striation is irregularly wavy, especially at the ends.

29. *Epithemia turgida, Kg.*—Berlin, Germany ; fossil. The costæ and areolation are so irregular as to destroy all pattern in one-half the shell and nearly so in the other.

30. *Nitzschia scalaris Ehr.*—Sodertelge, Sweden ; recent. In one part of the shell the keel is distorted, and instead of it appear two nodules on the face of the shell with irregularly radiating striæ.

"Whenever I speak of striation I mean to be understood that it is resolvable into dots, similar in character to those of the typical forms of same species, "In the examples which I have placed in Class II. and III. above, we see the distortion occurring by the miscarriage or interruption of the vital force which tends to produce the symmetrical sculpture of the shell of the diatom. In Class I. the cause of the irregularity would seem to be external and mechanical. It results, apparently, from the conditions of growth within a strong silicious box. When fission occurs the envelope of the new cells is at first flexible, and is often found very slightly silicified, but it acquires rigidity as the deposition of the silex goes on [1]

"Under these conditions, if we suppose that the diatom is better supplied with nutriment than common, and its circumstances are such as to make more vigorous growth, the valves of the new cell may tend to grow larger than the parent in all directions, and being confined by the strongly silicified coat of the mother cell, its own more flexible wall may fold upon itself and make a wavy irregularity of outline, such as is shown in some of the examples above noted.

"The example of irregular wavy outline suggest also the conclusion that if, in the circumstances last supposed, the diatom were one whose shell presented alternate strong and weak points in its circumference, the indentations resulting would also be regular, and we should have a crenulate form of a shell normally smooth in outline. My own observations have led me to think it probable that crenulated forms are thus originated. Once produced, further fissiparous division would tend to perpetuate the peculiarity, since the growing force in the new cells would force the flexible walls outward to fill the matrix.

"It would not be till the process of conjugation is reached that the resumption of the normal type could reasonably be expected; consequently it would be permature to conclude that the crenulation is a specific distinction, or even the mark of a lasting variety, until it is proven that after conjugation the new series of diatoms retains that form.

"Considerations of this sort may assist us in reducing the enormous catalogue of species in the *Diatomaceæ*, *a consummation devoutly to be wished.*"

But not only may the valve undergo modifications and alterations, but the living frustule is liable to be attacked by certain diseases, which are only at present known to us by the alterations that can be observed in the endochrome, and it may moreover be attacked by parasites both externally and internally.

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(1) See Study of *Isthmia nervosa* by the Author, in Am. Journal of Microscopy, Vol. III., p. 97 (1878).

It thus happens that on certain diatoms very singular filamentous parasites are occasionally found, which are thought to be algæ. The *Nitzschia* especially are frequently attacked in this way, and in the Atlas to my Synopsis (pl. 7, fig. 22) will be found a representation of a *Nitzschia angustata* infested in this way.

Recently Mr. Grenfell (1) has noticed various disciform diatoms having radiant filamentous appendices, which are very long, excessively thin, and fairly numerous. Every specimen of his gathering was in this condition (fig. 21). I have also personally established the existence of similar radiant appendices on the *Coscinodiscus excentricus* from a gathering made at Sheerness-on-Sea.

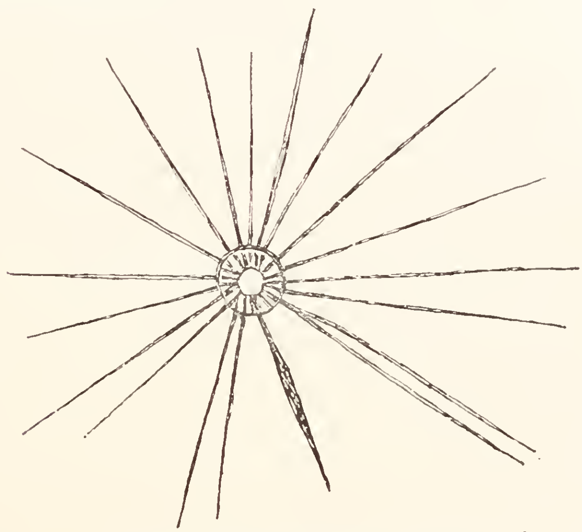

Fig. 21.—Diatoms with filamentous appendices.

The important question in all these cases is whether the appendices are true parasites or whether they are actually produced by the frustule; it is to be hoped that this problem will be solved by subsequent research. It is advisable in every case to draw attention to these appendices, as they are only to be seen with difficulty, and can only be seen to advantage when the living frustules are placed upon a slide and there allowed to dry of their own accord, the drop of liquid not being covered over with a cover-glass.

It would be well to try the effect of analine stains on gatherings in a living state to see whether these productions are not more frequent than is at present believed.

(1) On the occurrence of pseudopodia in the Diatomaceous genera Melosira and Cyclotella, by J. G. Grenfell, Q.J.M.S., 1891.

But not only the *exterior* of the diatom frustule suffers from the attacks of parasites; Dr. W. Zopf has described under the name of *Ectrogella Bacillariacearum*, a fungus which lives in the *interior* of living diatoms and specially attacks *Synedra* and *Pinnularia*.

Its presence is manifested in the first place by an alteration in the shape and position of the chromatophores. The latter recede from the walls, contract in the direction of their length, and conclude by being closely applied to the parasites. At the same time the nucleus is dissolved, and the protoplasm contracts. Later on, in consequence of the growth of the parasite, and of the pressure which it exercises on the valves, the latter open, and the parasite can emit its spores exteriorly.

At a meeting in London of the Royal Microscopical Society on the 19th October, 1892, Mr. C. Haughton Gill exhibited frustules of *Pleurosigma*, *Nitzschia*, and *Cymbella*, infested with a fungus. Mr. Gill was good enough to forward me photographs of the parasite and of his preparations, showing the latter in various stages of growth. In the letter, which accompanies the packet, our kind and learned correspondent expresses himself thus:—"The fungus, if not directly identical with, appears to bear a considerable resemblance to Zopf's *Ectrogella bacillariacearum* (Nov. act. der Kol. and Leop-Carol Deutscher Akad. xlvii. p. 145). In some respects it resembles even more closely the *Olpidiopsis* described by Cornu (Ann. des Sc. Nat. series 5, xv.) as infesting *Saprolegniæ*. The sporangia, which first make their appearance (in *Pleurosigma attenuatum*) at about the beginning of November, are at first of a plain sausage-shaped outline, and their contents are nearly homogeneous. As they arrive at maturity, granules appear in the interior, and shortly afterwards the thick wall of cellulose becomes tumid at one point, and a beak or tube of ejection is put forth—you will find more than one spore sac at this very stage (on the slide tinged with black) detached from the shell of the diatom.

"After some time the beak or tube bursts at its extremity and the zoospores issue rapidly into the surrounding water. I have not yet traced the further history of these zoospores.

"A very curious point, which greatly needs confirmation by other observers, is this — this parasite appears in *Pleurosigma attenuatum* in November, December, and January. I have been hitherto quite unable to find it either before or after those months in this particular diatom, and during those months I have found it in no other species, though *Nitzschia*, *Cocconema*, *Pinnularia*, etc., were abundant and were kept observed under identical conditions (in the same dish of water). About March the *Nitzschia* and *Bacillaria* became infested, while the *Pleurosigma* remained healthy

If these facts are not accidental, but are confirmed by repeated and independent observations, they will need a good deal of explanation.

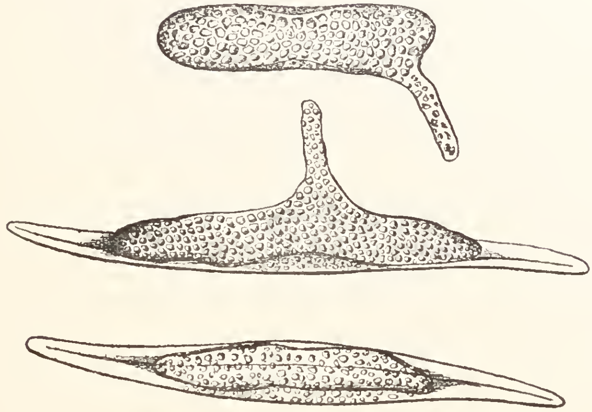

Fig. 22.—Parasite infesting *Pl. Angulatum.*

We give here (fig. 22) a representation of the parasite infesting the *Pleurosigma attenuatum* in three different phases of its evolution. This figure is copied from the photograph sent us by Mr. Gill.

§ 7. Preparation of Diatoms.

After a gathering of diatoms has been made, they must be separated from the mud which often accompanies them, then deprived of their endochrome, and subsequently prepared either in balsam or dry.

To isolate diatoms from mud, the entire mass is placed in a plate, a quantity of water just sufficient to cover them is then poured on to it, and the whole is exposed to the light in a well-illumined spot. After an interval, sometimes of a few hours, at others of a day or two, the diatoms may be seen to have come out of the mud and to be coating the surface of the water. The water surrounding them is then carefully drawn off and the diatoms thus exposed can be removed by means of a camel's hair pencil if the stratum is thin, or by means of a scraper or blade if the bed is thick.

Thus obtained, the diatoms ([1]) are placed in small tubes which are filled up with alcohol, and they can then be either prepared at once by a process of calcination on a cover-glass, which we shall afterwards describe, or they may be previously treated with acid. Fresh water

(1) It is assumed that fresh water diatoms are being dealt with. In the case of marine diatoms it would be necessary to wash them two or three times in distilled water, so as to rid them of every trace of sodium chloride.

diatoms are generally very silicious and are uninjured by being treated with acid. This, however, is not the case with many marine diatoms, which are very frequently only feebly silicious, and can only be submitted, therefore, to a moderate calcination at the utmost.

In treating diatoms with acid a small quantity is placed in a test tube, and covered over with one or two drops of nitric acid and the whole boiled for a few seconds (or sometimes for one or two minutes) in the flame of a spirit lamp, taking care that the dangerous vapours emitted do not injure the lungs or any instruments of precision. This operation should therefore be carried out in the open air or in the fume chamber of a laboratory.

When the tube has cooled, it is filled with distilled water and left to rest. Some time afterwards the diatoms will be found collected at the bottom of the tube, the supernatant liquid is then carefully decanted or drained off and replaced by a fresh quantity of distilled water, and so on until the water shows no trace of acid. Then the water is decanted for the last time and the diatoms are finally covered over with a small quantity of liquid ammonia, which, after the lapse of some hours is in its turn decanted, and any traces of it that may then remain are got rid of by successive washings with distilled water. After this last operation the diatoms are perfectly cleaned and they are then placed in alcohol as previously stated.

The mud of marine estuaries may be treated in the same manner, but great care must be taken to use only distilled water for washing. It has, in fact, the property of holding the clay in suspension, which can then be easily removed by decanting. If calcareous or saline water be used for the washings, the mud is precipitated with the diatoms.

However, it sometimes happens that the diatoms are mixed with so much organic matter (as is the case with guanos amongst others) that the treatment above-mentioned is not sufficient. In such a case the mass must be submitted to a more complicated treatment. This is carried out in the following manner:—

The material is treated with nitric acid as above described, especially when, as frequently occurs, the presence of calcium carbonate is suspected. It is then carefully washed and dried. Without this preliminary operation the final product will contain a large quantity of calcium sulphate crystals, which it would be almost impossible to get rid of.

The material, having then been treated as above, is placed in a deep porcelain evaporating dish; a small quantity of concentrated sulphuric acid is poured over it so as entirely to cover the diatoms, and the whole is boiled for two or three minutes.

By this operation the mass greatly increases in volume and the organic matter becomes carbonized. The spirit lamp (or Bunsen burner), which is being used, is then withdrawn, and, while the mass is still near boiling point, a saturated solution of potassium chlorate is added drop by drop to the water. As each drop is added a brisk effervescence is produced and the liquid is stirred with a glass tube. When a certain number of drops of potassium chlorate solution has been added—the quantity of which should be about half the volume of the sulphuric acid used—the liquid becomes quite clear; the diatoms are then washed as in the operation first described.

It may sometimes happen that after this operation, the diatoms are still not quite clean; in this case the whole operation will have to be repeated.

It is evident that very fragile diatoms and those but slightly silicified could not stand so energetic a treatment; it should therefore only be used when the cleaning can be done in no other way.

It should be again remarked that the last operation should only be carried out in the open air or in a fume chamber on account of the chlorinated vapours, which are very dangerous to breathe, and moreover because the solution of potassium chlorate can only be added drop by drop without running the risk of a dangerous explosion and the projection of the matter out of the tube.

The diatoms having been cleaned in this manner, it is then necessary to prepare them. Various methods may be followed, but that which gives the best results consists in burning the diatoms on a plate of mica or a cover-glass. I have adopted this method ever since I was first informed of it by the late Mr. De Brébisson, more than 25 years ago. This process, together with the preliminary and subsequent operations, has been described at full length by my friend Professor H. L. Smith, the learned American, so well known by his many excellent works on diatoms. I quote the article which he published on this subject in "The Lens," the journal of the State Microscopical Society of Illinois. [1]

Preparation of Diatoms according to Prof. H. L. Smith.—The following article, in the words of Prof. Smith, deals with the rapid method of preparing from crude material and with a mode of mounting *invariably on the cover of the slide:*—

"The gatherings should not be dried, but kept moist, in phials with a little creosote to prevent mould. I very much prefer to examine whole frustules, with both valves adherent, or if filamentous, still

[1] The Lens (1873), ii., pp. 209-212.

cohering. And I have many bottles of preparations for mounting, which are nearly as clean as though they had been treated with acids. And many of the most interesting preparations which I have were never boiled in acids. Of course, very much depends upon the skill and carefulness of the gatherer, and a little patience and judgment will enable any one to obtain the crude material tolerably pure. Only a few days ago I made a gathering of *Nitzschia*, in which I have the frustules almost as free from foreign matter as though they had passed through the most elaborate acid and chlorate of potassa treatment.

"Supposing, then, that one has before him a phial which will hold a considerable quantity of water compared with the sediment in it, the latter composed more or less of diatoms. We proceed thus, and if it has stood for some days, perfectly undisturbed, so much the better. The bottle is twirled rapidly, and the lighter material rising up in the axis will soon diffuse itself throughout the water.

"Allowing it to settle for two or three seconds, until to the eye the grosser portions have just been deposited, all that remains floating is now poured off into another phial, and it is from this stock that we are to separate the diatoms and sand from the clay and organic matter. The material poured into this second bottle is allowed to settle until the water simply appears milky or cloudy; the time will vary according to the minuteness of the diatoms, and can only be judged of from experience, say one minute, when all that remains floating must be poured off, and thrown away, unless there are very minute forms which it may be desirable to separate. The phial is again to be filled with rain, or distilled, water, (hard or lime water should be strictly eschewed) and again shaken up. As soon as the heaviest deposit touches the bottom, the rest should be poured off into a third phial, leaving say about one-fourth the amount behind in the second phial. This third phial will now consist mainly of sand and diatoms, with lighter organic matter and pure clay; the last two can be removed by elutriation; for this purpose, fill the phial No. 3 with water, and after well shaking allow it to settle two to five minutes, pour off and throw away the slightly milky water, and repeat the operation, allowing it to settle a somewhat longer time; the operation may be repeated a third time, when particles, suspended after an interval of eight or ten minutes, may be poured off. Often, after the first settling of bottle No. 2, the diatoms will rise more pure in the mass by twirling the bottle than by shaking it up.

"A little practice and care will enable anyone to separate certain diatoms according to size. I had a gathering of *Pleurosigma Spencerii* from Scioto

River, O., sent to me, but although it had been chlorated, still, when a mounting was made, not more than one or two frustules would be in the field of view, the great mass being either smaller forms, or fine fragments of silex; by careful watching and testing the time when the different sizes would remain suspended, I have made from this a preparation, which will show hundreds where before were scarcely any, and which would never be recognised as the same gathering. Supposing now a trial shows us the diatoms tolerably abundant, the trial being made by heating in the manner presently to be described; the phial is filled with alcohol and water, half and half. Some samples of alcohol leave behind a scum after evaporation, especially noticeable after burning in the mode presently to be described, and water which will leave crystals, or any scum, must be avoided. The beauty of the preparation will largely depend upon being particular in this matter.

"For mounting diatoms I invariably place a drop of the fluid containing them upon the cover, *never on the slide.* The alcohol and water will spread out on the slide, but will remain heaped up on the round cover, like a plane convex lens. I prepare a little stand, of quite fine wire (so as not to conduct off too much heat), bent at right angles and inserted into a base; the free end is bent into a ring, and upon this ring is placed a square plate of very thin iron, (1) (such as is used for the so-called "tin-types" in photography, with the Japan burned off), held in place by bending the corners of the square over the ring, loosely, to allow expansion, without bending when heated; upon this plate the cleaned cover is placed, and then, by means of a pipette, a drop of the alcoholic liquid with the diatoms is placed upon it, and the spirit lamp applied below. The alcohol takes fire and is allowed to burn out; the flame of the lamp is then placed beneath, and the rest gently boiled, the remaining alcohol escaping during this ebullition causes the diatoms, by this very act, to distribute themselves very evenly over the cover, and all matting is effectually prevented. It is better, after one perceives that this even distribution has taken place, not to push the heat so as to make large bubbles again, but to slowly evaporate until dry, after which the full power of the flame must be applied until the iron plate and the glass cover are red hot; at first the mass of diatoms, etc., will become black, but as the organic contents and *debris* burn away there will finally remain only the silex nearly white. I invariably burn in this manner on the cover; even the specimens which have been prepared with acids,

(1) I prefer to use a small square piece of platinum foil, with the corners folded back, and held tightly with a pair of *forceps.*—H.V.H.

for the diatoms thus treated when mounted appear much sharper and cleaner. (1) The amount of heat, if the diatoms are rigidly silicious, as most of them are, may be the full power of an ordinary alcohol flame continued for some time, but if they are imperfectly silicious, care must be exercised in the burning.

"I invariably use old balsam for mounting, just as bought from the shops, especially if I wish to have a specimen which will bear immediate handling, or be ready to be sent off as soon as mounted. Allowing then the cover to cool, while the slide is being cleaned to receive it, I place a drop of the balsam, which must not be fluid, only viscous, on the middle of the slide, and now *with this* pick up the cover from the little stand where it has been heated. The diatoms will be so fastened by the heating, that but few will flow out from under the cover, if any, in the subsequent treatment. I now hold the slide over the flame of the lamp (which should be much smaller than when used for the burning) until not only all under the cover is a mass of small bubbles, but until very large bubbles, balsam steam, appear; the flame is removed so soon as the bubbles are observed all running to one edge. I press down the cover at this place by a mounted pin, and start them in the opposite direction. This may seem unnecessary, but long experience shows that this is the better way to get rid of them; during this the slide is held somewhat obliquely, the cover is kept from slipping by the pin, and if all the bubbles do not disappear, then, with a very small flame, heat is applied just beneath the obstinate ones, the slide being held slanting, and that part upwards where the bubbles are nearest the edge of the cover. The description is longer than the actual process, and the slide, when cool, is ready for immediate use. Perhaps I am wedded to old ways, but after trial of fluid balsams, without heat, I have always come back to the old way; still, for selected diatoms, some of these preparations of balsam are good. If the diatoms are to be mounted dry, always the best way, if for real study, I make a ring of the zinc white in balsam (2) (sold by the opticians) and which in a moment or two is sufficiently hard to receive the cover, *and*

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(1) I entirely agree with Professor Smith in his opinion.—H.V.H.

(2) This cement is made as follows:—Some white of zinc boiled in oil is taken and all the oil removed from it by means of repeated washings in benzine. The white paste is slowly dried on a filter paper and then added to a thick solution of Dammar balsam dissolved in benzine. Generally speaking diatoms should be mounted dry as rarely as possible, for it is usually impossible to keep dry preparations without deterioration. They all ultimately become invaded by a mould arising from the varnish. There is, I believe, but one varnish which is suitable for mounting diatoms dry, and which will usually prevent the formation of this mould; viz., a thick alcoholic solution of gum-lac.—H.V.H.

never runs in ; after standing an hour or two I give a finishing ring of same, or the usual black varnish on the outside. I think anyone who will adopt the mode of mounting on the cover, and subsequent heating, as above described, whatever may be the rest of the procedure, will never consent to give up this part, since it effects so even a distribution and such destruction of residual organic matter, and gives such increased brilliancy to the preparations; sometimes, if the acid has not been thoroughly washed out of acid-treated specimens, snappy explosions will occur when the alcoholic mixture is heated; of course, the remedy is to pour off, and replace with pure water and alcohol."

Mr. Fred Kitton's method.—The learned English diatomist, Mr. Fredk. Kitton, has been good enough to send me a manuscript note of the method which he adopts in preparing diatoms. The reader will find in it much important information. "When cleaning diatoms," says Mr. Kitton, "I prefer to add at the end of the operation some small crystals of potassium chlorate, which I find easier to use than the aqueous solution of that salt, for if you add the latter rather too abruptly it produces such a brisk effervescence that the contents of the tube are liable to be projected. When the mass has been bleached and all acid got rid of by washings with pure water, I drain off the latter and pour 30 to 40 drops of concentrated liquid ammonia into the test tube which I stopper with a cork. The tubes which I use are 15 centimeters long and two centimeters in diameter. I leave the ammonia to react from half-an-hour to six hours. I then add 15 grammes of distilled water, and I give the tube a good shaking. When the diatoms have fallen to the bottom of the tube I draw off the supernatant water, which is often very thick, I add a fresh quantity of water and give it another shaking. I proceed in this way until every trace of ammonia has disappeared. Guanos, marine soundings, and certain fossil deposits require a different treatment.

"When every trace of acid has disappeared, I boil the gathering for three or four minutes in about 30 grammes of water, to which I add a piece of soap the size of a pea. When the diatoms have fallen to the bottom of the flask I remove the soapy water and boil the gathering in pure water. If these methods have been thoroughly carried out the residue will only consist of sand and diatoms. Should the gathering contain any large or heavy forms which I wish to secure for selection I allow the liquid to rest for 20 or 30 seconds, to allow them to fall to the bottom; then I decant the liquid which will contain fine sand and small diatoms. To separate the sand from the latter I have successfully pursued the following method:—

"I take two glass slips A and B. On A I place a drop of distilled water and on B a small quantity of the liquid to be treated. I give B a slight rotatory movement, keeping it in a horizontal position, which accumulates the sand in the centre of the liquid, and I then incline the slip towards one of its corners; the diatoms are drained off and fall into the drop of distilled water on slip A. This water is then spread on cover-glasses. By this method some gatherings which seem to be quite worthless furnish very good preparations, although it is often necessary to add several drops of B to the slip A. I recommended this method of working to one of my friends who complained of the trouble which a gathering of the mud from a rice plantation was causing him. In thanking me shortly afterwards he expressed his astonishment at the number of different forms he had obtained from this gathering, which at first appeared to be valueless.

"The preparation of deposits of marine origin is generally very difficult in consequence of the diatoms being apparently united together by a silicious cement which it is very difficult to get rid of without destroying the diatoms. I succeeded completely however by proceeding as follows:—A small portion of the material to be treated having been placed in a test tube I add some nitric acid, I boil it and wash to get rid of all lime. I then treat it with sulphuric acid and decolourise the mass which has generally turned brown under the action of the potassium chlorate. After a careful washing, the mass is boiled again for a minute in a small quantity of water, to which a little sodium carbonate has been added. After a subsequent washing the mass is returned to the test tube and shaken until it disintegrates. If this result is not obtained it should be boiled again in a solution of caustic potass, and just as it falls to pieces it should be poured into water to which some hydrochloric acid has previously been added.

"When a gathering of living diatoms has to be dealt with, and especially forms which develop in chains, a portion of the gathering is treated with acid which is added to the other portion which has not been used. In this way preparations are obtained in which the two faces of the frustule and its mode of development can be studied at the same time.

"I have often tried to use the method recommended by Professor H. L. Smith, but I have never been so successful as when I have previously got rid of all alcohol by washings. I prefer to allow the diatomiferous liquid to dry slowly without burning which has always furnished me with preparations containing some diatoms united in groups and in bands.

"Nor have I been more successful when I have put the balsam immediately on the diatoms, more particularly when I have been preparing large and convex forms such as the *Coscinodiscus* or *Aulacodiscus;* the balsam does not penetrate into the interior. In these cases I previously put a drop of oil of turpentine on the diatoms and when this has thoroughly penetrated the valves I add the balsam and let the whole rest in order that the balsam may slowly take the place of the oil, which is volatile.

"I have found this necessary sometimes even when using styrax, although this is more fluid than Canada Balsam.

"Mounting diatoms dry is the easiest process of all, but to prevent as far as possible the diatoms spoiling, which often happens after a short interval, in the first place the diatoms must be perfectly washed in distilled water, then the black varnish used for making the cell should not contain any oily matter, as is often the case, and this varnish should be thoroughly dry before applying the cover-glass, which is made to adhere by heating the glass-slip. The black varnish may be advantageously replaced by hard Canada Balsam dissolved in benzine ([1])."

Mr. J. Kinker's Method.—My friend, Mr. J. Kinker, is the skilful and learned diatomist, of Amsterdam, who has produced many very remarkable type-slides made after Möller's method. He has shown me in his own laboratory the method which he employs for cleaning diatoms, and we can testify to the advantage of his mode of operation from personal experience.

He begins by getting rid of the sand by successive washings, and of the lime by treating for a day in hydrochloric acid. Then he washes thoroughly and boils the deposit for fifteen minutes in sulphuric acid, to which has been added a few drops of nitric acid, the fifteen minutes being reckoned from the moment Mr. Kinker lights the gas.

The boiling is effected in a small glass flask or retort, fitted with a glass stopper, terminating in a long curved tube, which is plunged into an alkaline solution to absorb the acid vapours. The flask is placed in a sand bath.

([1]) See our previous footnote on gum-lac varnish, p. 70.—H.V.H.

The liquid having cooled, the diatoms are washed and then boiled in a solution of sodium carbonate of a strength depending upon the circumstances of the case. This operation, which is carried out in a porcelain dish, is carried on for ten minutes.

After again cooling, the liquid is decanted and water, containing a certain quantity of nitric or hydrochloric acid, is added. After again decanting and washing, the deposit is poured into a long narrow flask, so as to fill only a third of it and the whole is thoroughly shaken for one or two minutes. The shaking separates the material; water is then added, after which it is allowed to rest for a few minutes. The clear portion is then decanted by means of a pipette and the deposit is again shaken and the subsequent operations repeated, and so on as long as they continue to give a good result, *i.e.*, enable fresh diatoms to be separated.

The mass which is ultimately obtained from these successive operations is separated by decantation, if necessary, from any sand which may have been left behind, and placed in a large flat-bottomed measure glass which is filled up to the top and decanted into a measure No. 2 at the end of a minute, this is again decanted into a measure No. 3 at the end of three minutes, then again after five and ten minutes. The operation is performed six times in succession, and timed by a watch, then the diatoms will be sufficiently well separated according to their size. The diatoms are then placed in a small test tube, and as much water as possible is drained off, which should be replaced by pure alcohol. This alcohol is then drained off again and twice replaced by isobutylic alcohol. The diatoms, intended to be used for type-slides, are preserved permanently in this isobutylic alcohol. When preparations are made the diatomiferous liquid is placed, by means of a pipette, upon cover-glasses, which may then be used either for immediate mounting or for the purpose of selection.

The isobutylic alcohol cannot be mixed with water; it has the advantage of drying very slowly—taking at least several hours—and of avoiding the accumulation of the diatoms during evaporation: the valves remain absolutely in the same position in which they are placed at the moment when the drop falls, but they do not stick to the cover-glass as is the case with ordinary alcohol.

Professor Brun's method of preparation.—Professor Brun, the enthusiastic diatomist of Geneva, described in 1887 a method of preparing diatoms, which, according to experiments I have made, gives excellent results. He has thus described his operations :—

"A large number of recent microscopical writers," says Mr. Brun "have devoted their attention to pelagic gatherings, to those from lacustrine and marine muds and to fossil deposits. In such are found *Polycystins*, *Radiolaria*, *Globigerina*, *Foraminifera*, *Sponges*, *Diatoms*, and many other infinitely small and very varied organisms. In the marine muds of soundings only dead and mummified species are found. It is only at the surface of seas and lakes that *living* examples exist, *where both air and light are abundant*, and if in the deep muds a few specimens are occasionally met with in good condition, it is only due to the fact that they have dropped from the surface and that they have but lately ceased to live.

"A naturalist often experiences great difficulty in separating these organisms from the pulverulent or crystalline mass (*silicious*, *argillaceous* or *calcareous*), of which the greater portion of soundings consist. These substances, often mixed for centuries with organic detritus form usually a pasty or plastic mass, which may sometimes be even like tar, and is very troublesome and difficult to separate. A large quantity of volcanic ashes may also be frequently found mixed up with them. Sometimes the sounding only consists of mineral material without any trace of organisms.

"In order to study organisms having silicious shells, *e.g.*, Polycystins, some Radiolaria, and especially Diatoms, it is *indispensable* to entirely destroy this bulky organic matter. In guanos excrementary detritus are abundant. They resist to an extraordinary degree the process of putrefaction and even dissolvents, hydrochloric and nitric acid and chlorine. All these organic detritus are equally incapable of being *levigated* by reason of their varying specific gravity, and more particularly because mineral particles so persistently adhere to them.

"The following process effects the complete destruction of all this organic matter, and as *it does not give off any acid vapours* it has the advantage of not necessitating the use of a special laboratory or a strong up draft current during cleaning. It also gives results superior to any treatment with potassium chlorate or permanganate, or with nitric acid, the chemicals usually employed, since all these give off acid and corrosive vapours.

"The desiccated mass (which may be pulverulent or compact) is treated in a phial with *diluted hydrochloric acid* to remove the calcareous matter. The phial should be sufficiently large to hold all the viscous scum which the calcareous matter produces when it is thus intimately mixed up with organic matter in a state of decomposition. When these salts have been completely dissolved the liquid and the mud are placed on a filter paper, on which the insoluble deposit is washed, and then dried on the same filter paper.

"This dry *deposit* is then put into a phial and twice its volume of *concentrated sulphuric acid* poured on it. This is allowed to act for several hours, during which it is frequently shaken. The mass will grow black. Guanos require from five to six times their volume of sulphuric acid. This acid is the only efficient solvent of excrementary debris, and even then most of it can be removed by decanting three-fourths of the sulphuric liquid after leaving it to rest for a sufficient time. On this thick gruel-like and blackened matter some coarsely-powdered *potassium bichromate* is then added. It should be added by small successive doses, giving it a good shake each time. The mass becomes heated and oxygen is often given off. It should be stopped as soon as its colour has changed from black to red, or when crystals of chromic acid have been formed. In this treatment the organic matter is carbonized by the sulphuric acid, and the nascent chromic acid effects its combustion. The preliminary washing with hydrochloric acid is made so as to avoid the formation of lime sulphate.

"To the above liquid is added water little by little. The mass again becomes heated. An abundant supply of water is then added. The colour of the resulting deposit is now comparatively white. It is then carefully washed by decanting. The last decantings are made with distilled water. It is then ready for use. For this purpose it is diluted with distilled water, and the mixture dropped on to large cover-glasses, on which it is dried. From these cover-glasses the selection of species is made."

Preparations with Styrax and Liquidambar.—Towards the middle of the year 1883 I disclosed a new method of preparation, which I had myself practised for some considerable time.

I have given up Canada Balsam and I use Styrax instead, which, while being easier to manage, has a considerably greater index of refraction and shows the details of diatoms much more clearly. Since I introduced this medium to the public I have had the satisfaction of seeing it adopted by the most competent diatomists. I will therefore shortly explain the method of preparing and using Styrax. Styrax is a natural balsam which exudes from the *Styrax Orientalis Miller*, a native of Asia Minor.

It must be bought in the raw state as sold commercially, when it appears in the form of a soft, greyish mass. A thin layer of it should be spread on a plate and exposed to the air and light until it becomes sufficiently hard and has lost all the water which it contained.

This is then dissolved in a mixture of equal parts of alcohol and benzine (not to be confused with petroleum benzine) or, if preferred, in a mixture of sulphuric ether and absolute alcohol, and filtered through a filter paper. The following is the way in which I use the solution thus obtained, whilst I also give a description of the mode in which I have made my preparations for the last ten years or more—the mode indeed in which all my type collections of the Synopsis were prepared:—

I begin by placing the cover-glasses on a large plate of glass, or on a thick piece of cardboard, and on each of the former, by means of a pipette, I put a large drop of distilled water, on which I carefully let fall a small quantity of diatomiferous liquid. (1) The diatoms disperse in the drop of distilled water, which is consequently slightly agitated.

The cover-glasses are then covered over with a bell glass and left to evaporate of their own accord.

When this is completed the cover-glasses are taken one by one and heated to red heat on a plate of platinum and put back on the large plate of glass where, after having received a drop of very fluid solution of styrax, they are again left under the glass bell to evaporate.

In a few moments the layer turns white, but this phenomenon need not cause anxiety (it does not occur with the solution in chloroform), and at the end of 24 hours the benzine is completely evaporated. The cover-glass is then turned over and placed on a glass slip and heated gently, preferably with a Marie bath (hot water bath). Having got rid of the air bubbles, if there be any, by means of a clip, it only remains to remove any superfluous styrax from it, when cold.

Liquidambar is preferable to Styrax. This balsam, which is obtained from the *Liquidambar Styraciflua* is not met with commercially in Europe, but it can now be purchased from Messrs. Paul Rousseau & Co., 17, Rue Soufflot, Paris, purified and hardened according to our method, or in solution (when it is made up either with chloroform or benzine, and is preferable for mounting diatoms).

Liquidambar is more easily managed than Styrax and has a little higher index of refraction.

Preparations in very refractive liquids.—Various substances possessing a high index of refraction have been proposed for preparing diatoms in, *e.g.*, Monobromide of Naphthalin, Sulphur and Phosphorus dissolved in carbon bisulphide, &c. All these substances are very troublesome to use, and the last two do not keep. They can therefore only be employed temporarily and in those cases in which very indistinct details have to be studied.

(1) I preserve my diatoms in alcohol, which I decant before using, and substitute distilled water.

However, Prof. H. L. Smith has invented a medium which possesses an exceedingly high index of refraction, viz.: 2·25 to 2·4. We have given a detailed description of the way in which this medium is prepared in the last English Edition of our Treatise on the Microscope, and we refer to this work for the details on this subject ([1]).

Systematic preparations of Type Slides and selected diatoms.—Every microscopist is aquainted with the admirable type slides which were first introduced by Mr. J. D. Möller of Wedel, in 1867. I have a most vivid recollection of the appearance of the first slides (many of which are in my possession) and the sensation which they produced in the microscopical world.

Mr. Möller employs a specially constructed microscope to make his type slides, and he adopts his own particular methods, which he has hitherto disclosed to but three or four persons, of whom I am fortunately one.

I have now known it for a long time but am under an obligation not to reveal anything in connection with the subject.

Other professional preparers and enthusiastic amateurs have applied themselves in the same direction, and if their results are not as perfect as Mr. Möller's—a fact which anyone who has been initiated into his secret must recognise—they at least approach very closely to perfection; the type slides of Thum of Leipzig for example are deserving of all praise.

Type slides proper have not hitherto, so far as we know, been made other than by Möller and two enthusiastic and skilful amateurs, Mr. J. Kinker, of Amsterdam, and Mr. E. Weissflog, of Dresden, both of whom use Möller's process, and have produced genuine works of arts.

Mr. E. Weissflog, especially, has made himself quite master of the art, and has produced most important type slides, as for instance that of Santa Monica, which contains about 600 forms. Such work requires long and difficult application.

In connection with type slides we must not omit to mention the preparation of selected diatoms, *i.e.*, preparations containing one or more isolated diatoms. These preparations are very valuable, and every diatomist ought to know how to make them.

The methods moreover are very simple, and have been fully described by Mr. H. Peragallo, the eminent French diatomist, in his work on "*Les Diatomées de la Baie de Villefranche*," ([2]) and I shall now quote all the passages in which our learned correspondent describes them:—"I

([1]) The Microscope, London, 1893, p. 305.

([2]) Paris, Librairie Baillière, 1888,

use as sizing," says Mr. Peragallo, "the gum-tragacanth recommended by Professor Brun, of Geneva, and have always found it perfect; its refractive index being nearly the same as that of glass, renders its presence invisible when the mounting is finished; and moreover by using an aqueous solution of it the following great advantage is secured, namely, that all subsequent operations made with resinous media do not affect the adherence of the diatoms to the glass, and that a type slide can be prepared with heat in a few minutes without requiring either stove or lengthy drying in the air,—in other words, very little time, and scarcely any apparatus are needed—three solutions, a bristle needle, and a brass heating table being the only requisites for making one or more completely finished type preparations in the short space of five minutes.

"This being so, for the sake of greater clearness I will give a detailed description of my *modus operandi* step by step.

"A. Solutions.—1st. *Solution of Styrax.* Ordinary liquidambar dissolved in benzine or in a mixture of benzine and absolute alcohol. 2nd. *Imbibing solution* which should be the same as that which has been used to dissolve the balsam; a mixture of equal parts of benzine and alcohol containing a little styrax dissolved in it is highly to be recommended; the styrax in the solution remains in the interior of the diatoms and prevents the air from re-entering in case the liquid should be by accident allowed to evaporate completely before applying the styrax. 3rd. *Fixing medium.* This is obtained by making a saturated solution of gum-tragacanth in warm distilled water and then filtering. The small quantity of gum dissolved is amply sufficient; a little alcohol or creosote should be added to prevent mould. (This liquid has been recommended by Professor Brun.)

"B. Prepared Cover-glass.—I fix or get fixed with styrax some small cover-glasses of 5 mm. in diameter on some glass slips a little to the side of the centre and on this cover-glass I deposit the selected diatoms; this arrangement is the characteristic feature of my method and in my opinion offers the following advantages:—

"1st. I do not break or lose cover-glasses while manipulating; 2nd. When I have deposited a diatom on a cover-glass, and have fixed it there in the way I shall hereafter describe, I can write on the slip observations which will enable me, if I have occasion, to deposit subsequently another individual of the same species by the side of the first; 3rd. I can manipulate the cover-glasses which I am using so as to keep them free from dust without either danger or risk. Lastly. When my preparation is finished, if I am not satisfied with it, or if I have no further use for it in consequence of having made a better one, my cover-glass is as good as new, because I deposit a fresh diatom on the surface which is now uppermost, and as soon as the cover-glass has been turned over a cleaning with alcohol will clear off the specimen which was last selected and which is still adhering to the surface which will now have become the upper surface. I have repeated such an operation several times without having made any mistake. If large cover-glasses are used, or even if on small cover-glasses it is desired to make a coloured ring round a diatom so as to be able to find it again with greater ease, it is only necessary before dropping the imbibing solution, and as soon as the diatoms are fixed, to place the slip bearing the cover on the turn-table, to centre the diatoms under a lens and make a ring with some water colour paints, *e.g.*, Prussian blue; this ring will not be injured during subsequent operations, since no more water will be used.

"C. Selection.—I dry the diatoms intended for selection either on English sized slips or, what is even more convenient, on German sized slips. In every case it is important to thoroughly eliminate the alcohol in which the gathering has been preserved, replacing it with very pure distilled water, and allowing the drying operation to go on naturally, without having recourse to heat. In this way one can be certain that the diatoms will not reunite in a mass, and will not adhere to the glass. If the water spreads badly over the glass, it should be cleaned with a solution of bichromate of potass, aciduated with sulphuric acid and containing in suspension a little tripoli (common diatomiforous earth; that of Auvergne serves the purpose very well).

"The diatoms can be transferred by means of a hair or bristle fixed to a handle, but I prefer to use small wooden handled brushes. When buying them I ascertain, by means of a lens, that one hair is longer than the others; I use this brush to transport the diatoms and to fix them. If it is desired to change the position of the diatoms without raising them from the surface, where they are found, it is necessary to use a brush, thoroughly cleansed from all grease by chloroform. If on the contrary one wishes to make sure of lifting the diatoms, the bristle should be greased by passing it over the skin, or better still, by previously brushing it on a slip slightly rubbed over with essence of turpentine, which has not been completely wiped off. To make sure of depositing the diatom on the prepared cover-glass, the latter should be previously moistened with the breath. The same operations must be gone through whenever it is wished to change the position of the diatoms on the prepared cover-glass and to arrange them conveniently, in order to avoid all risk of their being carried away by the bristle or brush.

"Diatoms should be selected under a compound microscope with a magnification of 80 to 100 diameters; they are placed on the prepared cover-glass by means of a lens or doublet, which is quite sufficient to give a general view of what is being done.

"D. Fixing.—The diatom having been placed in position, the brush is slightly soaked in the solution of Gum-Tragacanth, and, after moistening the cover-glass with the brush, the diatom should be gently touched with the brush, which should be glided over the cover-glass. If there is any fear of disarranging the placed diatom it may be sufficient to place some gum completely round it, and to moisten it thoroughly with the breath; the gum spreads and fixes the diatom, but the first procedure is preferable and surer. By passing the brush between the lips, its point is re-made, and it is ready for selecting. (This is the method of Mr. H. Dalton).

"E. Imbibition.—One or more diatoms having in this manner been placed and fixed, the prepared cover-glass is put under the microscope and examined, to see if the diatoms are exactly the same species, and whether they are suitably arranged. When these conditions are fulfilled and after every trace of moisture has disappeared (heat gently for greater security) a drop of the imbibing solution is deposited on the cover-glass, and the progressive absorption of air bubbles can be observed under the microscope, further liquid being added when the previous dose is on the point of being evaporated, but there is no cause for alarm if it should trickle slightly over the sides on to the slip.

"F. Mounting.—When the air bubbles have disappeared and before the imbibing solution has completely evaporated, a drop of styrax is added; it should be left a few moments to allow the balsam to penetrate the diatoms so as to take the place of the imbibing solution (without this the bubbles may reappear), then it is carried to the heating table. It is heated until the styrax commences to smoke; should any bubbles be seen on the cover-glass, they can be burst by bringing the flame of a lighted match close to them; then making the cover-glass slide to the edge of the slip with the end of a pair of forceps it is taken hold of and turned over on to the centre of the slip. By taking the slip under the microscope while it is still warm, the cover-glass may be turned round in such a manner that the diatoms are in the best position. It now only remains to let it cool and to remove all surplus balsam with a piece of linen saturated with alcohol

"These operations take longer to describe than to carry out and a large number of types may be prepared in a very short time.

"If one wishes to place but one to three specimens on a cover-glass, it is better to fix them as I have indicated above. If, on the contrary, it is desired to arrange a larger number of individuals seriatim, it is preferable to previously coat the cover-glass with a layer of gum.

"It is useless to trouble one's self about the appearance of the diatoms before the balsam has been applied, because the gum (unlike gum arabic) subsequently becomes quite invisible."

CHAPTER II.

Terminology and Classification of Diatoms.

We intend in this chapter to review the various parts of a diatom with reference to the terms which we shall use in the classification and description of species. We shall examine in succession the frustule, the valve and its processes, the raphe, and the endochrome.

§ 1. Frustule.

By *frustule* is meant the whole silicious box or epiderm. The frustule is always formed of two parts called *valves*, one slipping over the other or with edges opposed.

By *girdle view* is meant the view of the frustule which shews the line of suture or self-division, called the *connecting zone;* and by *valve view* that which presents the *raphe* fully or the punctate or striate valve.

The frustule is much developed in the girdle view when the axis which is parallel to the sutural line is much shorter than the other. The axis parallel to the sutural line is called the *longitudinal axis* and the axis which forms a perpendicular with the sutural line is called the *transverse axis.*

The connecting zone may be broad or narrow; it may be united or display folds or puncta.

The frustule is said to be *geniculate* or *genuflexed* when one of its margins, or sometimes both margins, display a more or less sharp bend as in the *Achnanthes* (pl. 8, f. 323-337); it is called *bent* when the two margins are curved alike and in the same direction, and lastly, it is *arcuate* when one of its margins is more curved than the other.

The frustule is said to be *torsive* or *twisted* when the two extremities (apices) are turned in contrary directions: ex. *Surirella spiralis* (pl. 13, f. 592).

It is called *bacillar* when it is much longer than it is broad, as in *Synedra* (pl. 10, f. 402-438).

The frustule is *complex* when it has several sets of valves as in some *Navicula*, and it is *compound* when each valve consists of two or more plates of different structure as in *Arachnoidiscus* and *Actinoptychus* (pl. 22, f. 648, 649).

The frustule sometimes exhibits *partitions* or *septa*, which are internal longitudinal plates, that is to say, parallel to the connecting zone, as in the case of the genera *Rhabdonema* (pl. 12, f. 486a-488a) and *Striatella* (pl. 12, f. 483a-485a); these partitions are frequently (and most probably always) perforated.

In other cases the frustule shows false partitions or *vittæ*; these are prolongations from the margins of the connecting zone towards the interior as in the genus *Grammatophora* (pl. 11, f. 479-482a). These imperfect partitions are only visible in the girdle view, as may be seen in the genus *Meridion* (pl. 11, f. 474).

The frustule is *free* when it is neither attached by any of its parts nor enclosed in tubes or fronds; it is *adherent* when it is attached either to stones or to other algæ or to any bodies by means of an appendix produced by a prolongation of the coleoderm (mucous envelope).

In the latter case it is *stipitate* when this appendix forms a filament of some length and *sessile* when its length is scarcely appreciable.

Again, the frustule may also be enclosed in a mucus or in tubes or in branched filaments resembling the higher algæ, and in this latter case these filaments are called *fronds*.

The mucus, tubes, and fronds are formed of one and the same substance, viz., that which forms the coleoderm. This material, which is hyaline, albuminoid, and slightly silicious, is sometimes called *thallus*.

The stipes, fronds, tubes, etc., are the result of an excessive development of coleoderm, and this development varies with the habitat of the species. Sometimes it is considerable, at other times it is entirely wanting; Mr. Kitton has found *Navicula serians* and *Melosira Solerolii* (which are invariably free forms) enveloped in a thick mucus.

Schizonema neglectum, *Thwaites* is nothing but *Navicula gracilis*, *Kütz.*, living in tubes.

We do not therefore attribute any specific and less generic value to these secretions of the frustule.

§ 2. Valves.

A.—General Description of the Valve.

The valve is the moiety of the frustule. In comparing a diatom to a box (*e.g.*, pill box), the sides of the box correspond to the connecting zone, and the valves to the top and bottom.

A valve should be examined with reference to (1) its general appearance; (2) its outline; (3) its extremities (apices); and (4) its processes (appendices).

1st. General Appearance.—The valve is said to be *smooth* when it displays absolutely no pattern or any marking on the surface. This word, which was so frequently used by former authors having but imperfect microscopes at their disposal, can only now be applied in a few rare cases.

The valve is *alveolate* (*cellular* or *cellulose*, according to some authors), when it is marked with coarse dots, giving an hexagonal or angular appearance as in the *Triceratium* (pl. 21, f. 643).

Many diatoms of the sub-family Crypto-raphidieæ have an alveolate structure. The valve is *striate* when it displays *striæ* or fine lines formed of delicate puncta, which the microscope resolves (separates) with difficulty, as in *Amphipleura pellucida* (pl. 5, f. 253). It is *moniliform* when these *striæ* are formed of rows of very distinct beads, as, *e.g.*, in *Navicula Lyra* (pl. 4, fig. 161).

The valve is furnished with *costæ* when it displays very distinct coarse lines, often thick, and resembling ribs, and cannot be resolved into puncta. These *costæ* are often the result of the confluence of alveoles; this term is, moreover, also applied to the thickened spaces between certain rows of fine puncta.

When the striæ or costæ are not interrupted by a median line or raphe the valve is said to be *pervious striate* or transversely furnished with costæ; it is said to be *dimidiate striate* or *costate* when the striæ or costæ only extend over the moiety of the valve.

The valve is called *arcuate* when one of the margins is more curved than the other, as in *Ceratoneis Arcus* (pl. 10, f. 401). The convex side is often called the *dorsum* or *dorsal* margin, and the concave side is called the *venter* or *ventral side.*

The valve is *cymbiform* when it has margins unequally curved in opposite directions as in many *Cymbella.*

In this case we have similarly applied the term *dorsal margin* to the most convex side, and *ventral side* or *margin* to that which is less convex and situate on the concave side of the raphe.

The valve is *bent* when the sides are curved alike and in the same direction and *geniculate* or *genuflexed* when either one or sometimes both sides have an acute fold.

2nd. Outline.—The forms of the valve may be classified into two groups; firstly, forms which are circular or derived from a curved line, and secondly, those which are polygonal.

A. Valves, whose outlines are derived from a curved line, may be :—

Circular or *orbicular*: *i.e.*, forming a circle. Ex. *Coscinodiscus* (pl. 23, f. 664-668).

Rounded: *i.e.*, of an approximately circular form. Ex. *Surirella crumena* (pl. 13, f. 586).

Oval: *i.e.*, in the shape of an egg. Ex. *Surirella striatula* (pl. 13, f. 580).

Elliptic: *i.e.*, the outline forms an ellipse, that is to say, an elongated circle whose two extremities are equally *rounded.* Ex. *Cymatopleura elliptica*, type form (pl. 12, f. 480b.)

Reniform: *i.e.*, in the shape of a kidney. Ex. *Surirella reniformis.*

Lanceolate: *i.e.*, in the form of a lance head with narrow and somewhat pointed apices.

Cuneate or *cuneiform*: *i.e.*, in form of a wedge with rounded angles, as in many *Gomphonema* (pl. 7, f. 301, 302).

B. Valves whose outline assume a polygonal form, may be :—

Triangular: *i.e.*, having three angles as in the *Biddulphia* (*Triceratium*) *Favus*, type form (pl. 21, f. 643).

Quadrangular (pl. 21, f. 642), and *pentangular* as in certain *Triceratium.*

3. Extremities (Apices).—The apices of valves exhibit characteristics of great importance for descriptive purposes. They may be :—

Acute or *sharp-pointed*: *i.e.*, they imperceptibly taper to a point.

Obtuse: *i.e.*, they are more or less blunt at the point.

Truncate: *i.e.*, they appear to be cut off abruptly.

Attenuate and tapering, when they lessen in breadth abruptly, a modification which authors often improperly designate by the term *produced.*

A B C D E

Fig. 23.—Different forms of acuminate termination.
A.B. Acuminate apices.
C. Rostrate apex.
D. Acuminate-capitate apex.
E. Rostrate-capitate apex.

Acuminate: *i.e.*, they terminate more or less abruptly at the apex in a kind of narrow extension. Two kinds of acuminate termination can be distinguished.

1st. The *acuminate* termination properly so-called, that is to say, the narrowing of the conical point (fig. 23, A.B.).

2nd. The *rostrate*, when the narrowing takes the form of a beak with parallel margins (fig. 23, C.), as in *Navicula Amphirhynchus* (pl. 5, f. 214).

When, after the narrowing, the valve is again enlarged in the form of a head, it is called *capitate.* The valve may therefore be *acuminate-*

capitate (fig. 23 D.), as in *Navicula rhynchocephala* (pl. 3, f. 119), or *rostrate-capitate* (fig. 23, E.), as in *Navicula mesolepta* (pl. 2, fig. 96).

The valve shows a *lumen* when its apex is more brilliant than the other portions, which results from a thickening of the internal terminal margin of the valve, such deposit of silica refracting the light with greater power. Ex. *Stauroneis acuta* (pl. 1, f. 51).

4. PROCESSES.—Processes are projections which are generally seen to be standing out beyond the other parts of a diatom when it is examined in the girdle view; they are either spines, as in *Chætoceros* (pl. 18, f. 604) or places of attachment in filamentous (and probably other) forms, as in *Biddulphia* (pl. 20, f. 630-636).

The term process is hardly applicable to the simple blank spaces that are seen on the concave valve of *Gephyria*, or on the valves of *Dimeregramma* or *Plagiogramma*.

Alæ or *wings* are expansions usually of the margins of the valves, as in the *Surirella* (pl. 13); at other times they arise on the surface of the valve itself, as in the genus *Amphiprora* (pl. 5, f. 287-293). When the *alæ* are only slightly projecting, as in the *Nitzschia* (pl. 15), the valve is said to be *Carinate* (like a keel).

There must also be classed with processes the *Ocelli* which are pseudo-openings (in reality true processes) which present well marked external outlines when the valve is seen in the girdle view, as in the genus *Auliscus* (pl. 21, f. 646).

B.—MICROSCOPICAL STRUCTURE OF THE VALVE.

The structure of the diatom valve has formed the subject of numerous and important works, among which must be specially mentioned those of Messrs. Flögel ([1]), Otto Müller ([2]), Prinz and Van Ermengem ([3]), Cox ([4]), Haughton-Gill ([5]), and Deby ([6]). Flögel has

(1) Flögel: Untersuchungen über die Structur der Zellwand in der Gattung Pleurosigma. Archiv, f. Mik. Anat. VI., 1870, pages 472-514.

(2) Uber den feineren Bau der Zellwand der Bacillariaceën insbesondere der *Triceratium* und der *Pleurosigma*. Reichert und Du Bois-Raymond's Archiv, für Physiol., 1871.

(3) Recherches sur la structure de quelques Diatomées contenues dans le "Cemenstein" du Jutland, par. MM. W. Prinz et E. Van Ermengem, Annales de la Soc. Belge de Microscopie t. viii.

(4) Structure of the Diatom Shell. By Jacob D. Cox. Amer. Month. Micr. Journal, March, April, May, June, 1884. This is the most complete general study on diatom valves up to the present time. The author, in support cf his statements, has made a series of photographs of broken valves, a collection of which he has been good enough to send us. In several points, the ideas of Mr. Cox closely correspond with our own.

(5) On some methods of preparing Diatoms so as to exhibit clearly the nature of their markings, by C. Haughton Gill, J.R.M.S., 1890, pp. 425-8.

On the Structure of certain Diatom-valves as shewn by sections of charged specimens, by C. Haughton Gill, J.R.M.S., 1891, pp. 441-2.

(6) On the Microscopical Structure of the Diatom valve, by Julien Deby, in Journal of the Queckett Mic. Club, Sept., 1886.

Id. Sur la structure Microscopique des valves des Diatomées par Julien Deby, avec une planche, Journal de Micrographie, 1886.

solved the question in a convincing manner by sections of various diatoms. Messrs. Prinz and Van Ermengem have based their conclusions on sections of diatoms found in the Cemenstein of Jutland. Mr. Haughton Gill has had recourse to a method as ingenious as it is novel: by employing a number of chemical solutions he has, by double decomposition, produced in the very alveoles themselves various deposits (principally of the metallic sulphides) and has at the same time clearly proved the existence of cavities *in* the valve. Mr. Gill has thus treated the most varied genera, those with the finest as well as the coarsest structures, and all have given the same results.

The first experiments of Mr. C. Haughton Gill were made by soaking the valves with ferric chloride, then by treating them with a solution of potassium ferro-cyanide, thus producing deposits of Prussian blue, which are fixed in the interior of the alveoles, whilst the exteriors of the valves can be cleansed by washing. Later he used the double chloride of sodium and platinum decomposed by the subsequent action of oxalic acid; then mercury nitrate with ammonium sulphide, giving a black deposit of mercury sulphide, and then finally silver nitrate and ammonium sulphide, which is suitable for diatoms with very fine alveoles such as *Pleurosigma angulatum*, etc.

Again quite recently Mr. Albert Brun, of Geneva, the son of the celebrated and learned diatomist, confirmed in his turn that the before mentioned diatom-beads are alveoles or depressions (1) by a very ingenious method, which consists in examining the bodies under the microscope in liquids of various indices.

When a particle of a transparent body, submerged in a liquid, is microscopically examined and exactly focussed and the tube of the microscope is then raised, the object will appear to have a *brilliant centre* if its index of refraction is *greater* than that of the liquid, and to have a *dark centre* if its index is *smaller* than that of the liquid. By lowering the tube the exactly opposite phenomena will be produced. Should the object occupy an appreciable portion of the field, a brilliant band is seen moving across the centre of the fragment, and the whole object to be lightened up—whilst the tube is being raised—or else a brilliant band moves away towards the circumference, and the object becomes darkened according as its index is greater or smaller than that of the liquid. By lowering the tube the phenomenon is inverted. By

(1) Procédé de détermination de l'indice de réfraction de cristaux ou fragments de cristaux extrêmement petits, par A. Brun. Archives des Sciences Physiques et Naturelles de Genève August, 1894.

screening oneself from reflected light and giving several quick turns to the fine adjustment screw, the variations in the luminous intensity of the object enable very minute differences of refractive index to be calculated.

It is indeed easy to calculate a difference of 0.001 without any ambiguity. To obtain a good measurement, it is well to use monochromatic light, the dispersive power of the liquid never being the same as that of the solid. From this it follows that it would always be known, at least to about 0.001 whether a crystal has a greater or less index of refraction than that of any given liquid. This is to a large extent sufficient to diagnose a mineral.

The following will shew how Mr. Brun's method can be applied to prove that the beads on diatoms are alveoles :—

A large species of *Coscinodiscus* is chosen and examined in pure water. The beads are then seen to have a less refractive index than that of the silicious skeleton, for on raising the tube of the microscope they are seen to have a dark centre.

The same species examined in styrax shews that the refractive index of the bead is greater than that of the silicious skeleton, for by raising the tube they are seen to have a brilliant centre.

This double experiment proves, therefore, that the bead always assumes the refractive index of the medium in which the diatom itself is placed; now if the bead were solid this could not be the case, and consequently it follows that the bead must be a cavity. Even as far back as 1885, in my "Synopsis," I had arrived at the conclusion that alveoles existed, among other reasons because of the appearance that the valves assumed in the yellow medium. Mr. A. Brun's method is more complete than my own, and both confirms and establishes it.

Lastly, Mr. Deby, Mr. Cox, Mr. Müller and myself have endeavoured to elucidate the structure of valves by examining the fragments of broken valves. The study of these fragments—which was pursued with objectives of the greatest perfection (among which may be specially mentioned the 1-10th Apochromatic of 1·60 N.A. of Zeiss ([1]))—mounted in the most refractive media, such as monobromide of naphthalin, iodide of methylene saturated with sulphur, the medium 2·4, etc., the injection of coloured liquids —as well as the examination of numerous preparations and photographs, for which I am indebted to the kindness of Mr. Haughton Gill—and lastly the careful examination of an admirable preparation by Flögel,

([1]) See Dr. H. Van Heurck. La nouvelle combinaison optique de M. Zeiss et la structure de la valve des diatomées. Anvers, 1890, in 8vo, with plates.

showing a Triceratium Favus cut into 48 successive sections, have furnished conclusive results, a summary of which I shall now give:—

1. In the simplest cases: *Navicula*, *Pleurosigma*, etc., the valve consists of two plates or membranes and an intermediate grating.

By grating is meant a plate pierced with holes like a sieve.

The plates are sometimes but slightly united to the grating and may be easily detached from it; this may often be observed in large diatoms: *Coscinodiscus*, etc.; at other times, *e.g.*, in many *Navicula* they are so completely united to the grating that they appear to be incorporated with it.

The upper membrane may be of excessive delicacy, as is the case in the *Coscinodiscus*, it is then easily destroyed in the treatment with acids, in cleaning by rubbing, etc.

The lower plate is simple or complex.

It is simple when it appears in the form of a more or less thick homogeneous plate.

It is complex when it shows internal cavities within itself, and appears like the valve of a *Navicula*.

The lower plate of *Triceratium Favus* is constructed in this manner. Figure 24, which is a reproduction of one of the sections of Triceratium

Fig. 24.—Section of *Triceratium* (Flögel).

made by Dr. Flögel, which have already been described, exhibits these cavities.

Sometimes the lower plate may exhibit genuine holes, as is the case in *Coscinodiscus Oculus-Iridis*. Perhaps in the living diatom, there may exist a delicate lamina of silica over these openings, but in prepared diatoms, if successfully manipulated, genuine apertures may be seen, for coloured solutions may easily be injected into the alveoles formed by the openings of the grating.

The most experienced diatomists agree in believing that the membranes may be sufficiently permeable to allow the valvular contents and the water outside to change places by a process of endosmosis, but that there is no direct communication, so long as the diatom is living and intact. The openings in the internal plate, if there is one, as may be the case in the *Coscinodiscus*, are in all cases closed in the living diatom by the application of a cellular membrane.

2. The walls of the opening may be upright, but most frequently the opening tapers slightly at least towards the top, thus producing, with the concurrence of the superposed membrane, a species of little dome. It is this arrangement which causes the illusion of a bead.

3. The openings of the grating assume an hexagonal form when they are arranged in alternate rows. If, on the contrary, they are placed in perpendicular rows they are square or extended.

4. The walls of adjacent alveoles may be absent ; there is then a confluence of these alveoles into a kind of tube or pipe ; such is produced in the case of *Pinnularia* (sub-genus of *Navicula*) when the grating exhibits a series of parallel tubes, which have been named by some authors *costæ* or *canaliculi.*

The hexagonal form, which is so frequent in nature, appears to be the typical form of the openings in the grating, and when the valve is broad it is most frequently present without the costæ of consolidation and should offer assistance to exterior agents. Even in forms with square openings, deviations and returns to the hexagonal type-form are very frequently observed on certain portions of the valve.

These, then, are the principal features in the structure of the valves of diatoms, so far as we can ascertain with such means as science is able at the present time to place at our disposal. But the general structure may appear complicated either by the presence of internal secondary valves (Regenerations-hülle) or by deposits of silica producing in one place spines, granules, etc., in another place internal partitions either true or false, in a third place costæ, etc.

All these deposits are only secondary productions of silica which do not modify, in the slightest, the structure of the valve in its primary features.

In describing the valve, it is said to be *alveolate* or of *cellular structure* when the alveoles are large, and appear polygonal ; it is called *moniliform* or *punctate* when the alveoles are comparatively small. We have already mentioned these terms at the beginning of this paragraph.

C.—Variation in the Striation.

Former diatomists believed that the number of striæ that could be counted on a given space of the valve was fixed and invariable in each species. This was asserted by Ehrenberg, amongst others, in 1835, and Count Castracane repeated it a few years back. More recent diatomists have not confirmed these assertions, and Mr. J. Schumann was the first to establish (1) that the striation is variable, and that the number of striæ of any species slowly increases, according to the elevation of the locality in which the particular specimen is found.

Schumann deduced from his oft repeated researches that temperature was the most essential cause of variation in the striation. He established that for the same species the number of striæ so nearly corresponds with the temperature that, for a given elevation, the temperature of the locality can be so accurately determined by the number of striæ as to make a thermometer quite superfluous.

Pursuing his researches still further, Schumann was able to dispense with the barometer, and to determine the heights of mountains by examining the striæ of certain species, which he had previously studied in various localities of different heights above the sea level.

The assertions of Schumann have been lately confirmed by Frère Héribaud, of Clermont Ferrand (2) who has also studied the effects of light on the striation of valves which have been gathered from lake-bottoms. The author concludes his memoir thus:—

1stly. Under the influence of a feeble illumination, probably approaching the physical darkness which exists at 13 to 15 metres in the Lakes of Auvergne, *the striation of the valves of diatoms is less compact;* and, moreover, the *general form of the frustules is more elongated and narrow.*

2ndly. Under the influence of altitude, the striæ are more numerous and less robust.

§ 3.—Raphe and Nodules.

The *raphe*, which in Prof. H. L. Smith's classification (adopted in this work) determines the primary divisions of the family of diatoms, appears to be, *at least on one portion of its length*, a true cleft through which the contents of the frustule are put into communication with the liquid which surrounds it (3).

The matter, however, appears to be placed beyond a doubt by the researches of Mr. W. Prinz. This skilful microscopist has succeeded in obtaining a perfect section of a large Navicula (which we believe to be *N. Dactylus*) contained in the fossil deposit of Franzenbad.

(1) Die diatomcen der Hohen Tatra. Vienna, 1867.

(2) See De l'influence de la lumière et de l'altitude sur la striation des valves des diatomées par le Frère. Héribaud in Comptes-rendus. Acad. Sc., Paris (1894), cxviii., pp. 82-84; J.R.M.S. (1894), p. 491.

(3) Some authors, including Dr. A. Schmidt, deny that the raphe is a slit.

Fig. 25 (for which we are indebted to Mr. W. Prinz) is a faithful representation of this section; *a* is the raphe; *b*, *c*, *d* one of the costæ of the valve; *e* the bevelled margin of the valve; *ff* the central nodules; *gg* the connecting parts. The magnification is 1500 diameters. The portions of the plate that are printed black are of a brown colour in transmitted light.

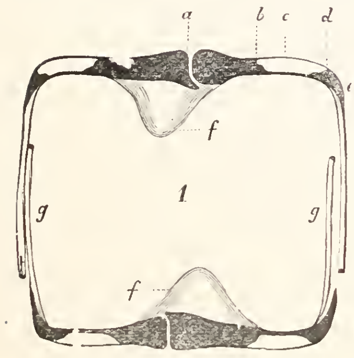

Fig. 25.—Section of *Navicula* (after W. Prinz).

The *raphe*, which is also called the *median line*, is generally interrupted by a *central nodule* and *two terminal nodules*.

The true raphe, such as exists in the *Navicula*, must be distinguished from the pseudo-raphe, which is a simple line or blank space and is without a central nodule, such for example as is seen in *Raphoneis*.

It is probable that all diatoms have more or less perfect raphes.

In the sub-family **I. Raphidieæ**, the raphe is quite evident, central or sub-central, but it sometimes only exists on one of the valves of the frustule, as is the case with the *Achnanthes* (pl. 8, f. 323-337) and the *Cocconeis* (pl. 8, f. 338-345).

In the sub-families **II. Pseudo-Raphidieæ** and **III. Crypto-Raphidieæ** it is obscure, marginal or sub-marginal; moreover the greater number of the valves of the sub-family II. have a central or sub-central pseudo-raphe.

The raphe may assume one of the following forms:—

1st. *Simple* as in most of the *Navicula* (plates 2-5).

2nd. *Bifurcated*, displaying in addition to the principal raphe a second raphe much narrower, and starting from the principal raphe, to which it also returns. Ex. *Stauroneis acuta* (pl. 1, fig. 51), *Navicula nobilis* (pl. 2, fig. 68).

3rd. *Double* placed on each side of the central and terminal nodules as in the *Vanheurckia* (pl. 5, f. 249-251).

The nodules are generally thickenings of the valve, which probably are the means of strengthening them.

In the Raphidieæ there are usually three nodules: the one placed in the middle of the valve is called the *central nodule*, and the other two situate near the extremities are called *terminal nodules*.

The central nodule is defective (or rudimentary) in the *Amphipleura* (pl. 5, f. 253), and it is duplicated in the *Berkeleya* (pl. 5, f. 254).

The nodules usually appear in the form of round or elliptical prominences. The central nodule is sometimes sub-quadrangular, and the terminal nodules are sometimes produced into the form of a crochet hook (Ex. *Cymbella Helvetica*, pl. 1, fig. 43).

When the central nodule is considerably enlarged transversely it receives the name of *Stauros*.

§ 4. Endochrome.

We have already examined the chemical and spectroscopical characters of the endochrome. It still remains to consider it as a criterion in certain classifications. The endochrome, as previously mentioned, is met with in two different states, viz., as plates or granules. These two states determine the primary divisions into sub-families in the classification of diatoms adopted by Professor Pfitzer, who has published an important work on the organography and evolution of diatoms. (1)

Afterwards the classification was taken up and completed by the examination of different marine forms by Mr. Paul Petit. Although we have not adopted the classification based on the endochrome, we give in the two pages following the key of the system as published by Mr. Petit in 1892. (2)

The table gives a resumé of our present knowledge of the different forms and positions of the endochrome.

The diatomist should, of course, be perfectly familiar with the modifications of the endochrome if he wishes to avoid finding himself in the position of a naturalist who contents himself with merely examining the skeletons of those organisms whose study he wishes to master completely. (3)

But one should not however exaggerate the value of the characteristics drawn from the modifications of the endochrome, and it is nowadays generally accepted that these modifications cannot claim for classification purposes the importance which Mr. Paul Petit has desired to attribute to them. With the exception of the primary divisions into Placcochromeæ and Coccochromeæ it is necessary in every instance to recur to the characteristics given by the valves in order to establish families.

(1) See the chapter "Bibliography."

(2) In the Journal de Micrographie of Pelletan.

(3) Recent observations have shewn that the form of the endochrome is not as invariable in the same genus as it was believed to be; thus, *e.g.*, in different Navicula, *N. Elliptica*, etc., the endochrome has been observed in a granular state. Count Castracane (*Brébissonia*, 1878, p. 75), asserts that the arrangement of the endochrome is variable, and that the arrangement of this substance "in small masses or distinct globules and of the same size, is the prelude to reproduction."

Table of the Pfitzer-Petit Classification.

Order. Diatomaceæ.—Unicellular algæ with a cell (or *frustule*) of two valves incrusted with silica, usually marked with very fine designs, striæ, dots, etc. *Endochrome* brown or dark green. Reproduction by conjugation and the formation of *auxospores.* Multiplication by division, the new frustules capable of remaining united in a filament or separating immediately. Cells free or adherent by a hyaline peduncle, or remaining united in filaments after bi-partition or contained in a mucilaginous tube :—

Sub-order (A).—PLACCOCHROMEÆ.

Endochrome arranged in more or less extended plates (*Endochrome Laminate*).

Sub-order (B).—COCCOCHROMEÆ.

Endochrome arranged in isolated scattered grains, arranged spirally or in rays (*Endochrome Granular*).

Sub-order (A).—PLACCOCHROMEÆ.

	Families.
1. A single plate of Endochrome	I. **Cymbellaceæ.**
2. A plate of Endochrome, but perforated in the centre, and often so as to completely divide it into two portions . .	II. **Nitzschiaceæ,**
3. Two plates of Endochrome	III. **Naviculaceæ.**

Sub-order (B).—COCCOCHROMEÆ.

Frustules compound or with diaphragms.	Valves linear, elliptic, constricted, cuneate or conical		IV. **Tabellariaceæ.**
Frustules simple . .	Valves elliptic or cuneate . . .		V. **Fragilariaceæ.**
	Valves rounded, furnished with long filaments		VI. **Chætoceraceæ.**
	Valves polymorphous, triangular, quadrate, polygonal . . .		VII. **Biddulphiaceæ.**
	Valves discoid, Frustules :—	Free. Valves more or less depressed .	VIII. **Coscinodiscaceæ.**
		United into cylindrical filaments or two and two. Valves more or less convex like a thimble . .	IX. **Melosiraceæ.**

Sub-order (A.)—PLACCOCHROMEÆ.

Family (I.)—CYMBELLACEÆ.

		Tribes.
Frustules with dissimilar valves		1. **Achnantheæ.**
Frustules with similar valves . .	Valves cuneate, asymmetrical about the minor axis	2. **Gomphonemeæ.**
	Valves cymbiform, asymmetrical about the major axis	3. **Cymbelleæ.**

Family (II.)—NITZSCHIACEÆ.

Frustules with similar valves . .	Valves linear, asymmetrical about one or both axes ; furnished with a punctate keel (Endochrome divided by a deep slit)	4. **Nitzschieæ.**

Family (III.)—NAVICULACEÆ.

		Tribes.
Frustules with similar valves, asymmetrical about both axes	Valves elliptic with a projecting keel .	5. **Amphiproreæ.**
	Valves sigmoid, without keels or alæ .	6. **Pleurosigmeæ.**
Frustules with similar valves, symmetrical about both axes	Valves naviculoid, without keels or alæ.	7. **Naviculeæ.**
Frustules with similar valves, symmetrical about the major axis .	Valves elliptic, with marginal alæ and robust costæ	8. **Surirelleæ.**
	Valves linear, without alæ or keels .	9. **Synedreæ.**
Frustules with similar valves, symmetrical about the minor axis .	Valves arcuate	10. **Eunotieæ.**

Sub-Order (B.)—COCCOCHROMEÆ.

Family (IV.)—TABELLARIACEÆ.

Frustules rectangular or cuneate, furnished with diaphragms or semi-diaphragms parallel to the valves .	Frustules rectangular. Valve view generally elliptic, never cuneate . .	11. **Tabellarieæ.**
	Frustules and valves cuneate, valve view cuneate	12. **Licmophoreæ.**
Frustules cylindrical, consisting of plates united by their margins and terminating in conical or pointed valves		13. **Rhizosolenieæ.**

Family (V.)—FRAGILARIACÆ.

Valves linear, elliptic, constricted or sometimes cuneate; striate transversely, without nodules or raphe	14. **Fragilarieæ.**
Valves elliptic, punctated with coarse puncta, often quadrate with hyaline spaces at the centre and apices	15. **Plagiogrammeæ.**
Valves always cuneate with coarse puncta, often quadrate or with slits like buttonholes. No hyaline space at the centre . . .	16. **Trachysphenieæ.**

Family (VI.)—CHÆTOCERACEÆ.

Valves rounded or elliptic, furnished with long filaments . .	17. **Chætocereæ.**

Family (VII.)—BIDDULPHIACEÆ.

Valves polymorphous, triangular, quadrate, polygonal, sometimes elliptic, never discoid, often furnished with spines . . .	18. **Biddulphieæ.**

Family (VIII.)—COSCINODISCACEÆ

Valves discoid, sometimes elliptic, furnished with one or more marginal ocelli or projecting tubercular processes	19. **Eupodisceæ.**
Valves discoid, divided (following the course of the radii) into sections alternately light and dark	20. **Heliopelteæ.**
Valves discoid with a central hyaline area connected by hyaline furrows to marginal ornate compartments	21. **Asterolampreæ.**
Valves discoid, sometimes elliptic, with surface covered with areoles of beads arranged in lines radiate, transverse or vertical, or well divided in concentric zones with different markings . .	22. **Coscinodisceæ.**

Family (IX.)—MELOSIRACEÆ.

Valves discoid, very convex, furnished with marginal spines. Frustules globose	23. **Xanthiopyxideæ.**
Valves discoid, flat or slightly convex, sometimes furnished with small spines on the surface. Frustules cylindrical, often united into cylindrical filaments	24. **Melosireæ.**

§ 5. Classification adopted in this Work.

As I have already stated above I have followed in this work the classification of Professor H. L. Smith, which was published by its author in 1872 in the Microscopical Journal *The Lens*, printed formerly at Chicago. The conflagration, which shortly afterwards laid a large portion of that city in ruins, also destroyed the greater portion of the edition of *The Lens*. I attempted to supply this loss by publishing in 1878, in the third edition of my treatise on the Microscope, a translation of Professor Smith's work, made from a copy which my learned friend had the kindness to forward me for my consideration, containing various corrections and numerous additions intended to elucidate the original text.

The classification of Prof. H. L. Smith is exclusively based on the structure of the silicious epiderm or box. He regards (1) any classification based upon the arrangement of the endochrome as simply impracticable, as it is manifestly impossible to study many of the forms (*e.g*, those of deep sea soundings and the various fossil deposits) with any regard to this endochrome arrangement. He admits "that if only living diatoms were available in every case, a system based on the endochrome might be preferable, and in certain cases it would be easier to distinguish the genus by the frustule, when living, than when mounted. Such is, for example, the case in small *Nitzschia*. Since it is evident that the structure of the frustule is, so to speak, co-ordinate with endochromatic arrangement, and the former is permanent while the latter is transient, the system which is based on the *general build* of the frustules cannot be considered wholly artificial. Indeed in the parallel case of the animal kingdom the two rival systems would be, one based on the position of the viscera (scarcely this, as no organs are observed in the diatoms, and so we may say distribution of the food), the other on the structure of the skeleton. Few would hesitate which to choose." I have therefore in this work followed the principal outlines of Professor Smith's classification, but I have altered its details very considerably, since I regard them from a slightly different point of view.

The present work gives a description and figure of every genus which is, in my opinion, at the present time admissible and of every species generally distributed in the countries bordering on the North Sea.

As already stated, all the original figures of this work have, as far as possible, been drawn or photographed at a magnification of 900

(1) Notes on Cent. I. of the Species typicæ Diatomacearum in the American Journal of Microscopy for August, 1877.

diameters and then reduced by phototypy to 600 diameters in the case of genera (except where otherwise stated) and to 400 diameters in the case of species.

The figures have as a rule been phototyped from the original plates of my *Synopsis des Diatomées de Belgique* Atlas, for which they were drawn from nature by Mr. A. Grunow and myself.

The large number of new figures which appear in this work have been drawn from photographs which I have made from some of my preparations. As I have been unable, in the case of a few genera, to procure actual specimens, I have in such cases reproduced the original figures published by their authors.

A few of the species have been reproduced from the original figures of Gregory, Ad. Schmidt, etc., reduced in every case to a magnification of about 400 diameters.

The originals of all the figures in the work will be found in the place cited after the name of the species. If my Synopsis Atlas is not mentioned, the figure is reproduced from the author quoted, and I have also indicated by an asterisk the work from which the figure is taken.

§ 6. Of Genus and Species.

In the text of the Synopsis which appeared in 1885, I gave tables for the determination of genera from the work of Professor H. L. Smith; but in the interval the science has advanced, and very many new genera have been established in the important works published during those ten years. In another respect my ideas have become slightly modified. While I certainly do not admit genera founded on unimportant characteristics, or on the variable modifications of the coleoderm, such as the sheath, the stipes, etc., I nevertheless believe that reductions must not be pushed to an extreme. A larger number of genera—so long as they are easily distinguishable—is advantageous, inasmuch as they restrict the number of species from which a selection has to be made.

All the forms are evolved from a small number of original forms, sometimes even from a single one; in proportion as researches multiply, a greater number of links are discovered, which connect forms with one another, between which there appeared formerly to be no connection whatsoever.

These new links naturally diminish the value of the differential characteristics previously admitted, and increase the difficulty of determining the species. It is therefore necessary to discover fresh divisions, often based on very slender differences, so as to have a sufficient number of distinctive features to enable their position in the scheme of classification to be determined without too much difficulty.

The value of generic characteristics is moreover very different in various groups, and authors also interpret them very differently. Moreover, this cannot be otherwise in the present state of diatomography so long as so many forms are still unknown to us, and others are only known by just a few rare valves or even in some cases by solitary ones.

In the same way I have been logically compelled to adopt certain genera rejected by Professor Smith. Such, for example, as those founded on a cuneate form. The *Gomphonema* are nothing else but cuneate *Navicula*. If the genus *Gomphonema* be admitted, it is impossible to refuse to admit *Meridion*, *Gomphonitzschia*, *Trachysphenia*, etc.

If difference of beading is of any importance, it is impossible to unite *Sceptroneis caduceus* with *Raphoneis*, with which *Trachysphenia* is also intimately connected, and it is also impossible, in my opinion, to unite *Sceptroneis caduceus* with *Sceptroneis gemmata*, which is closely allied to *Opephora*.

Such are a few of the reasons which I give for adopting a much larger number of genera than I previously admitted. In the future, when forms are better known, it will be necessary to decide whether many of the present genera, which I have admitted in this work to facilitate study, should be maintained, or whether they should not rather be considered as generic sections.

With reference to species [1] my ideas have not undergone any alteration. If it is difficult to agree on the relative value of higher plants it is, in my opinion, much more difficult to do so in the case of diminutive diatoms, and it is almost impossible—in our present state of knowledge at least—to fix with any certainty what forms should be considered as primordial species, that is, species that have given birth to those derived forms called secondary and tertiary species, varieties, etc., and which bear a more or less close relationship or resemblance to the primordial form.

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[1] I will here refer to a few classical definitions :—

A species is an aggregate of individuals which have been proved to have descended from a common ancestor, or are so similar to one another that they may be presumed to have done so.—J. D. HOOKER.

L'*espéce* est la réunion des individus descendus l'un de l'autre ou de parents communs, et de ceux qui leur ressemblent autant qu'ils se ressemblent entre eux.—CUVIER.

La *variation* est une forme passagère et fugace difficile à conserver.

La *race* est une variation qui se conserve habituellement par sélection artificelle, rarement par sélection naturelle.

La variété est une variation plus profonde qui se conserve tant que durent les causes au milieu desquelles elle s'est produite.—CAUVET.

Indeed such confusion has arisen *in our text books* as to many named forms, that any intermediate forms can be indifferently assigned to two totally different type forms created by *their authors*.

This would therefore force upon us the conclusion that forms are constantly and rapidly changing and that they pass from one species to another by infinitesimal transitions.

But this opinion cannot be maintained. I have previously stated that it may be assumed that our many existing forms sprang from one or from several primitive forms. These primordial forms have given birth to secondary, tertiary forms, etc., which were differentiated in certain directions and which have continued to evolve more or less in their turn in those directions.

But this evolution, we believe, has only been brought about very gradually, and probably also under the influence of special circumstances, of which we know but little, but some of which we may at least suspect, such as the presence of a greater or less quantity of silica or salt in the water, the temperature and the amount of illumination, etc.

The assumption of primitive and derived forms (species, varieties, etc.) is all the more easy to admit from the fact that diatoms can, in certain instances, if the experiments of Dr. Miquel can be trusted, reproduce themselves, almost indefinitely, by subdivision and without the intervention of any act of fecundation.

The diatomist has at his disposal in fossil forms, which came into existence ages immeasurably distant, materials so perfectly preserved that he might almost believe they dated from yesterday. These materials shew us that a diatom form can be maintained so quasi-indefinitely, that it is scarcely modified at all so long as it remains under the same conditions of life.

Van Heurckia rhomboides, which is found in so many different fossil deposits, is identically the same as that which is found living to-day in numberless localities; *Arachnoidiscus Ehrenbergii*, which is still found inhabiting the Sea of Japan and occurs in all respects the same in the deposits of Hungary, which date back to the remote tertiary period when a tropical sea covered Central Europe, again confirms this assertion.

It is therefore more logical to admit that the apparent transitions recorded arise from the fact that authors have created different "species" at the expense of varieties or of races of the same specific type form, and that true species are in reality much less numerous than has been hitherto imagined.

It cannot happen therefore, till research has been much further prolonged, that the many living or fossil forms, as yet unknown to us, can be compared and connected with one another; that studies can be guided by evolution, *i.e.*, genealogical descent; and that it will be possible to soundly appreciate the relative value of the forms of diatoms.

At present we are only guided by personal appreciation and we are describing and figuring many forms, which is certainly useful towards a final enumeration and a perfect knowledge of the genealogical series. But many of the present *specific* denominations have been created for *individual* forms and for *particular states* and ought therefore to be certainly curtailed.

The difficulty is moreover very great, because no certain and really fixed character exists for the delineation of species. The external outline, size, striation, the smooth portions of the valve are all characteristics which vary to a very considerable extent in examples of the same species, and even the two valves may differ from one another, while age may produce differences in their sculpture.

However, the best authorities endeavour to greatly reduce the species which it is really necessary to admit. Among these authorities figures in the first rank the Honble. J. D. Cox, of Cincinnati, who published a short time ago a work on this subject ([1]) which made a great stir amongst diatomists.

Mr. Cox would reduce to seven forms the numerous species (many hundreds!) of *Coscinodiscus*, even including in them *Actinocyclus Ehrenbergii.* These reductions have been severely criticised, as might be supposed, but having received from the author a special copy of his work, together with a number of photographs supporting his views, I am quite of the opinion of the learned American diatomist that it would be very advantageous to reduce the forms of *Coscinodiscus* to a small number of species. It is, moreover, what I myself ventured to propose some years ago in writing to many of my friends and it entirely accords with the text of the Synopsis. Nevertheless, in my opinion, the genus *Actinocyclus* ought to be kept separate.

Up to the present time the only attempt that has been made to escape from the labyrinth in which the diatomist thus finds himself, has been but a limited one, viz:—the study of pure gatherings, which are unfortunately rare; by the examination of the forms found in these gatherings, their relations may sometimes be ascertained.

We may now, however, expect to accomplish more in the future. The cultivations originated by Dr. Miquel afford to the diatomist results which he could not a short time ago have dared to hope for, and it may well be anticipated that through the aid of these cultivations

([1]) "The Coscinodisceæ." Notes on some unreliable criteria of genera and species, 1890.

we shall gradually be able to determine the variations of the principal forms which are to be found around us. It will be no inconsiderable service that Dr. Miquel will thus have rendered to diatomology by having thus suddenly developed a new method, which will enable diatomologists to confidently pursue a series of studies, which cannot but lead to results of the utmost importance in the future.

Whilst I have endeavoured to fall in with these recent ideas, and as this work is especially intended for beginners, I have preferred to use "Species" in its widest sense, and I have adopted a small number of principal type-forms, to which I have referred secondary type-forms. This will prevent the beginner from losing himself in a complicated labyrinth of forms, while those who do not share this view have only to raise my varieties to the rank of species.

The preceding lines were written before I received from Mr. C. Naudin his work on "kindred species" ([1]). I am pleased to see that this learned botanist, who has had such prolonged experience and is so competent an authority on the subject, has arrived by the cultivation of Phanerogamia at the same conclusion as myself. "Any *objective* definition of species," writes Mr. Naudin, "is impossible, and one must either be content with the arbitrary definition of Linnæus and his successors or admit with me that Species, Race, and Variety are *purely rational* categories, which the fancy of each person modifies according to the impression that he receives of any object and this impression varies in each individual, and even in the *same* individual it will depend upon that mental state in which he happens to find himself. . . ." "Nomenclature," says the author a little further on, "should know when to stop on the downward course of subdividing, the exaggeration of which would produce the gravest consequences. It is first necessary to settle and fix amicably the limits at which it would be convenient to stop, so as not to overcharge with terms sciences already too much encumbered, and which, without this prudent check, would gradually become quite unapproachable." ". . . I know of certain authors whose writings would seem to shew that specific subdivision was quite a *mania* with them, and it is quite necessary to point out the mal-treatment that certain good Linnæan species have suffered at their hands: for before they had been cut about in this way they were perfectly recognizable, but since this so-called improvement these authors have in their books made quite an inexplicable *magma* of them. What benefit have these authors rendered to science?

([1]) Les espèces affines et la theorie de évolution par Ch. Naudin de l'Institut. Paris, Baillière et fils.

What new idea have they introduced? They have but wasted the best of their time and energy in seeking minutiæ which they alone perceive, and which, after all, only result in the overburdening of a nomenclature which is already very embarrassing. I feel very tempted to apply the following cruel adage to the results of their patient labour:—*Verba et voces prœterea nihil.*"

Let the diatomist reflect, and he will see that what Mr. Naudin has also said with regard to higher plants (in which comparison can easily be made with the naked eye) is even still more applicable to diatoms, which are probably affected by a good many more influences than we are ever likely to know of. When one has observed for the number of years that Mr. Naudin and myself have—if I may be permitted to join my name with his—the varieties of forms in the cultivation of Phanerogams, one is less inclined to create a fresh name for every slight modification in the valves of diatoms. It will be noticed that these innumerable forms have only been created by specialists who have not been accustomed to the study of the higher plants, whilst Walker-Arnott, Professor of Botany at Edinburgh, and de Brébisson, who are both of them eminent florists and Phanerogamists, have created new species but sparingly.

CHAPTER III.

BIBLIOGRAPHY.

§ 1.—General Bibliography.

The number of books or articles which have been written on diatoms is very considerable: Mr. Julien's Deby's work, *Bibliotheca Diatomologica*, gives an almost complete list, and to which useful work we refer those who desire to become acquainted with all the literature of the subject. We shall content ourselves by giving below a list of the more important works, either on the subject generally, or those possessing special interest from their descriptions of species, and which should, for that reason, have a prominent position assigned to them in the library of any one who desires to exhaustively study diatoms.

Agardh (C. A.)—Conspectus criticus Diatomacearum. Lundæ, 1830.

Borscow (Prof. E.)—Die süsswasser Bacillarien (Diatomaceen des Westlichen Russlands. Kiew, 1873.

The first volume, which was the only one that appeared, contains general remarks on diatoms.

de Brebisson (Alphonse).—Diatomées renfermées dans le vermifuge connu sous le nom de Mousse de Corse (Revue des Sciences Naturelles, Sept., 1872).

Brun (J.)—Diatomées des Alpes et du Jura et de la région Suisse et Française des environs de Genève. Genève, 1880, avec 9 planches.

Castracane (A. F.)—La diatomée in relazione alla geologia. Atti nuovi Lincei, 1874.

Instruzione per chi vogli raccogliere Diatomée. Atti nuov. Linc, 1875.

Se e qual valore sia da attribure nella determinazione delle specie al numero delle strie nelle Diatomee. Atti nuovi Lincei, 1879.

Report on the Diatomaceæ collected by H.M.S. "Challenger" during the years 1873-1876. 30 plates. Rep Chall. Expedit. Bot. Vol. II. 4to. London, Edinburgh and Dublin, 1886.

Cleve (Prof. P. T.).—Svenska och Norska Diatomacéer. Académie Royale de Suède, 1868.

Diatomaceer fran Spetzbergen (Idem, 1864).

Diatoms collected during the expedition of the "Vega" examined by P. T. Cleve, 1883, with 4 plates. Very important work.

The diatoms of Finland; Helsingfors, 1891, 8vo., with 3 plates.

Professor Cleve has published a large number of pamphlets, which will be found enumerated in Deby's work. Mr. Cleve has just completed a monograph on the Raphidieæ. This work, which is the result of prolonged study, will finally reduce to order those enormous groups called Amphora, Cymbella, Navicula, Amphiprora, Cocconeis, etc., in which the diatomist has experienced so much difficulty in classifying.

Cleve and Grunow.—Beitrage zur Kenntniss der arctischen Diatomeen. Académie Royale de Suède, 1880, with 7 plates.

Deby (Julien).—Ce que c'est qu'une Diatomée. Bruxelles Soc. B. Mic., 1877.

Les apparences microscopiques des valves des diatomées. Ann. Soc. Belge de Microscopie, 1880.

Analysis of the Diatomaceous genus Campylodiscus, published for Julien Deby, London, 1891, with 15 plates (phototypes). An excessively important work which has liberated the genus of the confused state in which it had previously been.

Bibliotheca Diatomologica seu catalogus librorum et collectionum exsiccatarum Bacillarieas quascumque sistentium; curante J. Deby, 8vo.

This important work forms the introduction to the work of De Toni. Some copies as a separate work have been distributed.

De Toni (J. B.)—Sylloge Algarum omnium hujusque cognitarum. Vol. II., Bacillariæ.

Sec. I. Raphideæ—Patavii, 1891.
Sec. II. Pseudo-raphideæ—Patavii, 1892.
Sec. III. Crypto-raphideæ—Patavii, 1894.

An indispensable work for the general study of species which have hitherto been named. It should find a place in the library of every earnest diatomist. There will be found in it an exact account of all forms established by various authors, together with a reference to localities, pages and figures, and a good description whenever sufficient information has been given to connect the form.

Donkin (A. S.)—The Natural History of the British Diatomaceæ—3 parts. London, 1870-1873.

The part which appeared comprises a portion of the *Navicula*. It was interrupted by the death of the author.

Ehrenberg (C. G.)—Mikrogeologie. Leipzig, 1854. Und Fortsetzung. Idem, 1856. Large folio with 41 plates.

A very expensive work, the figures of which leave much to be desired in exactness.

Gregory (William)—On new forms of Marine Diatomaceæ found in the Firth of Clyde and in Loch Fine. 4to (Trans. of Royal Society of Edinburgh, 1857), with 14 plates.

Greville.—His works mostly published in the Q.J.M.S. There has been published at Leipzig, at the expense of an American microscopist, a photographic reproduction of the plates of his works. This reproduction is very useful. It can be obtained at a reasonable price. Mr. W. Collins, of London, and Mr. Felix Dames, of Berlin, have sometimes some copies on sale.

Grove (E.) and **Sturt (G.)**—On a fossil Diatomaceous deposit from Oamaru, Otago, New Zealand. London, 1886-87.

Grunow (A.)—Ueber neue oder ungenügend gekannte Algen (Abh. kk. zool. bot. Gesellschaft in Wien, vol. X.), 1860, with plates.

Die Osterreichischen Diatomaceen (Idem, Vol. XII.), 1862.

Ueber einige neue und ungenügend bekannte Arten und Gattungen von Diatomaceen (Idem, vol. XIII.), 1863.

Reise seiner Maj. Fregatte Novara, Wien, 1868, 4to, with plates.

Algen und diatomaceen aus dem Kaspischen Meere. Separat-abdruck aus den Sitzung-Bericht der natur. Gesellschaft "Isis," 1878, 8vo, with plates.

Vorläufige Bemerkungen zu einer systematischen Anordnung der Schizonema und Berkeleya Arten, mit Bezug auf die in Van Heurck's Diatomeen flora von Belgien Veroffentlichten Abbildungen der Frustuln auf Tabel xv., xvi., und xvii. Separat-abdruck aus No. 47/48 des Botanischen Centralblattes, 1880.

Ueber die Arten der Gattung Grammatophora mit Bezug auf die Tafeln liii. und liii. bis in Van Heurck's synopsis der belgischen Diatomeen. Beilage zum Botanischen Centralblatte, 1881, band vii.

Beitrage zur Kenntniss der Fossilen Diatomeen Osterreich-Ungarns, 4to, with two plates. Wien, 1882.

Die Diatomeen von Franz Josef's land, 4to, with five plates. Wien, 1884 (see also Cleve and Grunow).

Habirshaw (Frederick).—Catalogue of the Diatomaceæ with references to the various published descriptions and figures. 1st edition. New York, 1877. Written with an electric pen by the Author, 50 copies being produced and generously distributed amongst Diatomists. An edition, printed and published at New York, by Mr. Romyn Hitchcock, was commenced, but was interrupted at page 58.

A new Edition has been published by Dr. Chase, entitled Habershaw's Catalogue of the Diatomaceæ, by H. H. Chase, Geneva. New York, 1885, 4to.

This work, which enumerates all the species of diatoms, giving the pages where described and the plates where they are figured, is indispensable to any one engaged in diatom work, but it is very difficult to obtain.

Heiberg (P. A. C.)—Conspectus criticus Diatomacearum Danicarum (in Danish). Copenhagen, 1863, with 6 plates.

Janisch (C.)—Expedition of the steamer "Gazelle." 14 magnificent photographic plates. The corresponding text has not yet been published and these plates, which have only been distributed amongst a few Diatomists, are not yet on sale.

Zur charakteristik des Guano's von Verschiedenen Fundorten—Breslau, 1862, with plates.

Juhlin-Dannfelt (H.)—On the Diatoms of the Baltic Sea. Stockholm, 1882. With 4 plates.

Kützing (Fred. Traugott.)—Die Kieselschaligen Baccillarien oder Diatomeen. Nordhausen, 1844, with 30 plates.

Species Algarum. Lipsiæ, 1849.

Lagerstedt (N. G. W.)—Sötvattens-Diatomaceer från Spetsbergen, och Beeren Eiland (Royal Academy of Sweden), 1873.

Lanzi (M.)—Le Thalle des diatomées. Ann. Soc. belge de Microscopie, 1878.

Leuduger-Fortmorel (Dr.)—Catalogue des diatomées marines de la baie de St.-Brieuc et du littoral des Côtes-du-nord. Paris, 1879 (Ext. bull. Soc. Bot., France).

Manoury (Ch.)—De l'organisation des Diatomées, Caen, 1869.

Müller (Otto).—Ueber der feinern Bau der Zellwände der Bacillariaceen, inbes. d. Triceratium Favus und der Pleurosigma.—Reichart und Dubois Reymond's Archiv, 1871.

Ueber den Bau der Zellwände in den Gattungen Grammatophora—Sitz. bericht der Gesell. Naturf. Freunde 1874.

Die Zellhaut und das Gesetz der Zelltheilungsfolge von Melosira arenaria. Berlin, 1883, with 5 plates.

Die chromatophoren mariner Bacillariaceen aus den Gattungen Pleurosigma und Nitzschia. Berlin, 1883.

O'Meara (**Rev., Eug.**)—Report on the Irish Diatomaceæ. (Proc. Royal Irish Academy, 2nd ser., vol. 2.) Only the first part appeared.

Pantocksek (**Jos.**)—Beiträge zur Kenntniss der fossilen Bacillarien. Ungarns, 8vo.

I. Marine Bacillarien, with 30 plates. 1886.

II. Brackwasser Bacillarien, with 30 plates, 1889.

III. Süsswasser Bacillarien, with 42 plates, 1892.

Peragallo (**H.**)—Diatomées du Midi de la France. 8vo. Toulouse, 1884.

Diatomées de la Baie de Villefranche. 8vo, with six plates. Paris, 1888.

Monographie du genre *Pleurosigma* et des genres alliés. 4to, with 10 coloured plates. Paris, 1891.

A capital work on the subject matter, and which must not be overlooked by anyone who would study exotic forms.

Monographie du genre *Rhizosolenia* et de quelques genres voisins. 8vo, with 5 plates, Paris, 1892.

The same remark applies to this work.

List of French diatoms in "Les Diatomées, par J. Pelletan." 8vo. Parif, 1888-9.

Petit (**Paul**).—Liste des Diatomées et des Desmidiées observées dans les environs de Paris, precédée d'un essai de classification des diatomées. Paris, 1877. (Extract from the Bulletin de la Societé. Bot. de France).

Pfitzer (**Dr. Ernst**).—Untersuchungen über Bau und Entwicklung der Bacillariaceen. Bonn, 1871. Extremely important.

Prinz (**W.**).—Etudes sur des coupes de diatomeés observeés dans des lames minces de la roche de Nykjobing (Jutland). Bruxelles, 1880. 1 pl.

Prinz (**W.**) **and Van Ermengen** (**É.**)—Recherches sur la structure de quelques diatomées contenues dans le "Cementstein" du Jutland. Bruxelles, 1883, with 4 plates.

Pritchard (**Andrew**). — A History of Infusoria, including the Desmidiaceæ and Diatomaceæ, British and foreign. 4th Edition, London, 1861.

Out of print; rare and very dear.

Rabenhorst (Dr. Louis).—Flora Europæa Algarum aquæ dulcis et submarinæ, Sect. i. Algas Diatomaceas Complectens. Leipziæ, 1864.

Rataboul.—Les Diatomées, récolte et préparation. Toulouse, 1883.

Rattray (John).—A revision of the genus "Aulacodiscus Ehr." 3 plates. London, 1888.

A revision of the genus "Auliscus Ehr," and of some allied genera; 5 plates. London, 1888.

A revision of the genus "Coscinodiscus Ehr," and of some allied genera; 3 plates. Edinburgh, 1890.

A revision of the genus "Actinocyclus Ehr." 1 plate. London, 1890.

Royal Microscopical Society.—(I.) Transactions recorded in the Microscopical Journal. London, 1841-3.

(II). Transactions. London, 1844-1852. 3 vols.

(III). Quarterly Journal of Microscopical Science; including the Transactions of the Microscopical Society of London. First series, 1853-1860.—Second series, 1861-1868. A very expensive work, but it includes numerous and important papers on Diatoms.

(IV.) Monthly Microscopical Journal. London, 1869-1877.

(V.) Journal of the Royal Microscopical Society. London. Commenced in 1878. This publication still continues.

Schmidt (Archidiaconus Adolf).—Atlas der Diatomaceenkunde Achersleben, 1874 and following years.

Plates in 4to., by Woodburytype.

Schumann (J.).—Preussiche Diatomaceen Mitgetheilt Von Oberlehrer. J. Schumann (Schriften der Konigl. Physikalisch-Okonomischen Gesellschaft, 1867). Supplement idem, 1869.

Smith (Rev. Wm.).—Synopsis of the British Diatomaceæ. Two volumes. London, 1853-1856.

A classical work with excellent plates. Out of print, rare and dear.

Smith (Prof. Hamilton, L.)—Synopsis of the Diatomaceæ, published in the "Lens," Chicago, 1862. A translation appears in the 3rd Edition of "Traité du Microscope," by Dr. H. Van Heurck.

Tempère (J.).—"Le Diatomiste," a journal devoted specially to diatoms, and to everything connected with them. Paris, J. Tempère, 168, Rue St. Antoine. Commenced in 1890. A very important journal for all diatomists. Price 12s. a year.

Van Heurck (Dr. Henri).—Le Microscope, sa construction, son maniement. 4th Edition. Anvers, 1891.

English Edition of the same, re-edited and augmented by the author, and translated by Wynne E. Baxter. London and New York, 1893.

Synopsis des Diatomées de Belgique. 8vo, 1880-1885.

(I.) An atlas of 138 plates, containing 3,200 figures.

(II.) A volume of text.

(III.) A volume of alphabetical tables.

Witt (O. N.).—Ueber den Polierschiefer von Archangelsk-Kurojedowo im Gouvernt. Simbirsk, 7 plates, 8vo. St. Petersburgh, 1887.

Witt (O. N.) and Truan (A.).—Die Diatomaceen der Polycystinenkreide von Jérémie in Hayti, West Indien. 7 plates, 4to. Berlin, 1888.

§ 2.—Collections of Diatoms.

Collections of diatom types have been published at different periods. The most important are :—

Cleve and Möller.—*Diatoms* Upsala, 1877-1882.—Six parts, containing altogether 324 very interesting preparations, and accompanied by a detailed analysis by Mr. A. Grunow.

Delogne (C. H.).—*Diatomées de Belgique* arranged in accordance with the synopsis of Dr. Henri Van Heurck. Published in parts containing 25 preparations. Brussels, 1880-1882, four parts containing about 100 preparations were published. The preparations, which are very well made, have a special interest to those who have our synopsis.

Eulenstein (Dr. Th.).—*Diatomacearum species typicæ.* Cent i. Stuttgart, 1868.

A collection of preparations which leaves nothing to be desired. Only the first 100 appeared. The second was about to appear when the author died.

Möller (J. D.)—Diatomaceen typen-platte. Under this title Mr. Möller, of Wedel (Holstein), sells a preparation containing 400 diatoms systematically arranged according to the classification of Mr. Grunow. A list accompanies the preparation, which is very useful to any one beginning the study of diatoms. The price is £3 15s. A second type slide containing only 100 diatoms costs £1 4s. Mr. Möller also sells at the present time two other preparations: one containing 800 different diatoms costing £20, and the other, containing 1600 diatoms, the price of which is £80.

Smith (Prof. Hamilton L.) *Diatomaceæ typicæ.*—This collection is one of the most important of those hitherto published, not only on account of the number, but also the scientific interest of the preparations. A large number are authentic type forms, and are taken from de Brébisson's gatherings.

The preparations are alphabetically arranged in series of 25 in boxes bookwise. The complete collection consists of 28 boxes, containing in all 700 preparations.

Smith (Rev. Wm.)—The author of the *Synopsis of British Diatomaceæ*, published 275 type preparations, illustrating his synopsis. These preparations are excessively rare at the present time. We have used some in making the drawings for our work. Mr. Smith has also published a series of preparations made from the material collected during his excursion in the Pyrenees. This collection is, we believe, still rarer than the previous one, and we have not seen any other than that in our possession.

Tempère (J.) and **Peragallo (H.)**—"Diatomées du monde entier." A collection of 625 preparations, comprising the larger portion of known fossil deposits, and a large number of marine, pelagic and fresh water gatherings, etc. With an explanatory text giving an analysis of each preparation.

Van Heurck (Dr. Henri.)—*Types du Synopsis des Diatomées de Belgique.* Under this title, we have published a collection of Diatoms, accompanied by notes and diagnoses by Mr. A. Grunow. The preparations are enclosed in boxes of 25 bookwise, identical with those of Mr. H. L. Smith. The preparations, 550 in number, are made in Styrax (a medium which we made known in 1883), and which has the double advantage of a high index of refraction and inalterability. These preparations comprise nearly all the important forms described in the Synopsis. Much of the material comes from the original gatherings of Walker-Arnott, Gregory, Greville, Eulenstein, etc.

§ 3.—Collections used for this Work.

In writing this work we have consulted the following collections, which now form part of our botanical museum :—

1. *Adan, H.*, author of the "*Monde Invisible.*"—This collection comprises about 2,000 slides, including a very considerable number of rare and interesting diatoms.
2. *de Brébisson.*—A large number of gatherings.
3. *Cleve and Möller's* Diatoms.—Collection previously mentioned.
4. *Delogne.*—Collection previously mentioned, as well as the material

from which the preparations were made, and the complete collections, including many thousand gatherings made by Mr. Delogne.

5. *Eulenstein.*—Collection previously mentioned, as well as the material intended for the three hundreds, as projected by the author, and also more than a thousand tubes, containing different prepared material.

6. *Grunow.*—A very large number of gatherings, and a large collection of *Schizonema*, which was used for his monograph on that genus.

7. *Kützing.*—The original collection of Kützing, which formerly belonged to Eulenstein.

8. *Möller.*—Various type slides, among others special type slides of 1. Mors. 2. Various rare diatoms. 3. The genera of the Synopsis. 4. The genus Pleurosigma. 5. The genus Nitzschia.

9. *Rabenhorst* (*Dr. L.*).—Diatomaceæ exsiccatæ totius terrarum orbis. Dresdæ, 1871. Die Algen Sachsens resp. Mettel-Europas Complet.

10. *Smith* (*Prof. H. L.*).—Diatomaceæ typicæ.

11. *Smith* (*Rev. Wm.*).—1. The type preparations of the Synopsis of the Brit. Diat. 2. The preparations of the Excursion in the Pyrenees. 3. Material collected by W. Sm., in view of a second Edition of his Synopsis. The material, with labels in the author's handwriting, enclosed in an herbarium, and arranged according to his Synopsis, comprises upwards of 1,200 gatherings from all parts of England.

12. *Tempère and Peragallo.*—" Diatomées du monde entier," the collection previously mentioned.

13. *Van Heurck* (*H.*).—1. The types previously mentioned and the bottles corresponding with each preparation. 2. The collection of Belgian gatherings; very numerous. 3. The type slides made by Mr. E. Thum from material obtained in the most interesting localities of Belgium. 4. A Collection of different Type slides made specially for the author by Mr. E. Thum, amongst others, Oamaru, 384 forms; China (Trépang), 389; Gulf of Mexico, 190; Samoa Isles, 146; Red Sea, 142; Gulf of Naples, 255; genus Amphora, 162; Pleurosigma, 70; Hemiaulus, etc., 40; Triceratium, etc., 238; Actinoptychus, 140; Aulacodiscus, 98; Coscinodiscus, 500; North Sea, Blankenberghe, 203; Scheldt, 286; Marstrand, 194; Cuxhaven, 156; South Sea, 234. The raphidieæ of all these Type slides have been determined by Prof. Cleve. 5. The type slide of 1,000 forms by Mr. Thum, arranged according to the Synopsis. 6. The general collection of preparations, containing preparations which have been used for the drawings for the Synopsis, preparations by the author, Eulenstein, Walker Arnott, dé Brébisson, etc.

14. *Walker-Arnott.*—Original collection of W. Arnott, including his own gatherings and those of all the celebrated diatomists of his time, Gregory, Greville, etc. The tubes number about 2,000, and to each there is a corresponding preparation. Manuscript Catalogues (written by W. Arnott) give an analysis of each tube.

15. *Weissflog.*—The celebrated collection of our excellent friend, prepared by him between 1867 and 1892, which has formed part of our collection since 1892. The Weissflog Collection comprises about 2,500 preparations of rare diatoms, mostly selected, and all prepared with the greatest care. These preparations have been used for the works of Deby, Cleve, Grunow, Rattray, Witt, Ad. Schmidt, etc. A large number of forms are unique specimens. Besides the selected diatoms, the collection comprises the following further type slides, prepared by Mr. Weissflog:—Sta. Monica, 541 and 389 diatoms; Seychelles Island, 402 and 257; Ngucy (Madagascar), 326 and 255; Balearic Islands, 300; Gazelle Expedition, 173; id. (Kerguelen Island), 82; Oregon, 84; Island of Rea (Singapore), 204; Simbirsk (Russia), 40 and 29; Demerara (Guiana), 95 and 77; Chalky Mount (Barbadoes), 102; Pensacola (Florida), 74; Oamaru, 500 and 254; Java, 168 and 167; Jeremy, 89.

§ 4. Special Bibliography of the British Isles.*

We have collected under this title the principal publications concerning the distribution of diatoms in the British Isles.

Beardsley (Amos)—On a diatomaceous deposit in Leven Water, near Coniston. T.M.S. (1857), v., p. 146-7.

Bennett (A. W., M.A., B.Sc. F.L.S.)—Freshwater Algæ (including Chlorophyllaceous Protophyta) of the English Lake district, with description of 12 new species. J.R.M.S. (1886), vi., Ser. 2, pp. 1-15 (2 plates); reference thereto by Dr. M. Moebius, Bot. Centralbl (1887), xxxii., p. 129.

Freshwater Algæ (including Chlorophyllaceous Protophyta) of North Cornwall, with description of six new species. J.R.M.S. (1887), pp. 8-19, 2 plates. Notar, Ann. I., n. 4, p. 218, 8vo. Venezia, 1887. Referat von Anton Hansgirg, Bot. Centralbl. (1887), xxx., p. 228.

Berkeley (Rev. J. M.) and Ralfs (John).—On a new genus of Diatomaceæ. Ann. Nat. Hist. (1844), xiv., pp. 328-9.

* Mr. Wynne E. Baxter has devoted much time and trouble in revising this Bibliography so as to render it as exact and complete as possible.—(H.V.H.)

Bossey (Dr. Francis).—Fresh and salt water diatoms found in Thames mud. Holmesdale Nat. Hist. Cl. Proc., 1879-80; J.R.M.S. (1882), ii., p. 94; Northern Micros. (1882), p. 75.

The preparation of the Diatoms from the London clay. Philadelphia Micr. Bull. (1883), iii., p. 178.

Bowman (J. E.).—On the Microscopic vegetable skeletons found in peat near Gainsborough by Mr. Binney, of Manchester. Ninth Rep., Brit. Assoc., 1840; M.J. (1841), i., p. 127.

On a white fossil powder found under a bog in Lincolnshire, composed of the silicious fragments of microscopic parasitical confervæ. Hooker Journ. Bot. (1840), ii., pp. 256-264; Manchester Geol. Soc. Trans. (1841), i. pp. 141-152.

Brightwell (T.).—Sketch of a Fauna Infusoria from East Norfolk, 19 plates, small 4to. Norwich, 1848.

Burgess (E. W.).—Diatoms from the Island of Lewis, near Stornaway. J.R.M.S. (1882), ii., pp. 665-6.

Caunter (Henry).—Notice of an Infusorial deposit in the Island of Lewis, 8vo. 1859.

Carruthers (William).—The Diatomaceæ in Handbook of British Freshwater Weeds or Algæ, by John Edward Gray. 8vo. London, 1864.

Comber (Thomas).—On the Diatomaceæ of the neighbourhood of Liverpool (Trans. Hist. Soc. of Lanc., Vol. XI., 1859), Q.J.M.S., (1860), viii., pp. 111-122.

Davidson (Rev. G.).—On a diatomaceous deposit in the district of Cromar, Aberdeenshire. Edinburgh, 1874.

List of Diatomaceæ found in Loch Kinnord Kieselguhr. J.Q.M.C., (1887), iii., p. 149. Edin. Geol. Soc. Tr. (1887), pp. 207-213.

Dickie (George.).—Notice of a deposit of fossil diatomaceæ in Aberdeenshire. A. and M.N.H. (1848), ii., pp. 93-95; Edin. Bot. Soc Tr. (1850), iii., pp. 65-67.

On a deposit of Diatomaceæ and Molusca in the County of Antrim. Q.J.M.S. (1859), vii., pp. 9-11.

Notice of a diatomaceous deposit at Methlic, Aberdeenshire. Bot. Soc., Edin., J. and Proc. (1873), xi., p. 394.

Dillwyn (L. W.).—British Confervæ. London, 4to, 1809.

[See hereon Mr. F. Kitton's Notes on the genera and species, J.Q.M.C. (1883), i., ser. 2, p. 166; Journ. Microg., Paris (1883), viii.; also Grossbrittanniens Conferven Nach. Dillwyn, für deutsche Botaniker bearbeitet, by Dr. F. M. Weber. Göttingen, 1809].

Donkin (Arthur Scott).—On the marine Diatomaceæ of Northumberland, with a description of 18 new species. T.M.S. (1858), vi., pp. 12-34, 3 plates; Q.J.M.S. (1861), i., pp. 1-15. See also thereon Walker Arnott, Q.J.M.S. (1858), vi., pp. 164-5, and in reply Q.J.M.S. (1859), vii., pp. 5-9.

The Natural History of British Diatomaceæ, illustrated with plates by Tuffen West. Parts 1-3 (all published), 12 plates; 105 figures of Navicula; 8vo. London, 1871-72. Review of the same in Q.J.M.S., Vol. XIV., p. 93.

On a species of filamentous diatom new to Britain, Q.J.M.S. (1858), vi., pp. 11-12.

On several new and rare species of fresh water Diatomaceæ discovered in Northumberland, Q.J.M.S. (1869), ix., pp. 287-296, 1 pl.

Notes on certain fresh water species of Diatomaceæ. Q.J.M.S. (1869), ix., pp. 397-400.

Drummond (James L.).—On a fossil infusoria found in the County Down, Ireland. London Mag. Nat. Hist. (1839), iii., n.s., pp. 353-359.

Ehrenberg (C. G.).—Mikrogeologie, pl. 28, writing chalk, Gravesend. Pl. 15, Mourne Mountains. Leipzig, 1854.

Fossile Infusorien aus England. Ueber Lager fossiler Infusorien in Ireland., Berl., Bericht (1842), pp. 335-339

Firth (William A.) and Swanston (Wm.).—References to the diatomaceous deposits at Lough Mourne and in the Mourne mountains. Proc. Belfast Nat. Field Cl. (1888), iii., ser. 2, pp. 62-64 (with list of species by Mr. Lawrence Hardman).

Gregory (W., M.D.).—Notice of a diatomaceous earth found in the Isle of Mull. T.M.S. (1853), i., pp. 92-99.

Additional observations on the Diatomaceous Deposit of Mull. Q.J.M.S., (1854), ii., pp. 24-28.

Notice of the new forms and varieties of known forms occurring in the diatomaceous earth of Mull, with remarks on the classification of the Diatomaceæ. Q.J.M.S. (1854), ii., pp. 90-100, pl. IV.; Edin. Royal Soc. Proc. (1857), iii., pp. 176-177, 204-207.

On a remarkable group of diatomaceous forms, with remarks on shape or outline on a specific character in the Diatomaceæ. T.M.S. (1854), iii., pp. 10-15, pl. II.

On a post tertiary lacustrine sand, containing Diatomaceous exuviæ from Glenshira, near Inverary (1855), iii., pp. 30-43, pl. IV.

On some new species of British fresh water diatomaceæ, with remarks on the value of certain specific characters. Edin. Bot. Soc. Proc. (1855), pp. 38-41.

On the presence of Diatomaceæ Phytolitharia and sponge spicules in soils which support vegetation. Edin. Bot. Soc. Proc. (1855), pp. 69-72.

Report on the Diatomaceæ collected during a botanical excursion to Falkland and the Lomond Hills. Edin. Bot. Soc. Proc. (1855), p. 74.

On the post tertiary Diatomaceous Sand of Glenshira, pt. II., containing an account of a number of additional undescribed species, illustrated by numerous figures drawn from nature. T.M.S. (1856), iv., n.s., pp. 35-48 pl. V. ; (1857), v., pp. 67-88, pl. 1 ; Edin. Roy. Soc. Proc. (1857), iii., pp. 358-366.

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On new forms of marine Diatomaceæ found in the Firth of Clyde and in Loch Fyne, illustrated by numerous figures drawn by R. K. Greville. Ed. Roy. Soc. Trans. (1857), xxi., part IV., 6 plates, 4to. Edinburgh, 1857 ; extract therefrom, Q.J.M.S. (1859), vii., pp. 60-64 ; Edin. Bot. Soc. Proc. (1858), v., pp. 144-146.

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The English Flora of Sir J. E. Smith (Diatomaceæ by Dr. Greville, Vol. V., part 1, pp. 401-415). London, 1833.

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Harkness (Robert).—Diatomaceæ found in a sub-fossil state in Dumfriesshire. Edin. Bot. Soc. Proc. (1855), p. 54-58 ; Edin. New Phil. Journ. (1855), ii., pp. 54-56.

Harvey (W. H., M.D.).—A manual of the British Algæ, 8vo. London, 1841.

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A microscopic examination of the water supplied to the Inhabitants of London, 8vo. London, 1850.

Häusler (Rudolf).—Die Diatomeen des London clay. Bot. Zeit. Leipzig (1881), xxxiv. col. 720-723.

Hodgson (Miss E.).—On a deposit containing Diatomaceæ, &c., in the iron-ore mines near Ulverstone, 8vo. Geol. Soc. Jour. (1863), xix., pp. 19-31.

Hutton (Captain F. W.).—On the discovery of *Arachnoidiscus ornatus* and *A. Ehrenbergii* at Malahide, Co. Dublin, 3 figs. Dubl. Mic. Cl. Journ. Proc. (1865), i., p. 4; Q.J.M.S. (1865), v., p. 132.

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Jenner (Edward).—Flora of Tunbridge Wells, 8vo. London, 1845.

Karop (G. C.) and Morland (H.).—The Loch Kinnord and Skye Diatomaceous deposits, with hints on cleaning refractory material. J.Q.M.C. (1877), Ser. 2, iii., pp. 92-3.

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Bell.	Belleroche.	Math.	Mathieu.
Bréb.	De Brébisson.	Meneg.	Meneghini.
Cleve.	Cleve.	Naeg.	Naegeli.
Deby.	Deby.	Petit (Ch.).	Petit (Charles).
Del.	Delogne.	Petit (P.).	Petit (Paul).
Ehr.	Ehrenberg.	Rabh.	Rabenhorst.
Gaut.	Gautier.	Schum.	Schumann.
Greg.	Gregory.	A. Schm.	A. Schmidt.
Grev.	Greville.	W. Sm.	W. Smith.
Grun.	Grunow.	Thw.	Thwaites.
Hantzsch.	Hantzsch.	V. d. Broeck.	Van den Broeck.
Heib.	Heiberg.	V. d. Born.	Van den Born.
Jan.	Janisch.	H. Vanh. or H. V. H.	Van Heurck.
Kickx.	Kickx.	Verb.	Verbeeck.
Kütz.	Kützing.	West.	Westendorp.

Unit of Measurement.

I have adopted in this work a hundredth part of a millimetre (0·01mm.), as the unit of measurement. I believe it to be the only convenient measure for organisms, whose size is so variable, that their maximum is often double their minimum size, and of which a considerable number are so large that if the mikron is used, too high a number (generally reaching into hundreds) has to be quoted.

We mark this unit by three letters, c.d.m. (centièmes de millimetre).

One c.d.m. = ·0003937 English inch = 10μ (mikrons).

End of Introduction.

DESCRIPTION

OF

GENERA AND SPECIES.

Diatomaceæ.

Unicellular algæ consisting of a frustule or silicious bivalve box, pseudo-unicellular, externally covered with a more or less apparent mucous envelope (called coleoderm), containing in the interior of the valves a cellular membrane enclosing a brownish yellow colouring matter (called endochrome), a nucleus, some oil globules and colourless protoplasm.

Diatoms multiply by gemmiparous self-division and are reproduced by conjugation.

The family of Diatomaceæ is divided into three sub-families:

1. **Raphidieæ** having a true raphe on at least one of the two valves.

2. **Pseudo-Raphidieæ** having, on at least one of the valves, a blank space, simulating a raphe, and never furnished with either teeth, awns, spines, or processes.

3. **Crypto-Raphidieæ** never possessing either a true raphe or a pseudo-raphe on the valves; generally circular, sub-circular or angular in form, and frequently furnished with processes, teeth, spines, or awns.

SUB-FAMILY I.—RAPHIDIEÆ.

Frustules mostly bacillar in valve view, sometimes broadly oval, always with a distinct raphe and nodules on one or both valves. Central nodule rarely absent or obscure; valves simple or complex. Raphe generally prominent in valve view, occasionally in girdle view, especially when constricted, with nodules at the constrictions. Frustules always without teeth, spines, awns, or processes.

ANALYSIS OF TRIBES.

- Valves alike . .
  - Valves more or less arcuate or cymbiform, not symmetrically divided by the raphe . . . . . **Cymbelleæ.**
  - Valves symmetrically divided by the raphe . .
    - Valves symmetrical; central nodule either equally distant from ends or absent, or rudimentary or divided . . . . . **Naviculeæ.**
    - Valves asymmetrical with apices of unequal breadth (valves cuneate) **Gomphonemeæ.**
- Valves unlike . .
  - Valves cuneate . . . . **Gomphonemeæ.**
  - Valves not cuneate . .
    - Frustules genuflexed, nodule or stauros on one valve only, usually on the concave margin (at the constriction) valves rarely broadly oval . . . . . **Achnantheæ.**
    - Frustules with a central nodule on only one valve, valves generally broadly oval, rarely bent, never genuflexed . . . . **Cocconideæ.**

TRIBE I.—CYMBELLEÆ.

- Frustules with connecting membrane very broad, often longitudinally plicate, striate, or punctate . .
  - Connecting membrane highly developed on the dorsal side, so that the two valves are seen at the same time and nearly flat; central nodule very apparent, rounded or changed into a stauros, raphe without keel . . **Amphora.**
  - Frustule constricted as Amphora, but the raphe furnished with a keel . . . . **Amphoropsis.**
  - Valve very asymmetrical, with dorsal and ventral parts situated in different planes and the raphe elevated on a very projecting keel . . . . . **Auricula.**
- Frustules with connecting membrane narrow and neither longitudinally punctate nor plicate . .
  - Valves without keel . .
    - Frustules free or stipitate; terminal nodules near the apices, raphe more or less arcuate . . **Cymbella.**
    - Frustules often enclosed in tubes; terminal nodules very distant from apices; raphe quite straight **Encyonema.**

GENUS I.—AMPHORA EHR, 1831.

Frustules generally free, solitary, oval, oblong, elliptic oval or sub-quadrangular, often inflated or constricted in the girdle view. Valves cymbiform, with central nodule marginal or sub-marginal, often dilated into a stauros, raphe often inflated. Connecting zone often longitudinally striate, plicate, or punctate.

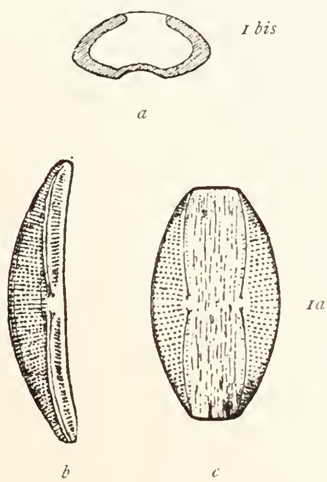

Fig. 24.

a Diagrammatic section of Amphora.
b *Amphora affinis*, valve view.
c *Amphora ovalis*, girdle view.

Endochrome formed by a single layer, the middle of which rests on the dorsal, connecting zone, and covers over the two adjacent valves and the other side of the zone, in the middle of which is found the line of separation.

A large number of Amphora are "complex." Those are so named whose connecting zone contains a more or less considerable number of cuneate segments which have been, somewhat justly, compared to slices of melon. These segments have sometimes a structure or striation analogous to that o the exterior segments (valves) but have neither raphe nor nodules; at other times however the striation of the interior segments is different.

The genus Amphora is one of the most difficult genera of diatoms, and it is also one of the most extensive, as authors have placed in it more than 200 species. Prof. H. L. Smith was the first to elucidate the structure of Amphora by demonstrating that the genus originated from Cymbella by the unequal development of the two sides of the connecting zone. Figure 24 *a* is a diagrammatic section of an Amphora showing at the same time the disposition of the layer of endochrome.

In the arrangement, in this Work, of the genus Amphora, the classification of Prof. Cleve has been followed. The sub-genera and the list of species are given in accordance with the manuscript documents kindly lent by the learned Professor.

Analysis of Groups.

Connecting zone not plicate .	Puncta rather coarse, very distinct, forming transverse striæ and undulating longitudinal lines . . .				Subg. 1. **Amphora.**
	Puncta not forming longitudinal lines .	Ventral portion of valve broad, striæ finely punctate on both parts of the valve .			Subg. 2. **Psammamphora**
		Ventral portion of valve very narrow, striæ not distinctly beaded . . .			Subg. 3. **Cymbamphora.**
Connecting zone plicate	Coarse puncta, very distinct, arranged in straight transverse and longitudinal lines				Subg. 4. **Diplamphora.**
	Puncta not forming straight longitudinal lines .	Valve with ventral portion narrow, apices generally rostrate-capitate and recurved, beads forming undulating longitudinal lines			Subg. 5. **Halamphora.**
		Not as above	Valve with central portion smooth, furnished with a longitudinal ridge		Subg. 6. **Calamphora.**
			Ventral portion striate.	Ventral portion rather broad, the two parts with identical striation, raphe with branches divergent from the central nodule .	Subg. 7. **Amblyamphora.**
				Ventral portion very narrow, with finer striation than that of the dorsal portion; raphe straight, near the margin; central nodule often stauroform . . .	Subg. 8. **Oxyamphora.**

A.—Sutural zone not plicate.

GROUP I. *Amphora*—Ventral and dorsal portions of the valve generally furnished with a longitudinal line (a rib or narrow area). Beads rather coarse, forming at the same time transverse striæ and undulating longitudinal lines. (Type: A. ovalis).

ANALYSIS OF SPECIES.

Non-marine forms.	Fresh water; striæ robust in the type form; pseudo-stauros very distinct			**A. ovalis**
	Humid places (walls, etc.)	Raphe slightly incurved, spurious stauros		**A. Normanii.**
		Raphe concave, no spurious stauros .		**A. perpusilla.**
Marine forms .	Frustule not subrectangular, apices obtuse or truncate .	14 to 16 striæ in 1 c.d.m. .	Striæ fine, resolvable . .	**A. marina.**
			Striæ strong, irresolvable . .	**A. Fusio.**
		About 10 striæ in 1 c.d.m. .	Raphe with ventral portion completely striated . .	**A. robusta.**
			Raphe with ventral portion having only some lines of dots	**A. Proteus.**
	Frustule with acute or subacute apices, dorsal margin of valve plicate longitudinally			**A. dubia.**
	Frustule subquadrangular, striæ extending throughout the ventral portion of the valve			**A. arenicola.**

A. ovalis Kutz. (Bac. p. 107, pl. 5, fig. 35 and 39; H.V.H. Atl., pl. 1 f. 1* Type No. 1) **plate 1, fig. 15.**

Frustule oval, very inflated at the median portion, then slightly attenuate; apices broadly truncate. Valves arcuate at dorsal margin, concave at internal margin; raphe inflexed; striæ strongly marked with coarse puncta from 10 to 11 in 1 c.d.m. without stauroneiform blank space. Length, 5 to 7 c.d.m.

Fresh water. Common everywhere.

β **gracilis** (A. *gracilis E.* Verb. p. 122, n. 11, pl. III. 1, f. 43—H.V.H. Atl., pl. 1, f. 3*) **plate 1, fig. 16.**

Considerably narrower and more slender in all parts than the preceding; apices rounded, subacute; raphe very inflexed.

Mixed with the preceding. Louvain.

γ. **affinis Kütz.** (Bac., p. 107, pl. 30, f. 66; *A. abbreviata Bleisch*; H.V.H. Atl., pl. 1, f. 2*; Type No. 2) **plate 1, fig. 17.**

Frustule oval, with apices slightly tapering; striæ rather finer (about 12 in 1 c.d.m.) leaving a stauro-form blank space very distinct on the dorsal side. Length, 3 c.d.m.

Fresh and slightly brackish water. Blankenberghe (pure gathering). Louvain (H.V.H.) Ardenne Liégeoise (De Wild). Free or mixed with the preceding. England (Norman, W. Sm.).

forma minor (*A. Pediculus major Grun*; H.V.H. Atl., pl. 1, f. 4, 5*) **plate 1, fig. 18.**

Smaller, about 3 c.d.m. in length; striæ fine, about 16 in ·01 c.d.m.

Louvain, etc.

δ. **Pediculus Kütz.** (*A. Pediculus* (*Kütz.*) *Grun.—Cymbella Pediculus Kutz.* Bac., p. 80, pl. 5, f. VIII., and pl. 6, f. VII. *A. minutissima, W. Sm.*, S.B.D. i., p. 20, pl. II., f. 30. H.V.H. Atl., pl. 1, f. 6, 7*; Type No. 3) **plate 1, fig. 19.**

Frustule small, with apices slightly narrowed; pseudo-stauros very distinct; raphe more or less concave; striæ 16 in 1 c.d.m.; length about 2 c.d.m.

Generally parasitic on other diatoms, and especially on *Nitzschia Sigmoidea*.
Common. Antwerp, Louvain, Blankenberghe (H.V.H.) Ard. Liég. (De Wild.), etc. England (W. Sm., Norman, Stolterfoth).

forma minor, Grun. (H.V.H. Atl., pl. 1, f. 8*), **plate 1, fig. 20.**

Still smaller, about 1·5 c.d.m. in length; about 20 striæ in 1 c.d.m.

forma exilis, Grun. (H.V.H. Atl., pl. 1, f. 9, 10*), **plate 1, fig. 21.** Small, very narrow, length from 1·5 c.d.m., striæ about 20 in 1 c.d.m.

A. perpusilla Grun (H.V.H. Atl., pl. 1, f. 11*; Type, No. 4), **plate 1, fig. 12.**

Very small. Frustule oblong or subglobose, rather truncate at apices. Valve very convex at dorsal margin, straight at ventral margin; raphe straight, scarcely concave, spurious stauros just visible; striæ very delicate, numbering from 9 to 10 in 1 c.d.m.; length less than 1 c.d.m.

Moist wall at Botanical Gardens, Brussels, associated with *A. Normanii* (Del). This form should probably be referred to *A. ovalis var Pediculus*.

A. Normanii Rabenh. (Fl. Eur. Alg., p. 88. *A. humicola Grun* in H.V.H. Atl., pl. 1, f. 12*; Type No. 5) **plate 1, fig. 4.**

Frustule elliptic with apices slightly rostrate-truncate. Valve with raphe slightly inflexed, showing a stauro-form blank space; apices rostrate-capitate; striæ fine, punctate, from 16 to 18 in 1 c.d.m. at the dorsal portion of valve, very fine, about 24 in ·01 at ventral margin. Length, 2.5 to 3 c.d.m.

On a moist wall at Botanical Gardens, Brussels (Del); Hull, England (Norman).

A. dubia (Greg, 1857?) Ad. Schm, 1875 (At., pl. 27, f. 20-26*; Clyde, p. 42, pl. 5, f. 76); **plate 24, fig. 672.**

Frustule elliptic. Valve angularly plicate round a line uniting the two apices, so that when viewed from the apex it appears to consist of two laminæ placed at an angle of 60°. Valve with lunate outline, arcuate near the exterior, with the interior margin straight and apices acute. Axial area moderately broad on the dorsal side of the raphe. Ventral portion of the valve linear, narrow, without striæ and longitudinal line. Dorsal side with transverse striæ robust, especially at the external portion. Striæ 10 in 1 c.d.m., coarsely punctate; 12 dots in 1 c.d.m. Sutural zone very narrow. Length of frustule 4 to 8 c.d.m.; breadth, 1·5 to 2 c.d.m.

Marine.—Coasts of Norway.

There is no known species analogous to *A. dubia* (Cleve).

A. Pusio Cleve (Syn. Nav. Diat., p. 102, pl. 3, f. 40*); **plate 35, fig. 906.**

Frustule broadly elliptic with truncate apices. Raphe strongly bi-arcuate. Central nodule large. Axial and central areas indistinct. Ventral and dorsal sides with robust striæ, about 14 in 1 c.d.m, not interrupted and not distinctly punctate

Marine and brackish water.—Coasts of Sweden (Cl. and Möll. Diat., No. 157).

A. arenicola Grun. (in Cl. and Möll. Diat., No. 310, sub *A marina var arenicola*; Cleve Syn. Nav. Diat., pl. 4, f. 19-20), **plate 35, fig. 907.**

Frustule almost rectangular, three times longer than broad. Valve linear with apices broad, unilaterally rounded. Raphe gently bi-arcuate, distant from ventral side. Axial area indistinct on dorsal side. Central area absent or orbicular. Striæ of dorsal side 10 to 14 in 1 c.d.m., coarsely punctate, not interrupted, with indistinct longitudinal line. Ventral side broad, with striæ radiant, coarsely punctate, sometimes crossed by a narrow hyaline band. Length of frustule, 4 to 7 c.d.m. Breadth, 1·7 to 2·1 c.d.m. Breadth of valve, 1 c.d.m.

Marine.—Coasts of Belgium and England (Cleve).

Var. major A. Baltic Sea (Cl).

A. marina H. Van Heurck (H.V.H. Atl., pl. 1, f. 16*; in Types Nos. 101 and 517), **plate 1, fig. 14.**

Frustule oblong, very inflated at median part, infinitesimally attenuated as far as the apices which are truncate. Valves with dorsal margin very convex, and ventral margin slightly and almost regularly concave; raphe well marked, inflexed at median part; striæ rather strongly punctated on dorsal side; about 16 in 1 c.d.m., same number at ventral margin. Length, 4 to 5 c.d.m.

Marine.—Shores of North Sea: England (W. Sm.), France (Grun., Bréb.), Belgium: Scheldt. (H. Van Hk.), and probably on all shores of North Sea.

According to Prof. Cleve this form should be recorded as having been first described by me, and the *A. marina* of Wm. Smith treated as only a form of *A. Proteus.*

A. robusta Greg. (Diat. of Clyde, p. 44, pl. 5, f. 79; Ad. S. Atl., pl. 27, f. 40-41*); **plate 24, f. 670.**

Frustule broadly oval with truncate or sub-truncate apices. Valve arcuate, with apices obtuse, raphe very inflexed, central nodule large, surrounded by a blank space slightly stauroform. Ventral margin concave. Ventral part of valve completely striated, striæ with coarse puncta, 7 to 8 in 1 c.d.m. Sutural zone completely smooth. Length, 8 to 11 c.d.m.

Marine.—Scotland (Gregory) and Shores of North Sea; Belgium: Scheldt (H. Van Hk.)

A. Proteus Greg. (Diat. of Clyde, p. 46, pl. 5, f. 81; Ad. Sch. Atl., pl. 27, f. 2-3; 5-6*); **plate 24, fig. 671.**

Frustule elliptic, with truncate apices. Valve with dorsal margin arcuate, ventral margin concave, apices obtuse. Raphe very inflexed; central nodule

K

rather large, often furnished with a stauroform blank space. Ventral part of valve having only a few rows of dots. Striæ very distinct with robust puncta; 8 to 10 in 1 c.d.m. Length very variable, from 7 to 15 c.d.m. Breadth, from 4 to 6 c.d.m.

Marine.—Scotland (Greg.), England, Belgium! Germany! Norway! etc.

2. *Psammamphora Cl.*—Ventral part rather broad. The two parts finely puncto-striated. Puncta not forming longitudinal lines. (Type form: A. arenaria).

ANALYSIS OF SPECIES.

Frustule with outer margins slightly introflexed, valves furnished with a stauros	**A. ocellata.**
Frustule with outer margins slightly gibbous, valves without stauros .	**A. arenaria.**

A. ocellata Donk (Q.J.M.S., 1861, p. 11, pl. 1, f. 11b; H.V.H. Atl., pl. 1, f. 26*); **plate 1, fig. 3.**

Frustule quadrangular, with rounded apices and outer margins slightly introflexed. Valve with raphe infinitesimally incurved; striæ very fine and very delicate. Length, 6 to 9 c.d.m.

Marine.—Found in washings of mussels and in the residue of a washing of sand from the beach at Blankenberghe. England; Ireland; France.

A. arenaria Donk. (T.M.S., 1853, p. 31, pl. 3, f. 16; Ad. Sch. Atl., pl. 40, f. 8-10*); **plate 24, fig. 673.**

Frustule hyaline, subquadrangular; apices rounded, truncate; median portion often slightly gibbous; raphe very inflexed. Valve broad, arcuate; apices very obtuse; terminal nodules recurved near the outer margin, rather broad and very elongated. Ventral portion of the valve very broad, finely puncto-striate, as is also the dorsal portion. Length, 10 to 12 c.d.m.

Marine.—England (Norman): Ireland (O'Meara); Shores of the North Sea.

3. *Cymbamphora Cl.*—Striæ not forming longitudinal lines, and not distinctly beaded. Ventral portion of valve very narrow. (Type form: A. angusta).

A. angusta Greg. (Diat. of Clyde, p. 38, pl. 4, f. 66*), **plate 24, fig. 674.**

Frustule small, linear, elliptic, narrow, apices truncate. Ventral margin of valve straight, raphe very inflexed. Part of valve narrow, striæ very delicate, not distinctly beaded, about 17 in 1 c.d.m. Sutural zone very narrow.

Marine.—Scotland (Greg.): Shores of North Sea.

B.—Sutural Zone plicate.

4. *Diplamphora Cl.*—Dorsal portion and often also ventral portion with puncta forming longitudinal lines. Puncta coarse. (Type form : A. crassa).

ANALYSIS OF SPECIES.

Valve without an ala .	Valve with double structure; furnished with costæ between which are found rudimentary beads .	**A. crassa.**
	Valve with structure simple, furnished with three longitudinal curved lines, dividing the valve into two zones	**A. Grevilleana.**
Valve furnished with an ala emanating from the dorsal portion . .		**A. alata.**

A. crassa Greg. (T.M.S., 1857, p. 72, pl. 1, f. 35 ; Diat. of Clyde, p. 52, pl. 6, f. 94a*) ; **plate 24, fig. 675.**

Frustule rectangular, elliptic, with rounded apices. Ventral margin and raphe strongly inflexed at the median portion. Valve with dorsal margin arcuate. Ventral margin concave, inflexed at the median portion. Striæ 5 in 1 c.d.m., formed of coarse punctæ, arranged in transverse and longitudinal lines. Connecting zone showing lines of coarse punctæ, showing the margins of internal segments. Length 8 to 10 c.d.m.

Marine.—Shores of the North Sea : Scotland (Greg.), England (Norm.), Ireland (O'Meara), Finmark (Cleve), etc.

* Note.—The striæ of A. crassa have hitherto been inaccurately described by authors. In reality the dorsal margin of the valve shows two rows of strong costæ and at the bottom of the intercostal spaces is a row of delicate puncta.

A. Grevilleana Greg. (T.M.S., 1857, p. 73, pl. 1, f. 36 ; Diat. of Clyde, p. 50, pl. 5, f. 89 ; Ad. Schm. Atl., pl. 25, f. 41*) ; **plate 24, fig. 676.**

Frustule almost oval, with apices slightly truncate. Valves marked with three longitudinal curved lines, dividing the valve into two compartments ; apices slightly diminuo-rostrate ; dorsal margin infinitesimally arcuate, ventral margin and raphe inflexed. Transverse striæ strong, moniliform, 11 in 1 c.d.m. Sutural zone showing 7 to 8 juxtaposed segments. Length 12 to 13 c.d.m.

Marine.—Scotland (Greg.) and various Shores of the North Sea.

A. alata Per. (Diat. Baie de Villefranche, p. 41, pl. 2, f. 11*); **plate 24, fig. 677.**

A form distinctly differentiated by the presence of a membranaceous ala, emanating from dorsal portion of the valve.

Marine.—North Sea (Cleve).

5. *Halamphora Cl.*—Longitudinal lines absent. Ventral portion of the valve narrow. Valve with apices generally capitate and recurved. Beads distinctly arranged in transverse striæ and in series of longitudinal undulations.

ANALYSIS OF SPECIES.

- Frustules complex, beads resolving into a mass of fine puncta . . . . **A. Eunotia.**
- Frustules not complex.
  - Frustules with external margins undulated . . . . **A. Sarniensis.**
  - Frustules with margins not undulated.
    - Striæ with puncta somewhat indistinct, very delicate . .
      - Transverse striæ almost invisible, longitudinal conspicuous . . . **A. coffeæformis.**
      - Transverse striæ fine, median more robust . . . . . . **A. veneta.**
    - Striæ with distinct puncta.
      - Frustules robust.
        - Sutural zone abruptly dilated at the apices . . . . . . **A. commutata.**
        - Sutural zone not dilated.
          - Frustule elliptic, with sutural zone lanceolate . . . **A. cymbifera.**
          - Frustule suboval, with apices rostrate-capitate . . . **A. rostrata.**
      - Frustules delicate.
        - Frustules more or less constricted in the middle.
          - Constriction slight, frustule broad, sutural zone with numerous folds . . . . **A. angularis.**
          - Constriction considerable, frustule narrow, sutural zone without folds . . . . **A. binodis.**
        - Frustules not constricted.
          - Connecting zone with very numerous folds . . . . **A. inflexa.**
          - Sutural zone not plicate.
            - Puncta robust, frustule rostrate-capitate . . **A. turgida.**
            - Puncta delicate or resolvable with difficulty.
              - Raphe straight.
                - Transverse striæ conspicuous, about 9 in 1 c.d.m.; frustule very long, about 8-9 c.d.m. **A. Ergadensis.**
                - Striæ conspicuous, about 12 in 1 c.d.m.; frustule short, about 5 c.d.m. . **A. macilenta.**
                - Striæ delicate, finely punctate, about 13-14 in 1 c.d.m.; frustule short, about 5 c.d.m. . **A. acutiuscula.**
              - Raphe curved, frustule very short, about 3—5 c.d.m.; striæ very delicate, about 19 in 1 c.d.m. . . **A. salina.**

A. commutata Grun. ! (*A. affinis W. Sm.* S.B.D. i., p. 19, pl. 2, f. 27, not Kutz !—W. Sm. prep. No. 27 !—H.V.H. Atl., pl. 1., f. 14*; Type No. 7) **plate 1, fig. 13.**

Frustule oblong with rounded or truncate apices; connecting zone abruptly inflated towards the apex, marked with several fine longitudinal striæ. Valves with dorsal margin straight at median part, then abruptly attenuate and forming an obtuse point in consequence of a corresponding constriction in the ventral margin; raphe strongly inflexed; striæ, robust on dorsal side, 9 in 1 c.d.m.; fine and marginal on ventral side, 15 in 1 c.d.m. Length, 5 to 6 c.d.m.

Brackish waters—Antwerp, Blankenberghe, Heyst, Ostend (H.V.H.); England (W. Sm! Stolterfoth.); Scotland (Greg); France; Germany! Norway! and probably throughout the shores of the North Sea.

A cymbifera Greg. (Diat. of Clyde, p. 54, pl. 6, f. 97. Ad. Sch. Atl., pl. 25, f. 13, 17-19* ; pl. 26, f. 33) **plate 24, fig. 678.**

Frustule elliptic, with produced truncate apices; valves narrow, arcuate with rostrate-capitate apices; ventral margin and raphe almost straight; striæ radiant, robust, 9-12 in 1 c.d.m. Sutural zone elliptic. Length, very variable, from 5 to 10 c.d.m.

Marine.—England, Scotland, Ireland, Denmark, Norway, etc.

A. rostrata W. Sm. (S.B.D. i., p. 20, pl. 30, f. 253*) **plate 24, fig. 679.**

Frustules inflated, sub-oval with apices rostrate-truncate showing longitudinal costæ marked with a double row of puncta. Valves arcuate semi-lunar with apices capitate; striæ robust, 6 to 7 in 1 c.d.m.

Marine.—England (W. Sm. Norman), Scotland (Greg.), Ireland (O'Meara).

A. angularis Greg. (Q.J.M.S., 1855, p. 39, pl. 4, f. 6; H.V.H. Atl., pl. 1, f. 21*, Type No. 12) **plate 1, fig. 8.**

Frustule panduriform with apices tapering, broadly truncate, connecting zone with fine transverse striæ, interrupted by numerous pleats. Valves with dorsal margin constricted in the middle, apices tapering, acuminate, raphe infinitesimally inflexed; striæ punctate, about 18 in 1 c.d.m. Length, 4 to 5 c.d.m.

Var. hybrida Grun. (In H.V.H.'s Type, No. 12). Valves with constriction only slightly if at all marked, showing a longitudinal line in the convex part.

Var. lyrata (*A. lyrata Greg.* Diat. of Clyde, p. 48, pl. 5, fig. 82, H.V.H. Atl., pl. 1, fig. 22*; in Type No. 12) **plate 1, fig. 9.**
Differing from the type-form in being shorter (about 3 c.d.m.) and its median constriction being less pronounced, which, when inadequately resolved, slightly resembles a stauros.

Brackish waters.—The type form, and varieties mixed together at Blankenberghe and Antwerp. Scotland, Ireland, Norway.

A. macilenta Greg. (Diat. of Clyde, p. 38, pl. 4, f. 65*) **plate 24, fig. 680.**

Resembling *A. salina.*—Frustules elliptic, long, narrow, with apices produced, tapering; valves very delicate, arcuate on dorsal side, ventral margin straight. Raphe very distinct. Striæ parallel, rather robust, 12 in 1 c.d.m. Sutural zone very narrow. Length, 4 to 5 c.d.m.

Marine.—Scotland (Gregory); North Sea.

This species is quite unknown to me, and the very poor figure given by Gregory makes it impossible to recognize it.

A. acutiuscula Kütz. (Bac., p. 108; H.V.H. Atl., pl. 1, f. 13* in Type No. 261), **plate 1, fig. 5.**

Frustules elliptic or elliptic-lanceolate, with apices slightly rostrate, truncate. Valve with dorsal margin arcuate, ventral margin slightly inflated; apices rostrate-capitate; raphe straight, striæ with distinct puncta, 13 to 14 in 1 c.d.m. on dorsal side, 18 to 20 on ventral side. Length, about 5 c.d.m.

Marine.—Blankenberghe; North Sea.

A. salina W. Sm. (S.B.D. i., p. 19, pl. 30, f. 251; H.V.H. Atl., pl. 1, f. 19*; Type No. 11), **plate 1, fig. 6.**

Frustule elliptic-oblong with apices slightly produced, truncate. Valves with apices rostrate, slightly capitate; dorsal margin arcuate, ventral margin straight or concave; raphe concave with reference to the connecting zone; striæ fine, punctate, 18 to 21 in 1 c.d.m. on the dorsal side, 20 to 21 on ventral side. Length, 3 to 5 c.d.m.

Brackish water.—Common at Antwerp, Blankenberghe, Heyst; England; Scotland; Ireland; Denmark; and probably throughout the shores of the North Sea.

β **minor.** (*A. borealis Kütz!* Bac., p. 108, pl. 3, f. 18; H.V.H. Atl., pl. 1, f. 20*), **plate 1, fig. 7.**

Smaller and broader, with a not very pronounced beak.

Slightly brackish water—Blankenberghe.

A. coffeæformis Kütz.! (Bac., p. 108, pl. 5, f. 27; Ad. Sch. Atl., pl. 26, f. 56, 58, 59*) **plate 24, fig. 681.**

General appearance resembling that of *A. Salina*, but frustules tapering infinitesimally to apices, which are generally very slightly produced. Valves with apices rostrate, very slightly capitate. Transverse striæ excessively delicate and almost invisible. Longitudinal striæ few but very distinct.

Brackish and Marine.—Shores of North Sea

A. veneta Kütz. (Bac., p. 108, pl. 3, f. 25; H.V.H. Atl., pl. 1, f. 17*; Type No. 10) **plate 1, fig. 11.**

Frustule oblong-elliptic, with apices slightly truncate. Valves with dorsal margin convex, infinitesimally attenuate; ventral margin flat or slightly concave; raphe concave; central nodule elongated; striæ fine, about 20 in 1 c.d.m., slightly more robust in median portion. Length, 2 to 3 c.d.m.

Brackish water.—Blankenberghe, Antwerp.

A. inflexa (Bréb.) H. L. Sm. (in Lens, 1873, p. 78.)

Under the name of *Amphipleura inflexa*, De Brébisson has described a rather singular diatom which he found on the coast of Normandy.

In 1868, Eulenstein formed the genus *Okedenia* with this species, and in our "Types du synopsis" we distributed it under the name of *Okedenia inflexa, Eul.*

After a careful study of this form, the result of which I communicated to Professor Cleve, the learned diatomographer thought that this diatom was simply an Amphora of the sub-genus Halamphora. Professor H. L. Smith had previously classed it among the Amphora; I therefore place it here under the name of *A. inflexa*. No correct figure of this diatom having yet been published we give here one of our photograms of it.

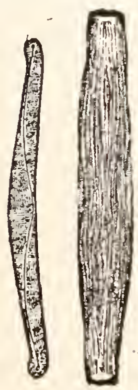

Fig. 25.—*A. (Okedenia) inflexa.*

Valves narrow, arcuate, with apices unilaterally capitate, recurved. Sutural zone very narrow on dorsal side, more or less developed on ventral side, and displaying a more or less considerable number of pleats. Raphe inflexed, quite on the margin of the frustule and scarcely visible. Central nodule very elongate and more or less rudimentary. Valve with puncta forming transverse striæ (about 18 in 1 c.d.m.) and longitudinal lines. Connecting zone finely striate transversely, about 20 striæ in 1 c.d.m. Length, 10 to 12 c.d.m. Breadth of valve, rather less than 1 c.d.m. at the median portion. Breadth of frustule, 7 to 15 μ.

Marine.—North Sea: France (Bréb!); England (W. Sm.!)

A. Sarniensis Grev. (T.M.S. 1862, ii., n.s., p. 95, pl. 9, f. 12; Ad. Schm. Atl., pl. 25, f. 80*), **plate 24, fig. 682.**

Frustule constricted at the median portion, with bi-undulated lobes, apices truncate, produced. Striæ about 12 in 1 c.d.m. Length, 4 to 5·5 c.d.m.

Marine—Guernsey (Wallich).

A. Ergadensis Greg. (Diat. of Clyde, p. 40, pl. 4, f. 71*), **plate 24, fig. 683.**

Frustule elliptic lanceolate, with apices diminuate, sub-rostrate-truncate. Valves very narrow with raphe approximate to the ventral margin, which is flat; dorsal margin regularly arcuate, extremely obtuse, somewhat prolonged-capitate. Transverse striæ strong, with difficulty resolvable into puncta, 9 in 1 c.d.m. Connecting zone showing 3 to 5 longitudinal rows of coarse puncta. Length, 8 to 9 c.d.m.; breadth at the median portion, about 1·5 c.d.m.

Marine—Lamlash Bay, Loch Fine (Scotland, Greg.)

Gregory's figure is very bad and renders the diatom scarcely recognizable. My description is made from an example from the Balearic Islands, determined by Mr. Grunow. The same remark applies to the figure given in my plates.

A. Eunotia Cleve (Diat. Arct. Sea, 1873, p. 21, pl. 3, f. 17*), **plate 24, fig. 684.**

Frustule complex, oval, broadly truncate, raphe straight. Valves coarsely striate, with striæ moniliform, about 6 in 1 c.d.m., consisting of very fine puncta, grouped, compact, about 9 in 1 c.d.m. Central nodule rounded, very distinct. Length, about 8 c.d.m.; breadth, 5 c.d.m.

North Sea; Greenland; Spitzbergen; Finmark, etc. (Cleve).

A. binodis Greg. (Diat. of Clyde, p. 38, pl. 4, f. 67*), **plate 24, fig. 686.**

Frustule linear-oblong, with apices attenuate-truncate, median portion constricted. Raphe flexuous, bi-arcuate. Striæ about 14 in 1 c.d.m. Length, about 4-5 c.d.m.; breadth, 1·25 c.d.m.

Marine—Coasts of Scotland (Greg.); England (Stolterfoth).

A. turgida Greg. (Diat. of Clyde, p. 38, pl. 4, f. 63*), **plate 24, fig. 685.**

Small, suborbicular-lanceolate, with apices rostrate, more or less capitate. Valves with dorsum very convex, venter flat, apices diminuate, rostrate, subcapitate. Striæ, 7 to 9 in 1 c.d.m., consisting of coarse puncta, somewhat distant and interrupted near the dorsal margin by a hyaline line, more or less conspicuous, following the outline of the valve. Length, 2·5 to 7 c.d.m. Breadth, 1·25 to 2 c.d.m.

Marine—Lamlash Bay; Loch Fine (Scotland, Greg,); England (Stolterfoth).

6. *Calamphora Cl.*—Ventral portion of valve smooth, furnished with a longitudinal line (or rib). Dorsal portion without rib and furnished with transverse striæ, indistinctly punctate, or with costiform striæ alternating with indistinct beads. (Type form: A. formosa Cl.).

A. limbata Cl. and Grove. (Le Diatomiste i., p. 159), **plate 35, fig. 908.**

Frustule rectangular, somewhat constricted in the middle, showing on each side a hyaline line which appears to come from the dorsal part. Valve narrow, linear with subcapitate apices and arcuate raphe; dorsal portion striate, 8 striæ in 1 c.d.m.; ventral portion without striæ, but with a longitudinal line. Connecting zone with 5-8 divisions, transversely striated, striæ about 8.5 in 1 c.d.m. Length of frustule, 4·5 to 7.5 c.d.m. Breadth, 2 to 3.5 c.d.m.

Marine—Grip (Norway, Cleve.)

7. *Amblyamphora Cl.*—Valves without longitudinal lines. Ventral portion rather large, with a structure similar to that of the dorsal portion or striæ finely punctate. The branches of the median line diverge from the central nodule. (Type form : A. obtusa).

ANALYSIS OF SPECIES.

Striæ very distinct, distant	**A. spectabilis.**
Striæ very delicate, indistinct, approximate . . .	**A. obtusa.**

A. spectabilis Greg. (Diat. of Clyde, p. 44, pl. 5, f. 80*), **plate 24, fig. 687.**

Frustule linear or linear-oblong with apices rounded, sub-truncate. Valve with apices obtuse, ventral portion rather broad, raphe strongly inflexed, central nodule large. Striæ rather broad, distant, diminishing in breadth from the side of the raphe, 5 to 6 in 1 c.d.m. Length, 8 to 15 c.d.m.

Marine and brackish water.—Coasts of the North Sea ; England (Stolterfoth) ; Scotland (Greg.), etc.

A. obtusa Greg. (T.M.S. 1857, v., p. 72, pl. 1, f. 34 ; Ad. Sch. Atl., pl. 40, f. 16-17*), **plate 24, fig. 688.**

Frustule broadly linear-oblong with apices rounded, not truncate. Valves arcuate on dorsal side, almost straight on ventral side, with apices very obtuse. Raphe very inflexed with central and terminal nodules very large. Ventral portion broad, with striation identical with that of the dorsal portion, ventral margin slightly constricted near the apices. Striæ very delicate, approximate, indistinct, about 12 14 in 1 c.d.m. Sutural zone narrow. Length, 8 to 13 c.d.m. Breadth of valves, 1·5 to 2 c.d.m.

Marine.—Coasts of the North Sea ; Scotland (Greg. !), etc.

8. *Oxyamphora Cl.*—Valves without longitudinal lines. Ventral portion generally very narrow and with striation identical (not finer) with that of the dorsal portion. Raphe generally straight and approximate to margin. Nodule often stauroid. Striæ punctate (Type form : A. acuta).

ANALYSIS OF SPECIES.

- Valve with stauros.
  - Frustules with the outer margins more or less inflated at the median portion . . . . . **A. ostrearia.**
  - Frustule with outer margins not inflated.
    - Raphe straight . . . **A. acuta.**
    - Raphe gradually inflexed . . **A. lævis.**
    - Raphe abruptly inflexed . . **A. lævissima.**
- Valve without stauros.
  - Frustule linear, elongate, subelliptic . . . **A. bacillaris.**
  - Frustule more or less quadrangular.
    - Frustule robust with striæ robust, moniliform . . . . **A. Arcus.**
    - Frustule hyaline.
      - Raphe straight . **A. hyalina.**
      - Raphe inflexed . **A. lineolata.**

A. bacillaris Greg. (Diat. of Clyde, p. 55, pl. 16, f. 100*), **plate 24, fig. 689.**

Frustule linear, narrow, with apices slightly rounded, subacute. Valve with ventral portion narrow, striation finer than that of the dorsal portion. Raphe slightly inflexed. Connecting zone narrow on ventral side, very large on dorsal side of frustule and showing 7 or 8 narrow segments.

Marine.—Scotland (Gregory).

A. Arcus Greg. (Diat. of Clyde, p. 50, pl. 13, f. 88*), **plate 24, fig. 690.**

Frustule subquadrangular, with outer margins infinitesimally inflated as far as the central portion, with truncate apices. Valves narrow, with ventral margin infinitesimally arcuate, ventral margin and raphe inflexed, apices strongly rostrate, slightly capitate. Striæ robust, moniliform, 6 to 7 in 1 c.d.m., Sutural zone showing 16 to 17 robust bars formed by the ventral margins being approximate to juxtaposed segments. Length, 9 to 10 c.d.m. Breadth, up to 5 c.d.m.

Marine.—England (W. Sm. Greg., Norman) ; Scotland (Greg).

A. lineolata Ehr. (*Navicula lineolata Ehr.* Inf., p. 188, n. 250 pl. 14, f. 4 ; *A. tenera,* W. Sm., S.B.D., i., p. 20, pl. 30, f. 252, H.V.H., Atl. pl. 1, f. 23* ; Type No. 6) ; **plate 1, fig. 10.**

Frustule elliptic-oblong, inflated at the median portion, infinitesimally attenuate up to the apices which are slightly rounded. Valves with raphe considerably inflexed, with striæ finely punctate, about 23 in 1 c.d.m. Connecting zone with very fine transverse striæ, interrupted by numerous longitudinal pleats. Length, 4 to 5 c.d.m.

Fresh and brackish water. Blankenberghe ; England (W. Sm. !)

A. hyalina Kütz. (Bac., p. 108, pl. 30, f. 18 ; S.B.D., i., p. 19, pl. 2, f. 28 ; Ad. Sch. Atl., pl. 26, f. 52-55*) ; **plate 24, fig. 691.**

Frustule slightly silicious, hyaline, very broadly elliptic, with apices slightly truncate. Valve very broad, with very convex dorsum. Ventral margin and raphe straight. Valves rather strongly striated longitudinally, with striæ parallel to the dorsal curvature. Transverse striæ excessively fine. Length, 5 to 8 c.d.m.

Brackish.—England (W. Sm. ! Norman, Stolterfoth) ; Ireland (O'Meara) ; France ; Germany ; Denmark ; Norway, etc.

A. acuta Greg. (Diat. of Clyde, p. 52. pl. 6, f. 93; Ad. Sch. Atl., pl. 26, f. 19; 20*); **plate 24, fig. 692.**

Frustule elliptic, with truncate apices. Valve broad, with dorsal margin regularly arcuate, ventral margin flat. Stauros rather broad, very distinct. Raphe straight. Striæ very distinct, distinctly moniliform, 14 in 1 c.d.m. Length, 8·5 to 13 c.d.m.

Marine.—Scotland; Greenland; Finmark, etc.

A. lævis Greg. (Diat. of Clyde, p. 42, pl. 4, f. 74; Ad. Sch. Atl., pl. 26, f. 8*); **plate 24, fig. 693.**

Frustule subquadrangular or elongate, with rounded apices, median portion constricted. Valve narrow, arcuate, with apices slightly tapering-rostrate, raphe gradually inflexed, stauros narrow; striæ fine, 24 in 1 c.d.m. Length, 3 to 4 c.d.m.

Marine.—England; Scotland; Ireland.

A. lævissima Greg. (Diat. of Clyde, p. 41, pl. 4, f. 72; H.V.H. Atl., pl. 1, f. 15*; Type No. 8); **plate 24, fig. 694.**

Frustule linear-oblong, with rounded apices; excessively hyaline. Valve with raphe abruptly inflexed towards the median portion, with a rather broad stauros. Striæ almost invisible. Length, 5 to 6 c.d.m.

Marine.—England; Scotland; Ireland; Norway; Finmark; probably indigenous to Belgium, but it has not yet been recorded.

A. ostrearia Bréb.! (in Kütz. Spec. Alg. p. 94; H.V.H. Atl., pl. 1, f. 25*) **plate 1, fig. 1.**

Frustule elliptic-oblong, with outer margins inflated at the median portion, apices regularly rounded, sometimes slightly truncate. Valve with raphe strongly inflexed, stauros very distinct, transverse striæ about 11 in 1 c.d.m., finely punctate. Connecting zone finely striate, transversely, and showing numerous pleats on the dorsal surface. Length, 6 to 8 c.d.m.

Marine.—France; England, etc., probably Belgium, but not yet recorded.

Sub-var. Belgica Grun. (In H.V.H.'s Type, No. 74).
Distinguished from *A. ostrearia* by the outline of the frustules being more quadrate, by the ventral portion of the valves being a little narrower, and by the striæ being closer (16 to 17 in ·01 mm. in the middle of the valve) and very finely punctate. Length, ·033—·048 mm.; breadth, ·021—·022 mm.

Marine.—Blankenberghe, washing of sand on seashore.

β. **quadrata Bréb.** ! (*A. quadrata* Bréb. in Kütz. Alg., p. 94 ; H.V.H. Atl., pl. 1, f. 24*), **plate 1, fig. 2.**

Differs from the preceding by its subquadrangular form and its hyaline condition, which renders details almost invisible.

Marine.—Same habitats as type-form. England (Norm.) ; Scotland (Greg.).

The **Amphora membranacea** of W. Sm. (S.B.D., i., p. 20, pl. 2., f. 29), according to authentic specimens from his herbarium, in our opinion, is only a narrow and oval form of *A. ostrearia.* The figure of W. Smith well represents its type-form.

England ; various localities (Sussex, W. Sm. !)

Amphoropsis Grun. in Syn. (1883).

Auricula Castr. (1873).

These two genera should be included in the Amphiprora and are described subsequently.

GENUS 2—CYMBELLA AG., 1830.

Frustules free or stipitate, with valves more or less cymbiform, divided into two unequal portions by the raphe and the central nodule eccentric.

Raphe generally more or less arcuate. Endochrome as in the Amphora.

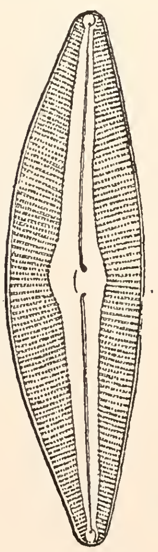

Fig. 26.—*Cymbella Ehrenbergii Kütz.*

The Cymbella are asymmetrical Navicula, presenting all possible variations from the type form Navicula, from having a lanceolate, straight valve to a valve in the form of an arc. Authors have, from the genus Cymbella, created two different genera, the genus Cymbella, properly so called, with frustules free and the genus Cocconema, the frustules of which are stipitate. All the Cymbella of our Section II. belong to the old genus Cocconema Ehr.

Cocconema having been described in 1829, and Cymbella only dating from 1830, the earlier name ought to prevail, but in order not to create confusion, we have preferred to adopt the later, which is now exclusively employed.

We are not aware to what *Syncyclia Ehr. 1835*, refers, in which this author includes cymbelliform frustules arranged in a ring, and of which one species *S. Salpa*, had been observed at Wismar, in the Baltic Sea on some fucus. We are much inclined to believe that this observation should be accepted with caution.

ANALYSIS OF SPECIES.

I. Dorsal and ventral margins bent in contrary directions.

- Valve broadly lanceolate or sub-elliptic.
  - Apices slightly produced . . . . C. Ehrenbergii.
  - Apices strongly rostrate-cuspidate . . . . . C cuspidata.
  - Apices rostrate-capitate . . . . C. amphicephala.
- Valve very elongated with dorsal margin much more arcuate than the ventral margin.
  - Apices imperceptibly attenuate.
    - Apices obtuse; raphe surrounded with a hyaline zone; striæ with well marked puncta . . . C. obtusa.
    - Apices sub-acute; raphe without a hyaline zone; striæ with puncta faint . . . . . . C. pusilla.
  - Apices slightly rostrate or rostrate-subcapitate.
    - Ventral margin strongly gibbous in the median portion; raphe edged throughout its entire length with a broad hyaline zone . . . . C. leptoceras.
    - Ventral margin not gibbous.
      - Raphe very arcuate, striæ distant, well marked . . . . . . C. affinis.
      - Raphe almost straight; striæ not well marked.
        - Apices rostrate - subcapitate; valve with almost equal sides . . . . . C. subæqualis.
        - Apices slightly tapering, rostrate.
          - Valve elongate, very narrow; dorsal margin slightly arcuate; striæ very delicate, 18 to 22 in 1 e.d.m. C. delicatula.
          - Valve rather broad, with dorsal margin very arcuate; striæ rather distinct about 14 in 1 e.d.m. . C. lævis.
  - Apices strongly rostrate-capitate
    - Striæ delicate 24 to 30 in 1 e.d.m. . C. microcephala.
    - Striæ robust about 14 in 1 e.d.m. . C. tumidula.
- Valve naviculoid, sub-lanceolate-linear margins scarcely bent, almost straight, striæ delicate . .
  - Striæ approximate, valves with apices rostrate-capitate . C. æqualis.
  - Striæ very distiant, apices scarcely contracted . . C. abnormis.

II. Ventral and dorsal margins bent in the same direction: raphe bent parallel to dorsal margin.

- Terminal nodules not very much elongated.
  - Striation not interrupted by a broad hyaline space on the ventral side of the valve.
    - Curvature of raphe considerable and raphe bent regularly parallel to the dorsal margin.
      - Raphe surrounded with a broad hyaline zone; striæ with coarse punctæ . . C. gastroides.
      - Raphe with a narrow hyaline zone; striæ with puncta rather fine . . . C. lanceolata.
    - Curvature of raphe inflected on the ventral side in the middle of the valve C. cymbiformis.
  - Striation interrupted by a broad hyaline space on the ventral side of the valve.
    - Valves with apices for some length produced-rostrate; central nodule usually having a small furrow across it; central nodule often accompanied by one or two isolated granules . . C. tumida.
    - Apices obtuse, rounded, slightly or not at all produced rostrate; nodule surrounded by 2 to 5 isolated granules . C. Cistula.
- Terminal nodules very much elongated . . . . . C. Helvetica.

Sect. I. *Ventral and dorsal margins bent in contrary directions.*

§ **Valve broadly lanceolate or sub-elliptic.**

C. Ehrenbergii Kütz. (Bac. p. 79, pl. 6, f. 11. H.V.H. Atl., pl. 2, f. 1, 2*; Type No. 15); **plate 1, fig. 22.**

Valves broadly elliptic-lanceolate, apices slightly produced rostrate; raphe a little bent, surrounded by a broad hyaline zone, rather enlarged near the central nodule; transverse striæ about 8 in 1 c.d.m., robust and very finely divided crosswise. Length 6 to 13 c.d.m.

Fresh water.—Common.

C. cuspidata Kütz. (Bac. p. 79. pl. 3, f. 40; H.V.H. Atl., pl. 2, f. 3*; Type No. 16); **plate 1, fig. 23.**

Valves broadly lanceolate, ventral margin sometimes depressed, with apices longitudinally rostrate-cuspidate; raphe bent, surrounded by a faint hyaline zone, very inflated round the central nodule; transverse striæ 6 in 1 c.d.m. in the middle of the valve, 12 in 1 c.d.m. at apices, finely divided crosswise. Length 6 to 8 c.d.m.

Fresh water.—Common.

β. **naviculiformis Auersw.** (in Rab. Alg., n. 1065; H.V.H. Atl., pl. 2, f. 5*); **plate 1, fig. 24.**

Considerably smaller, apices rostrate; raphe straight; hyaline zone very inflated round the central nodule; striæ finely punctate, about 15 in 1 c.d.m.; length 3 to 4 c.d.m.

Fresh water.—Belgium, Ard. Liége. (De Wild.). Denmark (Heiberg).

C. amphicephala Nægeli (in Kütz. Sp. Alg., p. 890; H.V.H. Atl., pl. 2, f. 6*; Type No. 19); **plate 1, fig. 25.**

Valves elliptic with apices rostrate-capitate; ventral margin sometimes depressed; raphe almost straight; hyaline zone narrow, slightly inflated round the central nodule, where the striæ are also more distant; striæ finely punctate, about 12 to 14 in 1 c.d.m. Length 2·25 to 3 c.d.m.

Fresh water.—Antwerp, etc. (H.V.H.), Ard. Liége. (De Wild.)

β. **Anglica Lag.** (Diat. Spitzb., p. 42, pl. 2, f. 18*), **plate 25, fig. 695.**

Only differs from C. amphicephala in the hyaline space surrounding the raphe. This hyaline space is more visible in the C. Anglica.

Fresh water.—Belgium, Ard. Liége. (De Wild.). England (W. Sm.). Spitzbergen (Lagerstedt.)

§ § **Valve very elongate, with dorsal margin much more arcuate than ventral margin.**

C. subæqualis Grun.! (H.V.H. Atl., pl. 3, f. 2; Suppl. f. 1*; Type No. 29); **plate 1, fig. 26.**

Valves almost symmetrical, oblong-lanceolate, slightly attenuate, with apices obtuse, rounded, sub-capitate, ventral margin very slightly less arcuate than the dorsal margin; raphe almost straight, surrounded by a hyaline zone rather broad, and dilated round the central nodule; striæ very radiant, finely punctate, about 10 in 1 c.d.m. in the middle of the valve, 14 near the apices. Length 4 c.d.m.

Fresh water.—Botanical Gardens, Brussels (Del.); Ard. Liége. (De Wild.)

[According to Professor Cleve, this form should really constitute the C. æqualis of W. Sm.]

C. obtusa Greg.! (Q.J.M.S., 1856, p. 5, pl. 1, f. 19; H.V.H. Atl., pl. 3, f. 1a*; in Type No. 257); **plate 1, fig. 27.**

Valves lanceolate, with dorsal margin inflated, infinitesimally attenuate; ventral margin almost straight, slightly inflated in the middle; raphe straight, a little flexuous, surrounded by a slight hyaline zone, very slightly dilate on the dorsal side round the central nodule. Median striæ 12, terminal 15 in 1 c.d.m. Length about 3 c.d.m.

Fresh water.—Not yet found in Belgium; Scotland (Gregory); England (Norman.).

C. pusilla Grun.! (in Ad. Schm. Atl., pl. 9, f. 36, 37; H.V.H. Atl., pl. 3, f. 5*; in Type No. 12); **plate 1, fig. 28.**

Valves very lanceolate, with apices very attenuate, slightly obtuse; dorsal margin very arcuate, ventral margin almost straight, very slightly convex in the median part; raphe straight, surrounded by a narrow hyaline zone not dilated in the middle. Median striæ 14, terminal 16 in 1 c.d.m., finely punctate. Length about 3 to 4 c.d.m.

Brackish water.—Blankenberghe (H.V.H.); Ard. Liége. (De Wild).

C. delicatula Kütz. (Spec. Alg., pl. 59, n. 13; H.V.H. Atl., pl. 3, f. 6*; Type No. 31); **plate 1, fig. 29.**

Valves narrowly lanceolate, divided very unequally by the raphe, with apices produced-rostrate; dorsal margin considerably arcuate, ventral margin straight, slightly arcuate, not gibbous; raphe almost straight, slightly flexuous, surrounded by a very narrow hyaline zone, in no parts inflated; striæ delicate, slightly radiant, visible with difficulty; dorsal 18, ventral 22 in 1 c.d.m. Length about 3 to 4 c.d.m.

Fresh water.—Frahan, Belgium (Delogne); Ard. Liége. (De Wild.)

C. lævis Nægeli! (H.V.H. Atl., pl. 3, f. 7*; in Type No. 257); **plate 1, fig. 30.**

Valves lanceolate, with dorsal margin very arcuate, ventral margin very slightly convex. Apices very shortly rostrate, rostrum narrow. Raphe very slightly arcuate, surrounded by a narrow hyaline zone; striæ faintly marked, 14 in 1 c.d.m. Length about 3 c.d.m.

Fresh water.—Ard. Liége. (De Wild.); S. Abbe Head, England.

Var. rupicola Grun.—(*C. rupicola Gr.* in A. Schm. Atl., pl. 71, f. 70-71*; in H.V.H. Type No. 28); **plate 25, fig. 696.**

Differs only from the type form by its valves being somewhat more symmetrical.

Fresh water.—Scotland.

C. affinis Kütz. (Bac., p. 80, pl. 6, f. 14; H.V.H. Atl., pl. 2, f. 19*; Type No. 26); **plate 1, fig 31.**

Short, ventricose; valves broadly lanceolate, with dorsal margin very convex, ventral margin very slightly convex, not gibbous; apices produced rostrate; raphe very arcuate, parallel to dorsal side, surrounded by a narrow hyaline zone; striæ median, dorsal 9, ventral 11 in 1 c.d.m. Length 2·5 c.d.m.

Fresh water.—Antwerp, Brussels, Louvain (H.V.H.); England (W. Sm., Norman); Scotland (Greg.); Ireland (W. Sm., O'Me.)

C. leptoceras Kütz. (Bac, p. 79, pl. 6, f. 14; H.V.H. Atl., pl. 3, f. 24*; in Type No. 211) **plate 1, fig. 32.**

Valves rather broadly lanceolate, short, with apices attenuate, sub-obtuse; dorsum very arcuate, ventral margin extremely gibbous; raphe almost straight, slightly flexuous, surrounded throughout its length by a rather broad hyaline zone; striæ well marked, about 8 in 1 c.d.m. Mean length, 2 to 3 c.d.m.

Fresh water.—Brussels, Antwerp, &c.

Var β elongata (*C. leptoceras* H.V.H. Atl., pl. 3, f. 18; suppl., f. 2*; in Type No. 211) **plate 1, fig. 33.**

Considerably longer than the preceding, with apices much more rostrate, ventral margin almost straight and strongly gibbous. Length 3.5 to 4 c.d.m.

Fresh water. Louvain, Brussels, Antwerp, etc.

C. microcephala Grun. (H.V.H. Atl. pl. 8, f. 36—39*; in Type No. 211), **plate 1, fig. 34, 34.**

Valves rather narrowly lanceolate, scarcely cymbiform, with apices strongly rostrate-capitate; raphe sub-arcuate; striæ delicate, 24 in large forms, 28 to 30 in small forms. Length 1.5 to 2.3 c.d.m.

Fresh water. Brussels (Delogne).

C. tumidula Grun. (in Ad. Schm. Atl., pl. 9, f. 33*; H.V.H. Type No. 27 sub nom. *C. affinis var. tumidula*); **plate 25, fig. 697.**

Valve linear-lanceolate, with rostrate apices. Dorsal margin very arcuate; ventral margin straight or slightly gibbous at the median portion. Raphe somewhat eccentric; surrounded by a narrow hyaline area. Striæ about 14 in 1 c.d.m., somewhat radiant, punctate, shortened on the dorsal side round the central nodule, where they leave a small rounded hyaline area, while on the ventral side each of the two median striæ are terminated by a distant isolated dot. Length 3·3 to 3·5 c.d.m. Breadth 0·75 to 1·0 c.d.m.

Fresh water.—England (Thames, Oxford (F. Okeden)).

This form is very closely allied to *C. affinis,* and it has been recorded with it by W. Arnott and Grunow. The dorsal, median, hyaline area does not exist in C. affinis; in that form there is seen on the ventral side one coarse isolated dot, but never two, the striæ also are in an equal manner more robust and more distant.

§ § § Naviculoid, sub-lanceolate-linear valve, both margins scarcely bent, almost straight, striæ delicate.

C. æqualis W. Sm. (S.B.D. ii., p. 84; Ad. Schm. Atl, pl. 9, f. 69*) **plate 25, fig. 698.**

Valve lanceolate almost naviculoid, with dorsal margin regularly arcuate, slightly produced at apex. Ventral margin rather more strongly arcuate, with apices rostrate-capitate. Raphe and central nodule surrounded by a well marked hyaline space. Striæ delicate, about 12-13 in 1 c.d.m. Length, 3·5 to 6 c.d.m.

Fresh water.—England, various localities; Germany, etc.? According to Prof. Cleve, this form should be the C. angustata of W. Sm.

C. abnormis Grun. (in H.V.H. Syn., pl. 3, f. 8*; Bot. Centbl, 1880, p. 249), **plate 25, fig. 699.**

Valve sub symmetrical with apices slightly produced, dorsal margin arcuate, ventral margin almost straight, slightly inflated at the median portion. Raphe straight, surrounded by a rather broad hyaline space. Striæ rather strong, not moniliform, very distant, about 10 in 1 c.d.m.; absent in median portion where they leave a broad stauroform blank space. Length, about 2·5 c.d.m. Breadth, 0·5 c.d.m.

Fresh water.—France (Normandy), Sweden, Norway (Grunow)

Sec. II.—Ventral and dorsal margins bent in the same direction; raphe with concavity turned towards the ventral margin.

§ Terminal nodules not very elongate.

(*a.*) STRIATION NOT INTERRUPTED BY A BROAD HYALINE SPACE ON THE VENTRAL SIDE OF THE VALVE.

C. gastroides Kutz. (Bac., p. 79, pl. 6, f. 4 b; H.V.H. Atl., pl. 2, f. 8*; Type 20) **plate 1, fig. 35.**

Valve broadly cymbiform with apices obtuse, rounded; dorsal margin arcuate, with median portion scarcely more inflated; ventral margin very slightly concave, with median portion somewhat prominent; raphe slightly arcuate, surrounded by a very broad hyaline zone, very slightly dilated round the central nodule; central nodule elongate; terminal nodules very robust; striæ very robust, 8 in 1 c.d.m., consisting of coarse distant beads. Length, about 15 c.d.m.

Fresh water.—Rather common.

β. **minor.** (H.V.H. Atl., pl. 2, f. 9*) **plate 1, fig. 36.**

Short, very broad, with raphe strongly arcuate. Length, 7 to 8 c.d.m.

Fresh water.—Not so common as the type form.

C. lanceolata Ehr. (*Cocconema lanceolatum Ehr.* Inf. p. 224, pl. 19, f. 6; H.V.H. Atl., pl. 2, f. 7*; Type No. 18), **plate 1, fig. 37.**

Valve cymbiform with dorsal margin strongly convex, ventral margin concave, inflated at the median portion; apices obtuse, raphe very arcuate, surrounded by a very narrow hyaline zone, scarcely dilated near the central nodule; central nodule rather large, elongate; terminal nodules of medium size. Striæ about 7 to 8 in 1 c.d.m. distinctly moniliform with granules small, approximate. Frustules stipitate in living state. Length, 8 to 15 c.d.m.

Fresh water.—Very common.

C. cymbiformis Ehr. (*Cocconema cymbiforme Ehr.* Abh., 1835. Inf. p. 225, pl. 19; H.V.H. Atl., pl. 2, f. 11, a.b.c.*; Type No. 22), **plate 1, fig. 38.**

Valve with dorsal margin slightly arcuate, ventral margin slightly concave, a little inflated in the middle; apices obtuse-rounded, sometimes somewhat produced. Raphe surrounded by a narrow hyaline zone, slightly inflated near the central nodule, and showing there an isolated punctum, unilateral (omitted in the figure); raphe slightly arcuate, with its convexity turned towards the dorsal margin as far as the central nodule, where it is abruptly inflected towards the ventral margin; striæ about 8 in 1 c.d.m., coarse, very finely divided cross-wise. Frustules stipitate. Length, 5 to 10 c.d.m.

Fresh water.—Not so common? Belgium, England, France, Norway, etc.

β. **parva.** (*Cocconema parvum,* W. Sm.) (H.V.H. Atl., pl. 2, f. 14*, Type No. 23), **plate 1, fig. 39.**
Smaller and often more inflated, with apices generally slightly produced-rostrate; striæ as in the type form, but not so distant near the central nodule. Length 3 to 5 c.d.m.

Fresh water.—Rather common? Belgium, England, Ireland.

(*b.*) STRIATION INTERRUPTED BY A BROAD HYALINE SPACE ON THE VENTRAL SIDE OF THE VALVE.

C. Cistula Hempr. (*Cocconema Cistula Ehr.* Inf., p. 224, pl. 19, f. 7; H.V.H. Atl., pl. 2, f. 12-13*, Type No. 24—*var. curta*; Type No. 25), **plate 1, fig. 40.**

Valve with dorsal margin very arcuate, median portion strongly gibbous, ventral margin slightly concave, inflated in the middle; apices obtuse-rounded; raphe regularly bent, surrounded with a rather broad hyaline zone and strongly inflated near the central nodule on the ventral side; the dilated portion showing from 2 to 5 isolated granules; striæ 7 to 8 in 1 c.d.m.; very robust, finely divided cross-wise. Length, 5 to 9 c.d.m. Frustule stipitate.

Fresh water.—Rather common, England, West Ireland. France, Belgium, Holstein, etc.

β. **maculata.** (*C. maculata Kütz.* nec Bréb.; H.V.H. Atl., pl. 2, f. 16, 17*), **plate 1, fig 41.**

Ventricose, with the isolated granules generally absent.

Fresh water.—Rather common, like the type form.

C. tumida Bréb (*Cocconema tumidum Bréb.*! in Kütz Sp. Alg., p. 60, n. 5; H.V.H., pl. 2, f. 10*; Type No. 21), **plate 1, fig. 42.**

Valves ventricose, with dorsal margin very arcuate, ventral margin concave, inflated in the middle, apices very produced-rostrate, truncate or rounded. Raphe very arcuate, surrounded by a rather broad hyaline zone, very considerably inflated round the central nodule, dilated portion sometimes showing one or two isolated granules; central nodule generally having a small furrow across it in the middle; striæ robust, quite moniliform, 8 to 9 in 1 c.d.m. Length, about 6 c.d.m. Frustule stipitate.

Fresh or slightly brackish water.—Antwerp, Louvain, Ostend, etc.

§ § **Terminal nodules very elongate**

C. Helvetica Kütz.! (Bac., p. 79, pl. 6, f. 13; H.V.H. Atl., pl. 2, f. 15*; Type No. 32); **plate 1, fig. 43.**

Valve very lanceolate, with dorsal margin rather convex, ventral margin very slightly concave, almost straight, abruptly inflated in just the middle portion; raphe slightly bent, with curvature inflected at the middle of the valve towards the ventral margin; raphe surrounded by a narrow hyaline zone, slightly inflated near the central nodule; terminal nodules very long, in the form of a coarse inverted comma; striæ rather well marked, divided crosswise, about 8 to 9 in 1 c.d.m. Mean length about 7 c.d.m.

Fresh water.—Very common, and found in all the countries comprised within our radius.

GENUS 3.—ENCYONEMA KÜTZ., 1833.

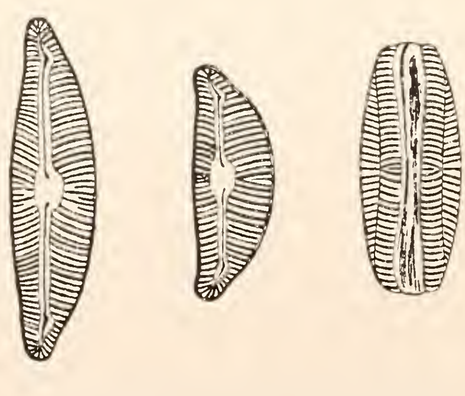

Fig. 27.—*Encyonema prostratum (Berk.) Ralfs.*

Frustules generally enclosed in tubes. Valve more or less cymbiform, divided unequally into two parts by the raphe and the central nodule, which is eccentric. Raphe straight. Terminal nodules considerably distant from the apices. Endochrome as in the *Amphora*.

ANALYSIS OF SPECIES.

Length of valve never exceeding 3 to 4 times its breadth.	Raphe surrounded by a hyaline zone inflated round the central nodule.	Apices broadly obtuse, rounded. . .	**E. prostratum.**
		Apices acute	**E. turgidum.**
	Hyaline zone not inflated round the central nodule.	Ventral portion of valve rather broad; ventral margin rather strongly inflated, especially in the median part . .	**E. cæspitosum.**
		Ventral portion very narrow; ventral margin straight or concave, rarely a little gibbous	**E. ventricosum.**
Valves very elongated, length 5-9 times its breadth.	Striæ very conspicuous, distant, having the same length throughout, ventral margin concave		**E. lunatum.**
	Striæ fine, approximate, shorter near the central nodule; ventral margin straight, or inflated in the middle		**E. gracile.**

Sect. I.—Length of valve never exceeding three to four times its breadth.

§ **Raphe surrounded by a hyaline zone, inflated round the central nodule.**

E. prostratum Ralfs ! (Ann. & Mag., vol. 16, pl. 3, f. 3; H.V.H. Atl. pl. 3, f. 9, 10, 11*; Type No. 34); **plate 1, fig. 44.**

Valve large, with dorsal side considerably inflated, ventral side with slight curvature; apices abruptly produced, obtuse, straight, recurved on ventral side; raphe straight, with its median ends slightly arcuate towards the dorsal margin, surrounded by a hyaline zone, broad and strongly inflated round the central nodule; terminal nodules very large and extremely elongate towards the dorsal margin, completely surrounded by striæ, except where they touch the raphe; striæ 6 or 7 in 1 c.d.m., robust (simulating costæ), divided crosswise; some near the central nodule being often only half as long as others. Length 6 to 9 c.d.m.

Fresh water.—Almost everywhere.

E. turgidum (Greg.) Grun. ! (*Cymbella turgida Greg.* Q.J.M.S. 1856, p. 5, pl. 1, f. 18; H.V.H., Atl. pl. 3, f. 12*), **plate 1, fig. 45.**

Valve cymbiform with dorsum very convex, venter almost straight, somewhat inflated in the middle; apices sub-acute; raphe straight, surrounded by a rather broad hyaline zone, inflated round the central nodule, and extending as far as the apex of the valve; striæ 7 or 8 in 1 c.d.m.; faint, finely divided cross-wise, not intermixed near the central nodule with shorter striæ. Length, 5 to 6 in 1 c.d.m.

Fresh water.—Not yet found in Belgium. Scotland (Gregory). West Ireland (West)

§ § Hyaline zone not dilated round the central nodule.

E. cæspitosum Kütz. (Spec. Alg., p. 61; H.V.H. Atl. Supp., f. 3*; Type No. 25), **plate 1, fig. 46.**

Valve very broadly cymbiform, with apices straight, obtuse, scarcely constricted; dorsal margin broadly convex, ventral margin regularly inflated; raphe almost straight, surrounded by a narrow hyaline zone, slightly inflated in the middle; striæ robust, divided cross-wise, 10 to 12 in 1 c.d.m. Length, about 3 c.d.m.

Fresh water.—Here and there in small quantities, almost everywhere—very variable, passes into the following forms by all intermediate stages.

Var. Auerswaldii. (*E. Auerswaldi Rabh.* H.V.H. Atl., pl. 3, f. 14*), **plate 1, fig. 47.**

Apices rounded, produced-subrostrate.

Var. lata. (H.V.H. Atl., pl. 3, f. 13*), **plate 1, fig. 48.**

Valve very widely lanceolate, sub-elliptic; apices very obtuse.

E. ventricosum Kütz. (Bac., p. 80; H.V.H. Atl, pl. 3, f. 17*; Types Nos. 36, 37, 38), **plate 1, fig. 49.**

Valve cymbiform, somewhat elongated, apices often rather abruptly attenuate; dorsal margin rounded, ventral margin straight, or almost straight; raphe straight, surrounded by a narrow hyaline zone, not inflated round the central nodule; striæ faint, about 12 to 16 in 1 c.d.m. at the middle of the valve, according to the size of the latter. Length, very variable, from 1·25 to 2·5 c.d.m.

Fresh water.—Rather common.

This species is excessively variable, not only in size, but also as to form; the apices are sometimes obtuse, in no way constricted, at other times rather constricted longitudinally, at other times somewhat prolonged into points beyond the ventral margin. Cleve unites this form with *E. cæspitosum.*

Sec. II.—Valves very elongated, being 5-9 times longer than broad.

E. lunatum (W. Sm.) H.V.H. (*Cymbella lunata W. Sm.!* in Grev. Ann., 2nd ser., vol. 15, pl. 9, f. 5, H.V.H. Syn., pl. 3, f. 23*, Type No. 39), **plate 28, fig. 791 bis. c.**

Valve cymbiform, with dorsum arcuate, ventral margin slightly concave with apices sub obtuse. Striæ very well marked, distant, 10 in 1 c.d.m., leaving off everywhere at a short distance from raphe. Length, about 3 c.d.m. Breadth, 1·5 c.d.m. in the middle portion.

Fresh water.—England, Scotland, Bræmar (Dr. Balfour) W. Sm. !

E. gracile Rabh. (Sussw. Diat., p. 25, pl. 10, Suppl. f. 1; H.V.H. Atl., pl. 3, f. 20,*) **plate 28, fig. 791, bis. b.**

Dorsal margin arcuate; ventral margin inflated at the median portion. Striæ delicate, about 12 to 13 in 1 c.d.m., leaving an elongated hyaline area round the central nodule. Length about 6 to 8 c.d.m.; breadth, about 1 c.d.m.

Fresh water.—Germany (Rabenhorst); West Ireland (West).

Var. Scotica (*Cymbella Scotica. W. Sm.* S.B.D. i., p. 18, pl. 2, f. 25; ii. p. 84. H.V.H. Atl., pl. 3, f. 21*; in Type No. 274), **plate 28, fig. 791, bis. a.**

Ventral margin straight, not inflated at the median portion; median striæ on dorsal side appearing to coalesce in the central nodule. Striation and size as in type form.

Fresh water.—Ard. Liége. (De Wild), England, Scotland, various localities.

Tribe II.—Naviculeæ.

- Frustules with compound valves (two superposed plates) . . .
  - One of the plates with normal striation, the other with only cells or marginal loculi . . . . **Mastogloia.**
  - One stratum with normal striation, the striæ crossing one another in three directions, the other stratum apparently reticulate, composed of broader cells, having a vasicular form . . . . **Dictyoneis.**
- Frustules not as above .
  - Valves not quadrangular.
    - Valves with a rounded central nodule or a stauros.
      - Valves with a conspicuous transverse smooth silicious band (stauros) not alate . . . **Stauroneis.**
      - Valves without stauros.
        - Valve sigmoid or arcuate or frustules alate or again raphe inflected or reflected.
          - Valves symmetrically divided by the raphe which is sigmoid, frustule neither alate nor carinate .
            - Girdle face straight, rarely constricted . . . **Pleurosigma.**
            - Girdle face genuflexed . . . . **Rhoicosigma.**
          - Valve or frustule not as above.
            - Frustule not carinate, valve with unequal margins, one inflated the other almost straight, raphe arcuate . . . . **Toxonidea.**
            - Frustule carinate.
              - Girdle face plicate.
                - Raphe sigmoid . . . . **Amphiprora.**
                - Raphe not sigmoid but bi-arcuate and very eccentric . . . . **Auricula.**
              - Girdle face not plicate . . . . **Tropidoneis.**
        - Valves not as above.
          - Frustules with genuflexed pleats, connecting zone broad . . . **Rhoiconeis.**
          - Frustules without genuflexed pleats.
            - Valves having a unique raphe.
              - Valve with straight connecting zone and raphe.
                - Terminal nodules considerably removed from the apices of the valves; valves with a some-eccentric structure . . . **Colletonema.**
                - Valve not as above.
                  - Frustules free . . **Navicula.**
                  - Frustules enclosed in tubes which simulate the higher algæ . . . **Navicula (s.g. Schizonema).**
              - Valve with sigmoid connecting zone and raphe . . **Scoliopleura.**
            - Central and terminal nodules linear-elongated, lying between the branches of a double raphe . . . . **Van Heurckia.**
            - Nodules small, round; raphe accompanied by two silicious ribs . **Stenoneis.**
    - Valves with central nodule not as above.
      - Central nodule rudimentary or obsolete; terminal nodules very elongate.
        - Valve with very delicate rectangular striation; girdle face straight . . **Amphipleura.**
        - Valve simulating an Amphipleura, but having transverse costæ and a cuneate girdle face . . . . **Gomphopleura.**
        - A row of coarse marginal beads and other rows round the nodules; girdle face somewhat sigmoid . . . . **Rouxia.**
      - Central nodule obsolete or indistinct; terminal nodules rounded, a very conspicuous ring at the median portion **Cyclophora.**
      - Central nodule linear, extremely elongate; apices inflated and apparently duplicated
        - Valves very robust; striæ radiate, coarse; frustule stipitate . . . **Brebissonia.**
        - Valves delicate, feebly silicious; striæ parallel, obscure; frustules enclosed in fronds . **Berkeleya.**
  - Valves quadrangular; raphe placed between two silicious ribs . . . . **Cistula.**

GENUS 4.—MASTOGLOIA. THWAITES, 1848.

Frustules naviculoid, most frequently enclosed in a gelatinous envelope, with valves furnished with loculi or marginal cells formed of silicious plates interposed between the connecting membrane and the valve, to which they most frequently appear to be adherent.

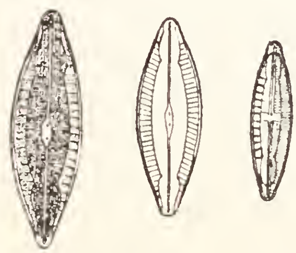

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Fig. 28.—*(1 2) M. lanceolata Tht.; (3) M. Smithii Thw., var. lacustris Grun.*

ANALYSIS OF SPECIES.

Valves with striæ not interrupted by sulci, making together the figure of a lyre.	Valve lanceolate, with loculi arranged in an arcuate row.	More than five loculi with outline not rounded.	Striæ radiant up to the apices of the valve.	Loculi rather broad, occupying almost half of the margin of the valve .	**M. Smithii.**
				Loculi narrow, very numerous, occupying almost the entire outline of the valve . .	**M. apiculata.**
			Striæ almost parallel at the middle of the valve, convergent at apices		**M. lanceolata.**
		3 to 5 loculi, with rounded outline .		Striæ radiant, divergent . .	**M. exigua.**
				Striæ radiant, convergent . .	**M. Closeii.**
	Valve linear-elliptic with loculi arranged in a straight row.	Apices abruptly attenuate; striæ finely punctate; marine or brackish . .			**M. Dansei.**
		Apices cuneate; striæ with coarse puncta; fresh water			**M. Grevillei.**
Valves with striæ interrupted by sulci, making together the figure of a lyre					**M. Braunii.**

A.—Valves with striæ not interrupted by sulci or hyaline spaces making together the figure of a lyre.

1. Valve lanceolate with loculi arranged in an arcuate row.

M. Smithii Thwaites. (W.Sm., S.B.D., ii., p. 65, pl. 54, f. 341, H.V.H. Atl., pl. 4, f. 13* ; Type No. 46), **plate 2, fig. 60.**

Valves elliptical with apices often slightly produced, rostrate; marginal plates broad; attenuate at the apices; showing from 6 to 8 loculi, central nodule slightly extended laterally; striæ robust, distinctly punctate, radiant up to the extremity of the valves, 15 to 17 in 1 c.d.m. Length, 3 to 4·5 c.d.m.

Fresh and brackish water.—Bergh, Brabant (Delogne), Antwerp (P.G.), Blankenberghe (H.V.H.).—England (W. Sm.! Kitton), Ireland (O'Meara, West).

Var. lacustris Grun. (H.V.H. Atl., pl. 4, f. 14* ; Type No. 47), **plate 2, fig. 61.**
Differs from the type form by being narrower and by the nodule being much more extended laterally.

Mixed with the type form at Bergh.

M. apiculata W. Sm. ! (S.B.D. ii., p. 65, pl. 62, f. 387*), **plate 25, fig. 700.**

Valves oval or lanceolate-elliptical, with apices apiculate, obtuse. Loculi narrow, very numerous, varying from 30 to 50, and arranged in a regular arc, which occupies nearly the entire outline of the valve; striæ transverse, distinctly punctate, radiant, up to apices of the valves, about 15 in 1 c.d.m. Length of valve 4 to 7 c.d.m.; breadth, 1·5 to 2 c.d.m.

Brackish water.—Shores of England (W. Sm. !), Ireland (O'Meara), Norway, France, etc. Will probably also be found in Belgium.

M. lanceolata Thwaites. (W. Sm., S.B.D. i., pl. 54, f. 340; *N. Meleagris Kütz.* H.V.H. Atl., pl. 4, f. 15, 16, 17*), **plate 2, fig. 62.**

Valves lanceolate, infinitesimally attenuate up to the sub-obtuse apices; loculi generally numerous; nodule not extended laterally; striæ about 20 in 1 c.d.m., slightly radiant nearly up the apices, where they become convergent. Length, about 5 c.d.m.

Brackish water.—Not yet found in Belgium. England, Ireland, Holland, Denmark, Sweden.

M. exigua Lewis. (Notes on new and rare spec., 1861, pl. 2, f. 5; H.V.H. Atl., pl. 4, f. 25, 26*; Type No. 50), **plate 2, fig. 63.**

Valves lanceolate, sometimes slightly produced, sub rostrate; loculi very few (often only 3), with rounded outline; striæ slightly radiate, 20 in 1 c.d.m. Length, 2·5 to 3·5 c.d.m.

Brackish water.—Rare? Blankenberghe, Antwerp (Scheldt, dry dock), H.V.H. England (H.V.H., Type 50).

M. Closeii O'Meara. (Irish Diat., p. 326, pl. 29, f. 10*) **plate 25, fig. 701.**

Valve elliptical, sub-rhomboid, with apices slightly acute; raphe straight, with very narrow hyaline area. Loculi, 5; the three central ones rounded, large; the two terminal elongated, abruptly attenuate. Striæ rather fine, very radiate, convergent, reaching the raphe. Length of valve, 4·5 c.d.m.; breadth, 2 c.d.m.

Marine and brackish water.—Ireland (O'Meara).

2. Valve linear-elliptic, with loculi arranged in a straight row.

M. Dansei Thwaites.! (W. Sm., S.B.D. i., pl. 62, f. 388; H.V.H. Atl., pl. 4, f. 18*; in Types Nos. 46 and 47—*Var. elliptica* in Types No. 103 and 106), **plate 2, fig. 64.**

Valve linear, elliptical, with apices slightly produced, broadly rounded; loculi 8 to 20, in a straight line; central nodule surrounded by a considerable hyaline area; striæ bent, radiate, finely punctate, 15 in 1 c.d.m.; the central ones rather more distant. Length, 3 to 5 c.d.m.

Fresh and brackish water—Blankenberghe (H.V.H.), Heyst (Deby), Bergh (Del.), Ard. Liege. (De Wild.), England (Kitton), Ireland.

Var. elliptica. (*M.* [*Frustulia*] *elliptica*, C. Ag.), differs from the type form by the inflated elliptical form of the valve.

M. Grevillei W. Sm. (W. Sm., S.B.D. i., p. 65, pl. 62, f. 389, H.V.H. Atl., pl. 4, f. 20*, Type No. 48), **plate 2, fig. 65.**

Valve linear with apices cuneate, obtuse; loculi 15 to 20; central nodule surrounded by a hyaline area; striæ about 10 in 1 c.d.m. radiate, robust and with strong puncta, the central more distant. Length 3·5 to 5 c.d.m.

Fresh water.—Ard. Liege. (De Wild). England (W. Sm. !), Ireland, Denmark, Sweden, &c.

B.—Valve having hyaline spaces (sulci) together making the figure of a lyre.

M. Braunii Grun. ! (Verh. Wien. 1863, pl. 13, f. 2 ; H.V.H. Atl., pl. 4, f. 21, 22*, Type No. 49), **plate 2, fig. 66.**

Valves lanceolate, with apices obtuse, slightly produced; loculi numerous, those in the centre considerably larger than the others; central nodule prolonged laterally; striæ about 18 in 1 c.d.m., finely punctate, interrupted on each side of the raphe by a long hyaline line united to the central nodule. Length, 5 c.d.m.

Brackish water.—Heyst (Deby),—England (Kitton),—North Sea.

> **Var. pumila Grun. !** (H.V.H. Atl., pl. 4, f. 23). Small, slender, with hyaline spaces in a double curve; striæ 23 to 24 in 1 c.d.m. Length, about 3 c.d.m.
>
> Not yet found in Belgium.

Some authors include the *Orthoneis* in the genus *Mastogloia* in consequence of their marginal loculi; we have preferred to retain them in the Cocconeideæ, to which they appear to have greater affinity, on account of their structure as a whole.

GENUS 4*a*.—STIGMOPHORA WALLICH, 1860.

The genus *Stigmophora* was created by Wallich for two species of *Mastogloia* from Bengal. These two species differ from *Mastogloia* in the first place in the number of the loculi which are only two, and next in each of the loculi, according to Wallich, having a central dot, but this we have been unable to discover in the example of *St. rostrata* in our possession.

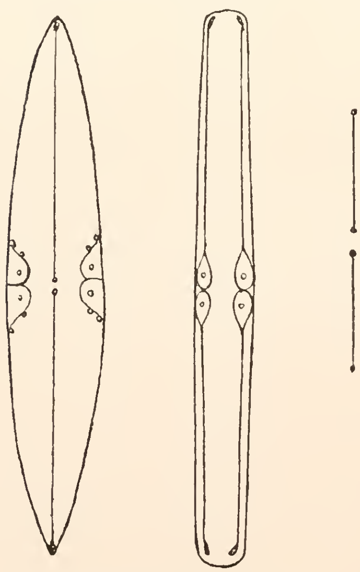


Fig. 28.[a]—*Stigmophora lanceolata*, after Wallich.

The two species of stigmophora are *St. lanceolata Wall.* (represented in the text) and *St. rostrata Wall.* which is distinguished by its apices being extremely rostrate, produced, and bearing 7 to 8 coarse dots on the raphe.

The genus *Stigmophora* should

be re-united with *Mastogloia* or made a special section of it, which would have for its characteristic the binary number of the loculi and their isolation at the median part of the valve where they are found. In true *Mastogloia* the loculi always form a long marginal line, either straight or curved.

GENUS 5.—DICTYONEIS CLEVE, 1890.

Valve elongated, of variable form, contracted or not at the median part. Raphe straight, surrounded by a very narrow hyaline zone, with apices generally in opposite directions. Valve with two layers superposed ; the external with fine puncta arranged in quinqunx, the interior with cells broader, vesiculate, giving a reticulate appearance to the stratum. Marginal cells often much broader than the others and simulating loculi.

Fig. 29.
Dictyoneis marginata Cl.

The genus *Dictyoneis* includes eight species which had been ranked by others in the genera *Navicula*, *Pseudo-diploneis* and *Mastogloia.*

None of these species belong to the North Sea.

The form represented opposite belongs to *D. marginata Cl.*

The forms united under the genus *Dictyoneis* have a different structure to all other raphidieæ ; this structure being in reality similar to that observed in many *Coscinodiscus* and *Triceratium.*

"The large marginal cells have the appearance of the loculi of the genus *Mastogloia* which have caused many of the species to be placed in the latter genus. However I find that these cells or loculi belong to the valve itself and not to a separate stratum as in the *Mastogloia*" (Cleve).

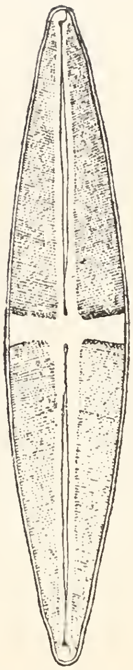


Fig. 30.—*Stauroneis Phœnicenteron Ehr.*

GENUS 6.—STAURONEIS EHR., 1843.

Frustules free or united in a small number, differing from *Navicula* by the central nodule being transversely dilated into a stauros. Endochrome similar to that of the *Navicula.*

We include in the genus Stauroneis the following groups which have been raised to genus rank by various authors :

Frustules not contained in mucous tubes	Frustules solitary.	Valves with decussating striæ.	**Staurogramma Rab. 1853.**
		Valves with sigmoid raphe	**Staurosigma Grun. 1860.**
	Valves cohering in filaments.		**Pleurostauron Rab. 1859.**
Frustules contained in mucous tubes (Schizonema W. Sm.)			**Endostauron Grun. 1868.**

ANALYSIS OF SPECIES.

Raphe straight.	Valves with margins not undulate.	Valves not perceptibly attenuate rostrate.	Stauros very broad.	Valve not terminated by a lumen : raphe bifurcate	Valve broad and large	**S. Phœnicenteron.**
					Valve small and narrow	**S. gracilis.**
				Valve terminated by a lumen.	Lumen very large, raphe bifurcate. Frustules united together many at a time	**S. acuta**
					Lumen small, raphe simple. Frustules isolated	**S. Gregorii.**
			Stauros narrow.	Valve very long, very narrowly lanceolate		**S. spicula.**
				Valve short, broadly lanceolate		**S. salina.**
		Valves with apices attenuate-rostrate				**S. anceps.**
	Valves with margins triundulate.	Valves short and broad ; terminal lumen very large				**S. Smithii.**
		Valves long and narrow ; terminal lumen very small				**S. Legumen.**
Raphe oblique, sub-sigmoid						**S. obliqua.**

I. Raphe straight.

A.—Valves with margins not undulate.

a.—VALVES WITH APICES NOT PERCEPTIBLY ATTENUATE ROSTRATE.

* *Stauros very broad, raphe bifurcated.*

S. Phœnicenteron Ehr. (Verb, 1843, pl. II. 5, f. 1., H.V.H. Atl., pl. 4, f. 2*, Type No. 40); **plate 1, fig. 50.**

Valve lanceolate infinitesimally attenuate up to the apices, which are obtuse, rounded, often slightly constricted; raphe formed of a double line on the greater part of its length, and surrounded by a broad hyaline zone; stauros, reaching the margins of the valve, very broad, generally a little dilated near its extremities; striæ radiant, about 14 in 1 c.d.m., finer but distinctly moniliform. Length, 10 to 17 c.d.m.

Fresh water.—Rather common everywhere.

According to Prof. H. L. Smith *S. Phœnicenteron* is simply a sporangial form of *S. gracilis*.

S. gracilis Ehr. (Amer., pl. 1, 2, f. 14, W. Sm.! S.B.D. i., p. 59, pl. 19, f. 186*; Type No. 41), **plate 25, fig. 702.**

Distinguished from the preceding species by its small, narrow valve, its fine striæ, 18—20 in 1 c d.m. Length 5.5 to 8.5 c.d.m.

Fresh water.—Belgium, England.

Observ.—Most authors distinguish *S. gracilis Ehr.* from *S. gracilis W. Sm.* the latter being characterised by a stauros which does not reach the margins of the valve. But this character is illusory—appearing so in frustules set dry or imperfectly, but in good preparations which we have made with various material from the herbarium of W. Smith, as well as in preparations made by Prof. Smith himself, this character no longer exists. We have, therefore, referred the form of W. Smith to *S. gracilis Ehr.*, as W. Smith did himself in his Syn. Br. Diat., vol. I., p. 59, and as does also Ralfs in Pritchard, p. 913.

S. acuta W. Sm. (S.B.D. i., p. 59, pl. 19, f. 187; H.V.H. Atl., pl. 4, f. 3*; Type No. 42), **plate 1, fig. 51.**

Valves lanceolate, with margins forming a slight cavity from the median portion up to the apices, which are obtuse, and show a very distinct lumen (formed by a thickening of the internal terminal margin); raphe formed by a double line throughout the greater portion of its length, surrounded by a very broad hyaline zone; stauros very broad, dilated near the margins of the valve; striæ slightly radiant, about 12 in 1 c.d.m., formed of rather distant puncta. Frustules united in bands of 3 to 6 individuals with girdle view tabular, showing the thickening of the internal apices of the valves and the connecting zone plicate-punctuate. Length, 8 to 15 c.d.m.

Fresh water.—Everywhere, but not so frequent as St. Phœnicenteron.

S. Gregorii Ralfs. (in Pritch., p. 913. *S. amphioxys Greg*, T.M.S., 1856, p. 48, pl. 5, f. 23; H.V.H. Atl., Suppl. f. 4*; in Types No. 74 and 389); **plate 1, fig. 52.**

Valve lanceolate, with apices subrostrate; more or less obtuse and showing a rather small lumen; raphe simple; stauros very broad; striæ finely granular, slightly radiant, delicate, about 18 to 20 in 1 c.d.m. Length, about 8 c.d.m.

Brackish water—Blankenberghe (rare?). England (Kitton). Scotland (Greg.).

*** Stauros very narrow, raphe simple.*

S. Spicula W. J. Hickie. (Monthly Micro. Journ., 1874, xii., p. 290; H.V.H. Atl. pl. 4, f. 9*; in Type No. 9), **plate 1, fig. 53.**

Valve very narrowly lanceolate, infinitesimally attenuate as far as the subacute apices; stauros very narrow, not dilated at the extremities; raphe simple, surrounded by a narrow hyaline zone; striæ delicate, scarcely radiant, 28 in 1 c.d.m. Length, 5 to 8 c.d.m..

Brackish water.—Very rare? Antwerp, Blankenberghe. England, Swansea Dock (Okeden in H.V H., Type No. 9), Norfolk (Kitton).

S. salina W. Sm. (S.B.D. i., p. 60, pl. 19, f. 188; H.V.H. Atl., pl. 10, f. 16*; Type No. 44), **plate 1, fig. 54.**

Valve rather broadly lanceolate, with apices sometimes slightly produced-rostrate; stauros narrow, only slightly or not enlarged at extremities; striæ delicate, finely punctate, scarcely radiant, about 18 in 1 c.d.m. Length, about 5 to 6 c.d.m.; breadth, 0.5 c.d.m.

Marine.—Blankenberghe, Antwerp, England, Ireland, Denmark.

b. VALVES WITH APICES ROSTRATE OR ROSTRATE-CAPITATE.

S. anceps Ehr. (Verb., p. 134, pl. ii., 1, 18; H.V.H., Atl. pl. 4, f. 4, 5*; Type No. 43), **plate 1, fig. 55.**

Valve elliptical or elliptical-lanceolate, with apices rostrate-capitate; stauros broad, dilated near its extremities; raphe simple, surrounded by a broad hyaline zone; striæ delicate, strongly radiant, about 20 in 1 c.d.m.; length, 3.5 to 5 c.d.m.

Fresh water.—Everywhere (but not very abundant?).

Var. linearis. (*S. linearis Kütz.* H.V.H. Atl., pl. 14, f. 8*); **plate 1, fig. 56.**

Valve with parallel margins; apices abruptly attenuate-rostrate.

Var amphicephala (*S. amphicephala Kutz.*; H.V.H. Atl. pl. 4., fig. 6 and 7*; in Type 67); **plate 1, fig. 57**

Valve with parallel margins, apices abruptly attenuate-rostrate-capitate. These two varieties are found mixed with the type form, from which it changes completely.

B.—Valves with tri-undulate margins.

S. Smithii Grun. (Ueber neue etc., 1860, p. 564; *S. linearis, W. Sm.*, S.B.D. i., p. 60, pl. 19, f. 193; H.V.H. Atl., pl. 4, f. 10*; Type No. 45); **plate 1, fig. 58.**

Valve oblong lanceolate-triundulate, with apices apiculate, sub-acute, showing a lumen; stauros rather narrow, slightly dilated at its extremities; raphe surrounded by a narrow hyaline zone; striæ delicate, about 30 in 1 c.d.m.; frustules united in bands by several individuals together. Length, 2 to 3 c.d.m.

Fresh water—Here and there, always in small quantities. Belgium, England, Scotland, France.

S. Legumen Ehr. (Mikr., pl. xxxix., 3, f. 104; H.V.H. Atl., pl. 4, f. 11*), **plate 1, fig. 59.**

Valve linear with three equal undulations, apices rostrate, a little capitate, showing a lumen; stauros rather broad, not dilated at the extremities; raphe surrounded by a narrow hyaline zone; striæ very delicate, about 28 in 1 c.d.m. Frustules in bands of several individuals together. Length about 3 c.d.m.

Fresh water—Antwerp (rare). England (Kitton), Scotland (Greg.).

This is probably only a narrow elongated form of the preceding.

II.—Raphe oblique, sub-sigmoid.

S. obliqua Greg.! (Q.J.M.S., 1866, p. 10, pl. 1, f. 35*), **plate 25, fig. 703.**

Valves sub-rhomboid oblong or rhomboidal lanceolate, with apices sub-acute or sub-obtuse; raphe oblique, sub-sigmoid; stauros enlarged infinitesimally up to the margins of the valve; striæ transverse, 20 to 22 in 1 c.d.m., rather strongly punctate, forming longitudinal undulate lines. Length of valve about 4 c.d.m. Breadth, 1·5 c.d.m.

Marine.—Scotland, Ireland (Gregory!)

Several species of *Stauroneis* of English authors do not belong to this genus, such as *St. dubia Greg.!* which is *Achnanthes Hungarica Grun.!*; *St. ovalis Greg.!* which is *Achnanthes ovalis* (*Greg.*) *H.V.H.*; *St. dilatata W. Sm.* which is *Navicula crucicula W.Sm.*; *St. punctata W.Sm.* which is *Navicula punctata W. Sm.*

GENUS 7.—NAVICULA BORY, 1822.

Frustules free or enclosed in tubes, rarely united in a chain. Valve with three nodules in a straight line ; raphe straight.

Endochrome divided into two layers, resting on each of the sides of the zone, with two lines of separation on the valves.

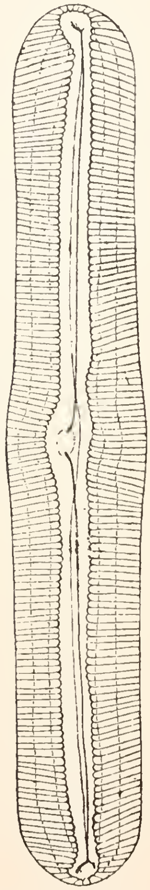


Fig. 31.—*Navicula nobilis Ehr.*

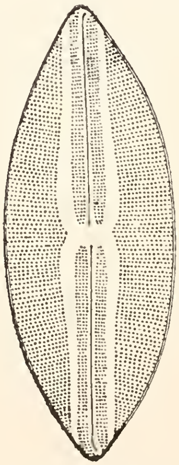


Fig. 32.—*Navicula Lyra Ehr*

The figures here given are two type forms of Navicula : the *N. nobilis* and the *N. lyra.* In the Monograph, in course of publication by Prof. Cleve, descriptions of all known forms of this immense genus will be found. Mr. Cleve has subdivided it into various sub-genera. As the groups which we proposed in our Synopsis are very convenient for determination, and have also been adopted in some important works, including the Sylloge of Prof. De Toni, we prefer to retain them here.

A.—True Naviculæ. Frustules free, not enclosed in gelatino-mucous fronds.

Sub-genus I.—Navicula.

Analysis of Groups.

I.—Valves without distinct puncta, furnished with costæ (canaliculi) or robust striæ, having the appearance of costæ; never didymous in form.

- True costæ, not resolvable into beads . . . 1. **Pinnulariæ.**
- Striæ robust, having the appearance of costæ but resolvable into beads; striæ radiate, almost or quite reaching to the raphe . . . 2. **Radiosæ.**

II.—Valves with very distinct puncta or fine striæ having no semblance to costæ or with costæ; or again with costæ alternating with rows of beads.

a. Valves with striæ interrupted by two sulci near the raphe.

- Sulci straight.
  - Sulci not lyre-shaped.
    - Valves more or less constricted in the median portion . . . 3. **Didymæ.**
    - Valves without constriction in the median portion . . . 4. **Ellipticæ.**
  - Sulci lyre-shaped . . . 5. **Lyratæ.**
- Sulci very broad and occupying the greater portion of the valve . . . 6. **Hennedyeæ.**

b. Valves more or less lanceolate, or elliptic or linear lanceolate, without any sulcus.

- Striation conspicuous.
  - Valves having the appearance of a stauros, either by the absence of striæ or by the space between them . . .
    - Valves having the appearance of a grater, with very large, elongated beads . . . 7. **Asperæ.**
    - Valves with fine striæ . . . 8. **Stauroneideæ.**
  - Valves without any appearance of stauros.
    - Valves with puncta not forming longitudinal lines in zig-zag.
      - Striæ with beads not forming longitudinal lines.
        - Striæ leaving a considerable hyaline space round the raphe and central nodule.
          - Hyaline space very elongate and infinitesimally diminuate . . . 9. **Palpebrales.**
          - Hyaline space rounded and abruptly diminuate . . . 10. **Abbreviatæ.**
        - Beads extending over the whole valve . . . 11. **Perstriatæ.**
      - Striæ with beads forming longitudinal and transverse lines.
        - Valve very elongate, almost linear . . . 12. **Johnsonieæ.**
        - Valve lanceolate . . . 13. **Crassinerves.**
    - Valves with puncta forming longitudinal lines in zig-zag.
      - Zig-zags interrupted by pale places where the valve is depressed . . . 14. **Sculpteæ.**
      - Lines in zig-zag, regular, not interrupted . 15. **Serianteæ.**
- Striation almost invisible with the best objectives, valve linear lanceolate, simulating an Amphipleura . . . 13*bis*. **Fusiformes.**

c. Valves having one or more narrow marginal or sub-marginal sulci.

- Valves not linear.
  - Valves lanceolate, large; striæ radiate, fine, leaving a large blank space round the centre nodule . . . . 16. **Formosæ.**
  - Valves elongate, generally more or less tri-undulate; sulcus marginal often inconspicuous; raphe surrounded by a hyaline space lanceolate, narrow; striæ radiate . . 17. **Limosæ.**
  - Striæ sub-parallel, often slightly oblique in reference to the longitudinal axis of the valve; sulcus broad, very conspicuous . . . . 18. **Affines.**
- Valves linear; striæ fine, sub-parallel; sulcus very conspicuous; terminal nodules elongate, distorted . . . . 19. **Lineares.**

d. Valves more or less linear, without any sulcus.

Striæ radiate, occupying only the margin of the valves . . . 20. **Americanæ.**

Striæ generally bent, reaching the raphe; valves with smooth, thickened apices . . . . 21. **Bacilleæ.**

e. Very small naviculæ with hardly visible structure. . . 22. **Minutissimæ.**

I. Pinnulariæ.

a. Striation not interrupted by a marginal sulcus.

* **Majores.**—Valves regularly elliptic-linear, often slightly inflated at the median portion and at the apices. Size usually large; costæ usually broad and robust.

ANALYSIS OF SPECIES.

- Not constricted in girdle view; fresh water species.
  - Valve not showing a hyaline band, forming a false stauros.
    - Costæ very distant from raphe; size very considerable . . . . . . **N. nobilis.**
    - Costæ rather approximate to raphe; size medium.
      - Valve inflated at the median portion . **N. major.**
      - Valve not inflated at the median portion . . . . **N. viridis.**
  - Valve showing a hyaline band in the form of a false stauros . **N. cardinalis.**
- Strongly constricted in girdle view; marine species.
  - Valve without false stauros.
    - Raphe bent like a brace, showing in girdle view longitudinal hyaline spaces . . . **N. Trevelyana.**
    - Raphe straight in the middle of the valve; girdle face without hyaline spaces . . . **N. rectangulata.**
  - Valve showing a false stauros.
    - Striæ very oblique, reaching the raphe everywhere . . . **N. cruciformis.**
    - Striæ parallel, perpendicular to the raphe . . . . **N. quadratarea.**

N. nobilis Ehr. (Abh. 1840, p. 20, H.V.H Atl., pl. 5, f. 2*; Type No. 52), **plate 2, fig. 67.**

Valve linear-elliptic, inflated in the median portion and at the apices with coarse costæ, considerably distant from the raphe. Girdle face linear with rounded angles. Costæ radiate, very robust, 5 or 6 in 1 c.d.m. Length, 20 to 40 c.d.m.

Fresh water.—Antwerp; probably not very rare. England, etc.

Var. Dactylus. (*N. Dactylus Ehr.*, H.V.H. Atl., pl. 5, f. 1*; Type No. 51), **plate 2, fig. 68.**

More robust than the preceding, with inflations absent or only slightly marked; costæ generally not so long and more robust, about 4·5 to 1 c.d.m.

Fresh water.—Heyst (J. Deby).

Var. gentilis (*N. gentilis Donk.*, in H.V.H.'s Typ. Syn., Nos. 53 and 481).

Absolutely similar to N. nobilis, but much smaller in all parts; it may be considered as a dwarf form of N. nobilis. Length, 14 to 20 c.d.m.; costæ about 7 in 1 c.d.m.

Fresh water and fossil deposits.—England, Scotland, Lough Mourne (Ireland), etc.

N. major Kutz. (Bac., pl. 4, f. 19; H.V.H. Atl., pl. 5, f. 3-4*; Type No. 54), **plate 2, fig. 69.**

Valve linear-elliptic, more or less inflated in the median portion, apices not inflated, somewhat conical. Costæ robust, 5 to 7 in 1 c.d.m., feebly radiate, rather approximate to raphe, and leaving an oblong hyaline space round the central nodule. Length, 18 to 30 c.d.m.

Fresh water.—Everywhere.

The *Navicula major* passes imperceptibly into the following:

N. viridis Kütz. (Bac., pl. 4, f. 18; H.V.H. Atl., pl. 5, f. 5*; Type No. 56), **plate 2, fig. 70.**

Valve linear-elliptic, without inflations, apices rounded. Costæ about 7 in 1 c.d.m., rather approximate to the raphe, and leaving scarcely any marked space round the central nodule; radiate at the middle of the valve, convergent towards the apices. Length, very variable, from 5 to 20 c.d.m.

Fresh water.—Everywhere.

Var. commutata Grun. (*Nav. hemiptera auct. nec Kütz.*—H.V.H. Atl., pl. 5, f. 6*; Type No. 57), **plate 2, fig. 71.**

Valve elliptic-linear, considerably attenuated at the apices; costæ slender, attenuated round the central nodule, about 11 in 1 c.d.m.

The two valves are dissimilar: one has striæ covering the whole valve; in the other the striæ are interrupted (see the figure) unilaterally, near the central nodule. Length, about 4 to 6 c.d.m.

Fresh water.—Manage (P. Gautier).

N. cardinalis Ehr. (Americ. I., 1,(1), 11(1), 21, H.V.H. Atl. Supp., f. 5*; Type No. 60), **plate 2, fig. 72.**

Valve linear-elliptic, sometimes feebly inflated at the median portion, apices broadly rounded, sometimes somewhat inflated. Raphe surrounded by a broad hyaline zone, dilated round the central nodule ; costæ robust, absent in the centre of the valve, where their absence forms a broad false stauros, gently radiate near the central nodule, convergent at the apices of the valve, about 5 in 1 c.d.m. Length, 15 to 20 c.d.m.

Fresh water.—Botanical Gardens at Brussels (Delogne). England, Ireland, France, Holland, Germany, Norway, Sweden, etc.

N. Trevelyana Donk. (Q.J.M.S. 1861, n.s. 1, p. 8, pl. 1, f. 2 ; H.V.H. Atl. Supp., f. 5 and 6* ; Type No. 72), **plate 2, fig. 73.**

Valve linear, gently inflated at the median portion and at the apices all are broadly rounded. Raphe curved with a brace, surrounded by a narrow hyaline zone, broadly dilated round the central nodule ; costæ well marked, 11 in 1 c.d.m., very radiate at the central portion, very convergent at the apex of the valve. Girdle face broad, very constricted at the median portion, with truncate apices. Striæ interrupted between the nodule and the apex of the valve by a smooth space, parallel to the connecting membrane ; smooth spaces very conspicuous in girdle view, slightly visible at the edges of the valve in valve view. Length, 10 to 13 c.d.m.

Marine.—Blankenberghe : washing of sand from shore. England, France, Denmark, Norway, etc.

N. rectangulata Greg. (D. of Clyde, p. 7, pl. 1, f. 7 ; H.V.H. Atl. Supp , f. 7* ; Type No. 74) ; **plate 2, fig. 74.**

Valve linear, with apices broadly rounded, inflated at the median portion and at the apices. Raphe bordered by a narrow hyaline zone, somewhat dilated round the central nodule. Striæ distant, 8 or 9 in 1 c.d.m., very radiate at the median portion, very convergent towards the apex of the valve. Girdle face oblong, constricted at the median portion, with truncate apices. Length, about 6 to 7 c.d.m.

Marine—Blankenberghe, in the sand of the shore. England, Scotland, France, Denmark.

Var. Stauntonei Grun. (*Alloioneis Stauntonei Grun.*, in Cl. and Möll. Diat. No. 304).

Marine.—England (Firth of Tay, Rattray).

N. cruciformis Donk. (Q.J.M.S. 1861, n. s. 1, p. 10, pl. 1, f. 7 ; H.V.H. Atl. Supp., f. 8* ; in Type No. 74) **plate 2, fig. 75.**

Valve linear, with apices rounded, not inflated, median portion sometimes very slightly inflated. Raphe not bordered by a hyaline zone, central nodule surrounded by a broad, cuneate pseudo-stauros; striæ flexuous 12 to 13 in 1 c.d.m., very radiate near the central nodule; very convergent at the apex of the valve. Girdle view constricted at the median portion, with truncate apices. Length 5 to 12 c.d.m.

Marine.—Blankenberghe, in the sand of the shore. England, Norway.

N. quadratarea Ad. Schm. (Nordsee, p. 90, pl. 2, f. 26*; *N. pinnularia Cl.*, Sv. o. Norsk. Diat., p. 224, pl. 1, f. 1-2), **plate 25, fig. 704.**

Valve linear-oblong, with rounded apices; striæ parallel, 9 or 10 in 1 c.d.m., reaching to the raphe, and leaving round the central nodule a broad quadrangular stauroform hyaline space. Length, about 9 c.d.m.; breadth, 1·25 c.d.m.

Marine.—North Sea (coasts of Ireland and Scandinavia).

**Minores.—Frustules of medium or small size, with valves of variable form, rarely regularly linear, often inflated at the median portion and diminuate at the apices ; costæ medium or narrow.

I.—Terminal nodules not laterally dilated like a hook.

a.—Valves neither undulate nor constricted in the middle.

ANALYSIS OF SPECIES.

- Costæ very robust and very distant.
  - Without any false stauros.
    - Costæ distant from the raphe.
      - Valve sublinear, abruptly inflated in the middle . . . . . . **N. lata.**
      - Valve broadly lanceolate . . . **N. alpina.**
    - Costæ reaching nearly to the raphe, valve sublinear . **N. borealis.**
  - With a false stauros.
    - Valve very large, with obtuse apices, costæ not resolvable . . . . . . **N. divergens.**
    - Valve very small, apices acute, costæ resolvable with difficulty . . . . **N. costulata.***
- Costæ approximate.
  - Costæ approximate to raphe not perceptibly shortened towards the central nodule.
    - Valve without a stauroneiform blank space.
      - Valve slightly inflated at the median portion ; costæ very fine ; fresh water species . . . . . **N. sublinearis.**
      - Valve linear, not inflated, costæ rather robust ; marine species . . . **N. retusa.**
    - Valve with stauronciform blank space, apices rostrate-capitate . . . . . **N. Hilseana.**
  - Costæ often approximate to the raphe, and imperceptibly shortened towards the central nodule.
    - Valves inflated at the median portion only slightly or not at all.
      - Apices not rostrate capitate.
        - Apices somewhat diminuate . **N. Brebissonii.**
        - Apices inflated.
          - Valves scarcely inflated in the middle **N. stauroptera.**
          - Valves considerably inflated at the median portion.
            - Median inflation abruptly diminuate **N. Tabelleria.**
            - Median inflation diminishing imperceptibly up to the apices . **N. gibba.**
      - Apices more or less rostrate-capitate.
        - Valve exactly linear ; apices strongly rostrate-capitate ; no pseudo stauros . . **N. bicapitata.**
        - Valve somewhat inflated with subcapitate apices ; costæ rather distant ; a false stauros **N. subcapitata.**
        - Valve somewhat inflated, apices subcapitate ; costæ approximate ; a false stauros. . **N. appendiculata.**
    - Valves considerably inflated at the median portion.
      - Valve linear-oblong, with apices broadly rostrate-capitate . . . . **N. globiceps.**
      - Valve linear-lanceolate, with apices to an average extent rostrate-capitate. . **N. Braunii.**

b. Valves undulate or constricted.

Valve rather broad, with median inflation not much larger than the terminal.	Apices strongly rostrate-capitate	. **N. mesolepta.**
	Apices scarcely diminuate-rostrate	. **N. Legumen.**
Median inflation much larger than the terminal inflations; valve very narrow		**N. polyonca.**
Median inflation much smaller than the terminal inflations . .		. **N. claviculus.**

II.—Terminal nodules dilated laterally like a hook.

Valve very inflated at the median portion, apices subcapitate costæ very robust. . . . . **N. humilis.***

b'. Striation interrupted by a marginal sulcus.

Striæ not reaching to the raphe and leaving a large hyaline space round the central nodule . . . . **N. blanda.**

Striæ reaching everywhere to the raphe and central nodule . . . **N. sejuncta.**

* For facility in determination we have left, in the Table of the Pinnularieæ, the *N. costulata* and *N. humilis*, which belong to the Radioseæ, but are very difficult to resolve into beads. See these species among the Radioseæ.

1. *Valves neither undulate nor constricted in the middle.*

A.—Costæ very distant and very robust.

* WITHOUT A FALSE STAUROS.

N. lata Breb. ! (W. Sm., S.B.D. 55, sub. Pinnularia, pl. 18, f. 167; H.V.H. Atl., pl. 6, f. 1, 2*: Type No. 61), **plate 2, fig. 76.**

Valve linear, with median portion slightly inflated, apices obtuse, broadly rounded. Costæ very robust, distant, 4 to 5 in 1 c.d.m., not reaching to the raphe, and leaving a dilated hyaline space round the central nodule; costæ feebly radiate at the middle of the valve, and changing direction imperceptibly towards the apices. Length, about 6 to 11 c.d.m.

Fresh water in mountainous regions.—Not yet found in Belgium. England, France.

N. alpina Ralfs. (in Pritch. Inf., p. 906; W. Sm. S.B.D. i., p. 55, pl. 18, f. 168*; H.V.H. Type de Syn. No. 51), **plate 25, fig. 705.**

Valve broadly lanceolate-elliptic, with apices obtuse. Costæ very robust, distant, radiate, 2·5 to 3 in 1 c.d.m., resting very distant from the raphe, and not symmetrically on each side of the valve. Raphe and nodules very robust. Girdle face quadrangular, elongate, showing on the connecting membrane two distant lines of fine elongate puncta. Length of valve, 10 to 20 c.d.m.

Fresh water of subalpine regions.—Scotland, France.

N. borealis Ehr. (Verb. pl. I., II., f. 6 ; H.V.H. Atl., p. 6, f. 3* ; Type No. 62), **plate 2, fig 77.**

Valves linear-elliptic, sometimes feebly attenuated at the apices which are rounded or subtruncate. Costæ rather robust, distant, about 5 or 6 in 1 c.d.m., and reaching almost to the raphe, except those in the middle, which are shorter ; costæ radiate at the median portion of the valve, becoming imperceptibly convergent towards the apices. Length, 3 to 6 c.d.m.

Fresh water.—Antwerp ; Frahan (Del.) ; probably not rare. Often found in mosses growing on rocks and humid walls. Found throughout Europe.

This type form is connected with *N. lata* by various intermediate forms, such as *N. lata var. minor Greg.* ; *N. Rabenhorstii Grun., etc.* These forms will be found in H.V.H.'s Types of Syn. No. 63, collected by Mr. Delogne at Frahan.

** WITH A FALSE STAUROS.

N. divergens W. Sm. ! (S.B.D. i., p. 57, pl. 18, f. 177* in H.V.H.'s Types of Syn. Nos. 51 and 484), **plate 25, fig. 706.**

Valve narrowly lanceolate, with apices somewhat attenuated. Costæ robust, about 5 in 1 c.d.m., not reaching to the raphe, radiate at median portion, convergent towards the apices, leaving near the central nodule a broad stauroform blank space. Length of valve, 7 to 16 c.d.m. Breadth 1.5 to 2.5 c.d.m.

Fresh water.—Ard. Liége (De Wild.), England, Scotland, France, Gottland, etc.

B.—Costæ approximate.

a. COSTÆ REACHING THE RAPHE THROUGHOUT AND SLIGHTLY SHORTENED NEAR THE CENTRAL NODULE.

N. sublinearis Grun. (H.V.H. Atl., pl. 6, f. 25 and 26*) **plate 2, fig. 78.**

Valve narrow, linear, sometimes somewhat inflated at the median portion, with rounded apices. Costæ reaching to the raphe, those round the central nodule slightly shortened; costæ fine, radiate in the middle of the valve, becoming convergent by imperceptible degrees towards the apices, 21 to 24 in 1 c.d.m. Length, 2 to 3 c.d.m.

Fresh water.—Not yet found in Belgium.

N. retusa Breb. (Diat. Cherb. pl. 16, f. 6.—H.V.H. Atl. Supp., f. 9*, in Type No. 168) **plate 2, fig. 79.**

Valve linear-oblong with rounded apices. Raphe bordered by a narrow hyaline zone, slightly dilated round the central nodule. Costæ robust, distant, with apices somewhat capitate, feebly radiate, 8 in 1 c.d.m. Girdle face contracted, apices truncate. Length, about 7 c.d.m.

Marin.e—Not yet found in Belgium, England, Ireland and France.

Var. subretusa. (*N. subretusa Grun!* in Type No. 74. H.V.H. Atl. Supp., f. 10*, in Type No. 74) **plate 2, fig. 80.**

Valves narrow; 6 striæ in 1 c.d.m., with non-capitate apices. Length, about 7 c.d.m.

Marine.—Blankenberghe, in the sand of the shore.

N. Hilseana Janisch. (in Schmidt. Atl., pl. 45, f. 65, etc. H.V.H. Atl., Supp., f. 11,* in Types Nos. 39 and 347) **plate 2, fig. 81.**

Valve linear, with rostrate-capitate apices. Raphe without hyaline zone; Central nodule surrounded by a pseudo-stauros rather broad, sub-cuneate. Striæ rather feeble 10 in 1 c.d.m.; radiate in the centre, convergent at the apex of the valve. Length, about 4 c.d.m.

Fresh water.—Paliseul (Delogne).

aa. COSTÆ NOT REACHING THE RAPHE THROUGHOUT, THOSE IN THE MIDDLE OF THE VALVE CONSIDERABLY SHORTENED OR ABSENT.

b. Valves only slightly or not inflated at the median portion.

N. Brebissonii Kütz.! (Bac. p. 93, pl. 3, f. 49; H.V.H. Atl., pl. 5, f. 7*; Type No. 58) **plate 2, fig. 82.**

Valve linear-elliptic, with apices rounded, somewhat diminuate. Raphe surrounded by a hyaline zone, narrow towards the apices, infinitesimally dilated towards the median portion. Costæ well marked, shortened towards the median portion and absent in the middle of the valve, where their absence forms a false stauros; costæ rather strongly radiate up to nearly the extreme third of the valve where they suddenly become strongly convergent, 11 in 1 c.d.m. Length, 4 to 5 c.d.m.

Fresh water.—Common throughout Europe.

Var. subproducta. (H.V.H. Atl., pl. 5, f. 9*), **plate 2, fig. 83.**
Broader and shorter, with apices somewhat diminuate sub-rostrate.

Park, near Louvain.

Var. diminuta. (H.V.H., pl. 5, f. 8*), **plate 2, fig. 84.**
Slender, very small, apices infinitesimally diminuate.

Frahan (Delogne).

N. stauroptera Grun. (Über neue etc. fam. Navicula, p. 517. H.V.H. Atl., pl. 6, f. 7*) **plate 2, fig. 85.**

Valve linear-elongate, scarcely inflated at the median portion, with apices rounded, inflated. Costæ radiate at the median portion, strongly convergent at apices; robust, leaving throughout a considerable hyaline space round the raphe, diminishing in length on nearing the central nodule around which they are completely absent, thus producing a pseudo-stauros; about 10 to 12 in 1 c.d.m. Length of valve, about 10 c.d.m.

Fresh water.—Eegenhoven near Louvain (P. Gaut.), etc., France.

Var. parva. (*Stauroptera parva* Ehr. H.V.H. Atl. pl. 6, f. 6*) **plate 2, fig. 86.**

Distinguished from the preceding by its smaller size (about 6 to 7 c.d.m.) and its median portion being more inflated.

Ditches near Nieuport (Westendorp and Wallays according to Rabenhorst: Fl. Eur. Alg., p. 222).

N. Tabellaria Ehr. (Verb., p. 134, pl. II. i., f. 26; Kütz. Bac. p. 98, pl. 28, f. 79; H.V.H. Atl., pl. 6, f. 8*), **plate 2, fig. 87.**

Differs from the preceding by the terminal and median inflations being much more marked, by the costæ occupying all or nearly all the valve, but reduced almost to dots at the exact median portion, their number being more considerable, 12 to 15 in 1 c.d.m., and lastly by its more considerable size, which attains to 14 c.d.m.

The terminal costæ have been designated radiate in error,—they are convergent, as in the preceding species.

Fresh water.—Eegenhoven near Louvain (P. Gaut.). England, France. Mixed with the preceding and the following.

Var. stauroneiformis.—Median striæ entirely absent.

N. gibba Kütz. (Bac. pl. 28, f. 70; H.V.H. Atl. Supp., f. 12*, Type No. 64), **plate 2, fig. 88.**

Differs from the preceding by the median inflation, which is prolonged, while infinitesimally diminishing up to the terminal inflations. Costæ about 12 in 1 c.d.m., sometimes absent in the median portion. Length, 5 to 7 c.d.m.

Fresh water.—Eegenhoven near Louvain (P. Gaut.). Found throughout Europe.

Var. brevistriata. (H.V.H. Atl., pl. 6, f. 5*), **plate 2, fig. 89.**

Costæ very short, occupying only the margins of the valve.

Mixed with the type form.

N. bicapitata Lagerstedt. (D. from Spitsb., n. 6, p. 23; H.V.H. Atl., pl. 6, f. 14*), **plate 2, fig. 90.**

Valve narrow, linear, with apices attenuated, rostrate-capitate; costæ rather fine, 9 to 10 in 1 c.d.m., radiate in the middle of the valve, convergent at the apices, leaving round the raphe a narrow hyaline zone, which expands into a sub-quadrangular area round the central nodule. Length, about 6 c.d.m.

Fresh water.—Not yet found in Belgium. England, Ireland.

N. subcapitata Greg. (Q.J.M.S. 1856, p. 9, pl. 1, f. 30, H.V.H. Atl., pl. 6, f. 22*), **plate 2, fig. 91.**

Valve very narrow, linear, somewhat attenuated at the median portion, with apices rostrate, gently sub-capitate; costæ rather distant, about 11 to 12 in 1 c.d.m., not reaching to the raphe, and absent in the middle of the valve; terminal nodules rather large. Length about 2·5 to 3·5 c.d.m.

Fresh water.—Noire-fontaine (Delogne); Manage (P. Gaut.); England, Ireland.

Var. paucistriata. (H.V.H. Atl., pl. 6, f. 23*), **plate 2, fig. 92.** Striæ short, diminishing gradually in length, and absent on all the median portion of the valve.

N. appendiculata Kutz. (Bac., p. 93, pl. 3, f. 18; pl. 4, f. 1, 2; pl. 5, f. 5; H.V.H. Atl., pl. 6, f. 18 and 20*), **plate 2, fig. 93.**

Valve narrow, linear, very feebly attenuate at the median portion, with apices feebly rostrate-subcapitate; costæ delicate, 16 or 17 in 1 c.d.m., not reaching to the raphe, radiate at the median portion of the valve, where they are gradually shortened, so as to leave a large stauroneiform hyaline space, convergent at the apices. Length, 2·5 to 3·5 c.d.m.

Fresh water.—Brussels Botanical Gardens (Del.). Found throughout Europe.

bb. Valves considerably inflated at the median portion.

N. globiceps Greg.! (Q.J.M.S. 1856, iv., p. 10, pl. 1, f. 34; H.V.H. Atl. Supp., f. 13*, in Type No. 284), **plate 2, fig. 94.**

Small, linear-oblong, inflated at the median portion with apices broadly rostrate-capitate. Costæ not reaching to the raphe, leaving a large hyaline space round the central nodule, 16 to 18 in 1 c.d.m.; the median ones very radiate, the terminal convergent; central nodule large. Length, 3 to 4 c.d.m.

Fresh water.—Rare. Antwerp in the Schyn, etc. Canal d' Herenthals. Scotland (Greg!).

N. Braunii Grun.! H.V.H. Atl., pl. 6, f. 21*), **plate 2, fig. 95.**

Linear-lanceolate, with apices to an average degree rostrate-capitate. Costæ not reaching to the raphe, 10 or 11 in 1 c.d.m.; the median ones strongly radiate, the terminal convergent, gradually shortened up to nearly the middle of the valve, where they leave a broad stauroneiform hyaline space; central nodule narrow. Length, 4 c.d.m.

Fresh water.—Liresse (Delogne).

2. *Valves bi-undulate or tri-undulate, or conspicuously constricted in the median portion.*

N. mesolepta Ehr. (Am. iv., II. 4[1]; H.V.H. Atl., pl. 6, f. 10 and 11*; Type No. 68), **plate 2, fig. 96.**

Valve linear-oblong, tri-undulate, with apices rostrate-capitate; striæ gradually shortened towards the central nodule, the median ones very radiate, the terminal convergent, 10 to 14 in 1 c.d.m. Length, 3 to 6 c.d.m.

Fresh water.—Almost everywhere.

Var. Termes (*N. Termes, Ehr.*, H.V.H. Atl., pl. 6, f. 12, 13*), **plate 2, fig 97.**

Valve with median inflation replaced by a slight constriction; striæ absent in the middle of valve, thus forming a pseudo-stauros.

Fresh water.—Antwerp, Louvain, etc. (H.V.H.), Ard Liege (De. Wild).

N. Legumen Ehr. (Mikrog, various figures—H.V.H., pl. 6, f. 16*; Type No. 69), **plate 2, fig. 98.**

Valve linear, gently tri-undulate, with undulations sometimes scarcely noticeable; apices diminuate-rostrate, scarcely capitate; raphe surrounded by a broad hyaline area, considerably dilated round the central nodule; striæ about 11 in 1 c.d.m., very radiate at the median portion, very convergent towards the apices of the valve. Length, 8 to 10 c.d.m.

Fresh water.—Liresse (Delogne). Found throughout Europe.

N. polyonca Breb.! (in Kütz. Sp. Alg., p. 85; H.V.H. Atl. Supp., f. 14*), **plate 2, fig. 99.**

Valve linear-narrow, tri-undulate, with median inflation much stronger than the others; apices strongly inflated-capitate; raphe surrounded by a large hyaline zone, which widens into a false stauros at the median portion; striæ about 12 in 1 c.d.m., shortened at the median portion where they are radiate, becoming very convergent at the apices. Length, 6 to 8 c.d.m.

Fresh water.—Rare. Liresse (Delogne), Scotland, Ireland, France.

N. claviculus Greg. (Diat. of Clyde, p. 6, pl. 1, f. 5*), **plate 25, fig. 709.**

Valve sublinear-narrow, feebly inflated at the median portion, more strongly inflated from and after the median portion, and this up to the apices which are rounded obtuse. Striæ not reaching to the raphe; only slightly or not radiate, about 14 in 1 c.d.m; absent at the median inflation. Length of valve, 3·5 to 5 c.d.m. Breadth, about 1 c.d.m.

Marine.—Scotland, Ireland, Jutland, Bahusie.

B.—Striation interrupted by a marginal sulcus.

N. blanda Ad. Schm. (Nordsee, p. 90, pl. 2, f. 27*; *Pinnularia Ergadensis Greg.*, T.M.S., 1856, p. 48, p. 5, f. 22?) **plate 25, fig. 707.**

Valves linear, with parallel or subparallel costæ, apices rounded, leaving a considerable hyaline area round the central nodule and not reaching to the raphe, feebly radiant in the centre of the valve and somewhat convergent at the apices, 8 to 10 in 1 c.d.m., interrupted by a very conspicuous marginal sulcus. Length, 5 to 13 c.d.m. Breadth, 1 to 2 c.d.m.

Marine.—North Sea, Hvidingsoe (Ad. Schm.)

N. blanda which has been found in various regions of the globe appears to be very rare in the North Sea; it belongs to a small group of forms of which *N. Powellii* (not yet found on our shores) is the type form.

N. sejuncta Ad. Sch. (Nordsee, p. 87, pl. 1, f. 18*) **plate 25, fig. 708.**

This species, still imperfectly known, has also been found at Hvidingsoe but it is equally rare. This form is much smaller than the preceding and the striæ reach the raphe throughout.

II. Radiosæ.

A. Terminal nodules approximate to apices of valves.

I. Median striæ radiate, terminal striæ convergent.

a. STRIÆ APPROXIMATE.

- Terminal striæ in broken lines . . . . **N. oblonga**
- Striæ in continuous lines.
  - Median striæ alternately long and short.
    - Valve broadly lanceolate, not rostrate-capitate . . . **N. peregrina.**
    - Valve broadly lanceolate, rostrate-capitate . . . . **N. salinarum.**
    - Valve anceolate, very narrow . . . . **N. cincta.**
  - Median striæ not alternately long and short.
    - Median striæ equally shortened forming a pseudo-stauros; striæ near the central nodule almost straight . . . **N. gracilis.**
    - No false stauros
      - Apices not rostrate-capitate.
        - Nodule surrounded by a considerable hyaline area; valve broadly lanceolate.
          - Apices not conspicuously diminuate-rostrate . **N. vulpina.**
          - Apices conspicuously diminuate-rostrate . **N. viridula.**
        - Hyaline area very small; valve narrowly lanceolate; median striæ very radiate . . . . . **N. radiosa.**
      - Apices rostrate-capitate.
        - Striæ robust.
          - Hyaline area dilated transversely, apices very robust . . . **N. cryptocephala.**
          - Hyaline area rounded, apices sub-obtuse . . **N. rhynchocephala**
        - Striæ scarcely visible . . . **N. gregaria.**

b. STRIÆ VERY DISTANT AND VERY ROBUST; VERY SMALL FORMS WITH TERMINAL NODULES LIKE HOOKS.

- Valve rhomboidal with acute apices; median portion furnished with a broad pseudo-stauros . . . . **N. costulata.**
- Apices capitate; no pseudo-stauros . . . . . . **N. humilis.**
- Valve elliptic; with obtuse apices, median striæ simulating a schizo-stauros **N. nana.**

II. Median striæ radiate, terminal striæ perpendicular to the raphe (straight).

- Median striæ of quite the same length.
  - Valves narrowly linear or linear-lanceolate.
    - Apices short, acute . **N. cancellata.**
    - Apices rather long, inflected . **N. inflexa.**
  - Valves broadly lanceolate, robust forms . . . **N. fortis.**
- Median striæ alternately long and short.
  - Valve rather narrowly lanceolate, with sub-obtuse apices; hyaline area not stauroneiform; striæ with very delicate puncta . . . . **N. digito-radiata**
  - Valve broadly lanceolate or elliptic, with very obtuse apices; hyaline area stauroneiform; striæ with strong puncta . . . . . **N. Reinhardtii.**

III. All the striæ radiate.

- Valves lanceolate.
  - Without any appearance of a false stauros.
    - Striæ very robust.
      - Valve broadly lanceolate, striæ very distant . **N. distans.**
      - Valve very narrowly lanceolate, striæ approximate . **N. longa.**
    - Striæ fine approximate 10 to 12 in 1 c.d.m.
      - Valve with obtuse apices **N. solaris.**
      - Valve with acute apices . **N. lanceolata.**
  - Showing the semblance of a false stauros.
    - Valve with apices broadly rostrate, not capitate . . . . **N. Gastrum.**
    - Valve with apices capitate . . **N. Anglica.**
    - Valve with apices rostrate-acute . . **N. crucifera.**
- Valves oval-oblong.
  - Apices somewhat constricted . . . . **N. Semen.**
  - Apices diminuate, rostrate, not capitate . . . **N. capitata.**
  - Apices rostrate, sub capitate . . . . **N. dicephala.**
- Valves linear.
  - Valves with apices strongly rostrate, not capitate . . **N. apiculata.**
  - Valves neither rostrate nor capitate, but very gently inflated at the median portion, connecting zone very broad . **N. Kützingiana.**

IV. All the striæ perpendicular to the raphe.

- Valve very long, narrow, lanceolate, striæ very robust and very distant, girdle face narrow . . . . **N. directa.**
- Valve short, rather narrowly lanceolate, striæ fine, approximate, girdle face equal to 3-4 times the breadth of the valves . . . . **N. Northumbrica.**

B. Terminal nodules distant from the apices.

Valves with sides equal.	Valves with median longitudinal portion elevated and consequently appearing to be formed of two superposed valves	**N. superimposita.**
	Valves with only the apices elevated . . .	**N. compressicauda.**
	Valves flat	**N. opima.**
Valves with sides unequal.	Apices subacute	**N. Cesatii.**
	Apices rostrate-capitate	**N. inæquilatera.**

A. Terminal nodules approximate to apices of valves.

I. Median striæ radiate, terminal striæ convergent.

A. Striæ approximate.

a. TERMINAL STRIÆ IN BROKEN LINES.

N. oblonga Kütz. (Bac., p. 97, pl. 4, f. 21; H.V.H. Atl., pl. 7, f. 1*; Type No. 76), **plate 3, fig. 100.**

Valve linear-elliptic, perceptibly inflated in the median portion, with apices very gently inflated-capitate. Raphe surrounded by a conspicuous hyaline zone dilated circularly round the central and terminal nodules. Costæ robust finely striate transversely, very distant round the central nodule (5 in 1 c.d.m.) then more compact (7 in 1 c.d.m.), radiate, flexuous, lastly the terminal ones still more approximate (8 in 1 c.d.m.), their lines of direction broken abruptly in the middle, radiate from the edge of the raphe, convergent from the edge of the margins. Terminal nodules very robust. Length, 15 to 18 c.d.m.

Fresh water.—Rather common and found throughout Europe.

b. STRIÆ IN CONTINUOUS LINES.

a. Median striæ alternately long and short.

N. peregrina (Ehr. ?) Kütz. (Bac., p. 97, pl. 28, f. 52; H.V.H. Atl., pl. 7, f. 2*; Type No. 77), **plate 3, fig. 101.**

Valve broadly lanceolate, with apices very feebly diminuate-rostrate. Raphe surrounded by a narrow hyaline zone dilated round the central nodule, where the blank space forms more or less a square transversely elongate. Costæ divided finely transversely, very robust; distant round the central nodule (5 or 6 in 1 c.d.m.) where the long striæ are frequently mixed with one or two shorter striæ; median striæ very radiate (6 or 7 in 1 c.d.m.) the terminal ones very convergent, about 8 in 1 c.d.m. Terminal nodules rather robust. Length, 8 to 11 c.d.m.

Brackish water.—Scheldt at Antwerp, and throughout Europe.

var. Meniscus Schum. (H.V.H. Atl., pl. 8, f. 19*), **plate 3, fig. 102.**

Smaller, more broadly lanceolate, with apices diminishing more abruptly. Length, 4 to 7 c.d.m. Striæ, 7 or 8 in 1 c.d.m.

Brackish water.—Belgium, etc.

var. Menisculus Schum. (H.V.H. Atl., pl. 8, f. 20, 21 and 22*; in Type No. 190), **plate 3, fig. 103.**

Very small, lanceolate-elliptic, infinitesimally attenuate towards the apices, or diminuate-rostrate. Hyaline space round the central nodule sometimes next to nothing. Striæ, 8 to 12 in c.d.m. Length, 2·5 to 3 c.d.m.

Fresh water.—Louvain (P.G.)

id. forma Upsaliensis Grun. (H.V.H. Atl., pl. 8, f. 23, 24*), **plate 3, fig. 104.**

More narrowly lanceolate, with apices more or less diminuate-rostrate. Striæ delicate from 8 to 12 in c.d.m. Length, 3 to 4 c.d.m.

Fresh water.—Louvain (P.G.)

N. salinarun Grun. (Arct. Diat., p. 33, pl. 2, f. 34; H.V.H. Atl., pl. 8, f. 9*, Type No. 95), **plate 3, fig. 108.**

Valve broadly lanceolate, sub-elliptic, with apices strongly rostrate, and more or less capitate. Central nodule surrounded by a hyaline area very elongated longitudinally. Striæ rather strongly divided crosswise 14 to 16 in 1 c.d.m., the median radiant, the terminal feebly convergent. Length, 2·5 to 3·5 c.d.m. Breadth, 1 to 1·5 c.d.m.

Brackish water.—Heyst (according to Deby); Antwerp (Scheldt, H.V.H.); Norfolk (England, Kitton).

N. cincta (Ehr!) Kütz. (Mik., pl. X. 2, f. 6; H.V.H. Atl., pl. 7, f. 13-14*; Type No. 82), **plate 3, fig. 105.**

Valve lanceolate, very narrow, with rounded obtuse apices; central nodule surrounded by a hyaline area somewhat extended transversely; striæ delicate, about 12 in 1 c.d.m., those round the central nodule much more distant. Length, about 4 c.d.m.

Fresh and brackish water.—Ard. Liég. (De Wild.). England.

forma minuta. (H.V.H. Type No. 83); very small; Ostend.

var. Heufleri Grun. (H.V.H. Atl., pl. 7, f. 12 and 15*), **plate 3, fig. 106.**

Smaller with median hyaline space round, striæ more robust and more distant, about 10 in 1 c.d.m. Length, about 2 to 2·5 c.d.m.

Somewhat brackish water—Austruweel near Antwerp (P.G.).

var. leptocephala Breb. (H.V.H. Atl., pl. 7, f. 16*; Type No. 84), **plate 3, fig. 107.**

Like the preceding variety, but still somewhat smaller. Valve with median portion somewhat inflated, with apices gently tapering sub-rostrate.

Austruweel near Antwerp (H.V.H.).

b. Median striæ not alternately long and short.

a'. MEDIAN STRIÆ EQUALLY SHORTENED, FORMING A PSEUDO-STAUROS; THE STRIÆ NEAR THE CENTRAL NODULE ALMOST STRAIGHT.

N. gracilis Kütz (Bac., p. 91, pl. 3, f. 48; H.V.H. Atl., pl. 7, f. 7-8*; Type No. 81), **plate 3, fig. 109.**

Valve elongate, narrowly lanceolate, with the portion quite terminal, sometimes very gently produced, somewhat acute; striæ robust, the 2 or 3 close to the central nodule equally shortened; the median scarcely radiant, almost straight; the terminal convergent; on an average 10 in 1 c.d.m., all reaching to the raphe. Length, 4 to 8 c.d.m.

Fresh water—Antwerp, etc. (H.V.H.), Ard. Liég. (De Wild.). Found throughout Europe.

var. schizonemoides H. Van Heurck. (*S. neglectum Thwaites* —H.V.H. Atl., pl. 7, f. 9-10*) **plate 3, fig. 110.**

Valve usually somewhat narrower near to apices; median striæ longer and of unequal length. Frustules included in mucous tubes.

Fresh water.—Louvain (P.G.), &c. Bristol, England (Thwaites).

A'A'. WITHOUT FALSE STAUROS.

* *Apices not rostrate-capitate.*

N. vulpina Kütz. (Bac., p. 92, pl. 3, f. 43 (?); H.V.H. Atl., pl. 7, f. 18*; in Type No. 132), **plate 3, fig. 111.**

Large, valve broadly lanceolate, with apices gently produced, rostrate. Central nodule surrounded by a broad hyaline area, sub-quadrangular, rounded. Striæ reaching to the raphe, robust, the median ones bent, radiant, the terminal convergent, average number 10 in 1 c.d.m.. Length, about 9 c.d.m.

Fresh water.—Ard. Liég. (De Wild.). Finnety, Scotland.

N. viridula Kütz. (Bac., pl. 30, f. 47; H.V.H. Atl., pl. 7, f. 25*; in Type No. 36), **plate 3, fig. 115.**

Valve broadly lanceolate, with apices tapering, rostrate, obtuse. Central nodule surrounded by a broad rounded hyaline area. Striæ robust, reaching to the raphe, the median ones radiant, about 8 in 1 c.d.m. ; the terminal convergent, 10 in 1 c.d.m. ; terminal nodules robust. Length, about 7 c.d.m.

Fresh water.—Brussels (Delogne). Throughout Europe.

forma minor.—H.V.H. Atl., pl. 7, f. 26*), **plate 3, fig. 116.**

Smaller with more rostrate apices.

var. avenacea. (*N. avenacea Bréb.;* H.V.H. Atl., pl. 7, f. 27*; Type No. 88), **plate 3, fig. 117.**

More lanceolate; apices more narrowly rostrate. Length, about 5 c.d.m.

Fresh water.—Brussels (Del.). Ard. Liég. (De Wild.). Pentland Hills, Scotland.

var. Slesvicensis (*N. Slesvicensis Grun.!*); H.V.H. Atl., pl. 7, f. 28 and 29*; Type No. 89), **plate 3, fig. 118.**

Small, rather broadly lanceolate, apices conspicuously rostrate with a broad rostrum. Striation as in the type form, 8 or 9 striæ in 1 c.d.m. Breadth, 3 to 5 c.d.m.

Fresh and brackish water.—Rather common. Antwerp (Scheldt), Louvain (P.G.), &c. Stoneferry, near Hull, Duddington Lock, Northamptonshire (England).

N. radiosa Kütz. (Bac., p. 91, pl. 4, f. 23; H.V.H., pl. 7, f. 20*; Type No. 85), **plate 3, fig. 112.**

Valve lanceolate, narrow, slightly attenuate, with apices very gently subcapitate. Central nodule surrounded by a very small hyaline area. Median striæ bent, very radiant, the terminal ones convergent; about 11 or 12 striæ in 1 c.d.m. Frustules, narrow in girdle view, with apices diminuate. Length, 4·5 to 6 c.d.m.

Fresh water.—Common throughout Europe.

var. acuta. (*Pinnularia acuta, W. Sm.;* H.V.H. Atl., pl. 7, f. 19* Type No. 86); **plate 3, fig. 113.**

More elongated, more narrowly lanceolate, and with apices more acute Length, about 8 to 9 c.d.m.

Fresh water.—As the preceding form with which it is often mixed.

Var. tenella. (*Nav. tenella Bréb.;* H.V.H. Atl., pl. 7, f. 21 and 22*; in Type No. 107), **plate 3, fig. 114.**

Differs from the type form in its size, being smaller, its apices more acute, and its striæ more delicate and more approximate, 15 to 18 in 1 c.d.m.

Fresh water.—Brussels, etc.

N. cryptocephala Kütz.! (Bac., pl. 3, f. 26; H.V.H. Atl., pl. 8, f. 1 and 5*; in Type No. 25; *var. intermedia*: Type No. 92; *var exilis*: Type No. 93), **plate 3, fig. 122.**

Valve lanceolate, elongate, with apices rostrate, slightly capitate. Central nodule surrounded by a rounded hyaline area. Striæ rather robust, with very feeble transverse divisions, radiant at the median portion of the valve, scarcely convergent at the apices, about 16 in 1 c.d.m. Length, 2·5 to 3·5 c.d.m. Breadth, about 0·5 c.d.m.

Fresh and brackish water.—Antwerp (H.V.H.), Ard. Liég. (De Wild.). Throughout Europe.

var. veneta. (*Nav. veneta Kütz.!* H.V.H. Atl., pl. 8, f. 3 and 4*), **plate 3, fig. 123.**

Smaller than the type form, with apices scarcely rostrate-capitate, striæ distant, about 14 in 1 c.d.m. Length, about 2·5 c.d.m. Breadth, about 0·5 c.d.m.

var. exilis. (H.V.H. Atl., pl. 8, f. 2*; Type No. 93), **plate 3, fig. 124.**

Very short; rostrum scarcely marked.

Fresh water.—Brussels. England.

Constitutes the link with the following species.

* * *Apices extremely rostrate or rostrate-capitate.*

N. rhynchocephala Kütz. (H.V.H. Atl., pl. 7, f. 31*. Type No. 90), **plate 3, fig. 119.**

Valve broadly lanceolate, with apices strongly acuminate-capitate. Central nodule surrounded by a rounded hyaline area. Striæ robust, clearly divided transversely, very slightly shortened round the central nodule. The median ones radiant, the terminal feebly convergent, about 9 to 12 in 1 c.d.m. Length, about 5 to 6 c.d.m.

Brackish water.—Antwerp. Found throughout Europe.

var. amphiceros. (H.V.H. Atl., pl. 7, f. 30*), **plate 3, fig. 120.** More shortly lanceolate with apices strongly rostrate, feebly capitate. Striæ 8 to 10 in 1 c.d.m.

Brackish water.—Antwerp.

var. rostellata. (*N. rostellata Kütz.?* H.V.H. Atl., pl. 7, f. 23 and 24*. Type No. 87), **plate 3, fig. 121.**

Broadly lanceolate; apices narrowly rostrate; hyaline area surrounding the narrow central nodule. Striæ rather robust, about 10 or 11 in 1 c.d.m. Length 4 to 6 c.d.m.

Brackish water.—Antwerp. Norfolk, England.

N. gregaria Donkin. (Q.J.M.S., 1861, p. 10, pl. 1, f. 10*; *N. cryptocephala W. Sm.;* H.V.H. Atl., pl. 8, f. 12, 13, 14 and 15; Type No. 94), **plate 3, fig. 125.**

Differs from the preceding species, of which perhaps it is only a variety, by its very feeble striæ, sometimes scarcely visible and scarcely radiant, almost straight, about 18 in 1 c.d.m. Length, about 2·5 c.d.m.

Brackish water.—Common: Antwerp (Austruweel), Blankenberghe. England. France.

The apices are sometimes simply rostrate, scarcely capitate (Blankenberghe), sometimes strongly capitate (Antwerp).

AA. Striæ very distant and very robust, very small forms with terminal nodule like a hook.

N. costulata Grun. ! (Arct D., p. 27; H.V.H. Atl. Supp., f. 15*; Type No. 71), **plate 3, fig. 126.**

Small, rhomboidal lanceolate, costæ reaching to the raphe, very robust, very distant (7 or 8 in 1 c.d.m.), strongly radiant at the median portion, convergent near the apices, 5 to 7 on each quarter of the valve; absent at the median portion, where they leave a very broad stauroneiform hyaline space. Terminal nodules like hooks. Length, 1·25 to 1·5 c.d.m.

Fresh water—Rouge-Cloitre (Delogne).

N. humilis Donk. (Brit. Diat., p. 67, pl. 10, f. 7.—*N. inflata W. Sm., nec Kütz.*—H.V.H. Atl., pl. 11, f. 23*; Type No. 70), **plate 3, fig. 127.**

Valve linear, very inflated at the median portion, with apices rostrate capitate, truncate, rounded. Raphe not surrounded by a hyaline area. Costæ very robust, 8 in 1 c d.m., radiant at the median portion, convergent at the apices. Terminal nodules like hooks. Length, 1·5 to 2 c.d.m.

Fresh water.—Common. Antwerp, Brussels (H.V.H.), Ard. Liég. (De Wild.), England.

These two forms, which are very closely allied, have hitherto been mixed up with the Pinnulariæ; by examining them in the yellow medium of Prof. H. L. Smith, I have been able to demonstrate that they are clearly Radiosæ, but with striæ very difficult to resolve into beads. One figure is a little defective, there ought not to be a hyaline area round the central nodule.

N. nana Greg. ! (Q J.M.S. 1856, iv., p. 3, pl. 1, f. 8), **plate 25, fig. 711,** after a photograph by H.V.H.*

Valve minute, oval elliptic, with apices rounded, obtuse; striæ reaching almost to the raphe, very radiant; the median ones simulating a schizo-stauros in consequence of their distance from one another, 10 or 11 in 1 c.d.m. Terminal nodules like hooks. Length of valve, 2 to 3 c.d.m. Breadth, 1 c.d.m.

Fresh water.—Near Edinburgh, Scotland (Gregory !).

II. Median striæ radiant, the terminal ones perpendicular to the raphe (straight).

N. cancellata Donk. (Brit. Diat., p. 55, pl. 8, f. 4a and 4b.; H.V.H. Atl. Supp., f. 16*; Type No. 73), **plate 3, fig. 128.**

Valve narrow, linear or linear lanceolate, with apices tapering, acute or sub-acute. Raphe surrounded by a narrow hyaline zone, somewhat enlarged near the central nodule. Striæ very distant, 6 or 7 in 1 c.d.m.. faintly divided cross-wise, radiant at the median portion of the valve, perpendicular near the apices. Girdle face constricted in the middle. Length, 5·5 to 7 c.d.m.

Marine.—Not yet found in Belgium. England, Scotland, Ireland, France.

var. ammophila Grun. (Oest. Foss. Diat., p. 14, pl. 2, f. 66-67*; in H.V.H.'s Types Nos. 11, 94, 116), **plate 25, fig. 712.**

Small, narrow, striation approximate, 10 or 11 in 1 c.d.m. at the median portion, 12 or 13 at the apices. Length, 1·75 to 3 c.d.m.

Marine and fresh water—Antwerp in Belgium. Creswell, Northumberland, England.

var. Scaldensis H.V.H. (Atl. Supp., fig. 17*, in Type No. 11), **plate 3, fig. 129.**

Narrowly lanceolate, with apices attenuate-sub-rostrate. Striæ 9 to 11 in 1 c.d.m. at the median portion of the valve. Length, 4·5 to 5·5 c.d.m.

Brackish water—Antwerp.

N. cancellata is not a true Radiosa. It ought to form, with allied forms, a special group, intermediate between the Pinnulariæ and the Radiosæ. The same is true of *N. humilis* and *costulata*.

N. crucifera Grun. ! (in Ad. Schm. Atl., pl. 46, f. 50-54*), **plate 25, fig. 710.**

Valve lanceolate with apices cuneate, rostrate-acute. Transverse striæ 5 or 5·5 in 1 c.d.m., distant, robust, finely divided cross-wise, not reaching to the raphe, all radiant; the two median ones equally shortened and leaving an elongated stauroneiform hyaline space. Length of valve, 3 to 5·5 c.d.m. Breadth, about 1·5 c.d.m. Girdle face subquadrangular with somewhat concave sides, showing a smooth space at the apices. Connecting membrane smooth. Breadth of girdle face, 3·5 c.d.m.

Marine—North Sea (?), Baltic Sea, etc.

N. inflexa (Greg.) Ralfs. (in Pritch. Inf., p. 905 ; A. Schmidt's Atl., pl. 46, f. 69-70*), **plate 25, fig. 713.**

Very narrowly lanceolate, with apices sub-acute, inflexed. Striæ, 10 in 1 c.d.m., distinctly punctate, radiate, reaching almost to the raphe, much shortened near the central nodule. Length of valve, about 3 to 5 c.d.m· Breadth, about ·75 c.d.m.

Marine—Scotland (Greg.), England (Donk.), Ireland (O'Meara).

N. fortis Greg. (T.M.S., 1856, iv., p. 46, pl. 5, f. 19, sub *Pinnularia ;* in Ad. Sch. Atl., pl. 46, f. 27*), **plate 25, fig. 715.**

Valves oblong, with apices obtuse, rounded. Striæ very robust, about 5 in 1 c.d.m., not reaching to the raphe, gently radiate in the median portion ; almost perpendicular at raphe, near the apices, leaving a hyaline area round the central nodule. Length, 8 c.d.m. Breadth, 2 c.d.m.

Marine—Scotland (Greg.), England (Donkin, Kitton), Ireland (O'Meara). A species not very well known.

N. opima Grun. (Novara, p. 100, pl. 1a, f. 13 ; Ad. Schm. Atl., pl. 46, f. 25-26*), **plate 25, fig. 714.**

Valve elliptic or elliptic sublanceolate, with apices broadly lanceolate, terminal nodules considerably distant from the apices. Striæ all radiant, distant, about 6 in 1 c.d.m., rather distant from the raphe and leaving a hyaline space, rounded, conspicuous, round the central nodule. Length, 5·5 to 9·5 c.d.m.

Marine.—North Sea ; Baltic.

N. digito-radiata Greg. (Q.J.M.S. 1856, p. 9, pl. 1, f. 32 ; H.V.H. Atl., pl. 7, f. 4* ; in Types 103, 260 and 261), **plate 3, fig. 130.**

Valve narrowly lanceolate, with apices obtuse-rounded ; striæ very delicately punctate, shortened round the central nodule, longer striæ alternating with shorter, the median ones radiate, 8 in 1 c.d.m., the terminal almost straight, somewhat more compact.

Brackish water.—Antwerp, Blankenberghe. England, and probably throughout all the coasts of the North Sea.

var. **Cyprinus**. (*N. Cyprinus W. Sm.*, H.V.H. Atl., pl. 7, f. 3*; Type No. 78), **plate 3, fig 131.**

Differs from the type form by the inflation in the median portion. Length, 6 to 8 c.d.m. Breadth in the median portion, 1·5 to 2·75 c.d.m.

Marine.—Ostend (Deby); Blankenberghe (H.V H.); England (frequent).

N. Reinhardtii Grun.! (*Stauroneis Reinhardtii Grun.*, Nov., p. 566, pl. 4. f. 19; H.V.H. Atl., pl. 7, f. 5 and 6*; Type No. 79), **plate 3, fig. 132.**

Valve short, elliptic or lanceolate, with apices very obtuse-rounded, median portion abruptly inflated. Raphe surrounded by a narrow hyaline zone, dilated in form of stauros round the central nodule. Striæ surrounding the nodule alternately long and short, the median radiate, the terminal almost straight, all very strongly punctate, and about 9 in 1 c.d.m., except those in the neighbourhood of the nodule which are more distant. Length, 3·5 to 6 c.d.m. Breadth, about 1·5 c.d.m.

Fresh water.—Rather common: Antwerp, Louvain, Brussels—probably England and other places.

The preceding and the following forms are generally mixed together.

var. **gracilior Grun.** (in H.V.H. Types du Syn. No. 71, *N. digito-radiata var. striolata Grun.* in Arc. D.; Type No. 80.)

Very similar to *N. digito-radiata*, from which it cannot be distinguished under a low magnification, but from which it is differentiated by its habitat and by the strongly punctate character of its striæ.

Fresh water.—Rouge-Cloitre (Delogne).

III. Striæ radiate up to the apices of the valves.

N. distans (W. Sm.) H.V.H. (*Pinnularia distans W. Sm.*, S.B.D., pl. 1, f. 56, pl. 18, f. 169; H.V.H. Atl. Supp., f. 18*), **plate 3, fig. 133.**

Valve lanceolate, with sub-acute apices. Raphe placed in a sulcus, inflected on each side of the central nodule and forming round the raphe a broad hyaline zone. Central nodule surrounded (outside the sulcus) by a rounded hyaline zone. Striæ very robust and distant, about 4 in 1 c.d.m., radiate up to the apices of the valve. Length, 9 to 13 c.d.m.

Marine.—Blankenberghe (very rare). England, and probably on all the coasts of the North Sea.

N. longa Greg. (T.M.S., 1856, iv., p. 47, pl. 5, f. 18, sub. *Pinnularia*); Ad. Schm. Atl., pl. 47, fig. 6*), **plate 25, fig. 716.**

Valve very narrowly lanceolate-subrhomboidal with subacute apices. Raphe surrounded by a very narrow hyaline zone. Striæ robust, radiate up to the apex of the valve, 4 or 5 in 1 c.d.m., leaving a small hyaline area round the central nodule. Length, 10 to 20 c.d.m. Breadth, about 1·5 c.d.m.

Marine.—England, Scotland, Ireland, Denmark, Jutland.

N. solaris Greg. (T.M.S., 1856, iv., p. 43, pl. 5, f. 10*), **plate 25, fig. 717.**

Valve elongate, narrowly lanceolate, with very obtuse apices. Striæ 14 to 16 in 1 c.d.m., radiate up to the apices of the valve, resting rather distant from the raphe and leaving a considerable hyaline area round the central nodule. Length, 6 to 12 c.d.m. Breadth, 1 to 1·5 c.d.m.

Marine—England, Scotland, Ireland, Denmark.

N. lanceolata Kutz. ! (Bac., p. 94, pl. 30, f. 48; H.V.H. Atl., pl. 8, f. 16*; Type No. 96), **plate 3, fig. 139.**

Valve lanceolate, with apices gently diminuate-rostrate; striæ shortened round the central nodule, radiate up to the apices of the valve, about 12 in 1 c.d.m. in the middle of the valve; 15 to 16 at the apices. Length, about 3 to 5 c.d.m. Breadth, about 1 c.d.m.

Fresh water—Between Louvain and Parck (P.G.), Ard. Liég (De Wild.). Throughout Europe.

forma curta. (H.V.H. Atl., pl. 7, f. 17*), **plate 3, fig. 140.**

Mixed with the preceding.

var. phyllepta. (*N. phyllepta Kütz;* H.V.H. Atl., pl. 8, f. 40*; Type No. 100), **plate 3, fig. 141.**

Smaller than the type form, with striæ more delicate and much more compact, about 18 in 1 c.d.m.

Brackish water—Blankenberghe.

var. arenaria. (*N. arenaria Donk.*, H.V.H. Atl., pl. 8, f. 18*; Type No. 97), **plate 3, fig. 142.**

Much larger and more gradually attenuate than the type form. About 10 striæ in 1 c.d.m.

Marine—Not yet found in Belgium. England (Donkin), Ireland (O'Meara), Scotland.

N. Gastrum (Ehr.) Donk. (Br. Diat., p. 22, pl. 3, f. 10; H.V.H. Atl., pl. 8, f. 25, 27 and 32*), **plate 3, fig. 134.**

Valve broadly elliptic with obtuse apices, broadly rounded, very gently constricted-subrostrate. Central nodule surrounded by a hyaline area, rounded or elongated transversely. Striæ surrounding the nodule, alternately long and short. Striæ finely divided transversely, radiate up to the apex of the valve, 8 to 10 in 1 c.d.m. in the large forms, 12 to 14 in the small. Length, 2·5 to 4·5 c.d.m. Median breadth, 1.25 to 1·75 c.d.m.

Fresh water.—Antwerp and probably elsewhere England (Kitton), Ireland (Donk. O'Meara), Scotland (Greg).

var. **Placentula.** (*N. Placentula Ehr.*, H.V.H. Atl., pl. 8, f. 26 and 28*), **plate 3, fig. 135.**

Apices somewhat more inflated, striæ 6 to 9 in 1 c.d.m., those surrounding the central nodule not alternately long and short.

Brackish water—Antwerp (rather common).

N. Anglica Ralfs. (in Pritch. Inf., p. 900, *N. tumida W. Sm.*; H.V.H. Atl., pl. 8, f. 29*, in Type No. 59), **plate 3, fig. 136.**

Does not differ essentially from the preceding species, to which it is closely connected, except that its apices are rostrate-capitate. Striæ 10 to 12 in 1 c.d.m.

Fresh water—England, Ireland.

var. **subsalina Grun.** (H.V.H. Atl., pl. 8, f. 31*), **plate 3, fig. 137.**

Apices rostrate, scarcely somewhat capitate.

N. crucifera Grun. See this form after *N. cancellata*, with which it is closely allied.

N. semen Ehr. (Verb. Amer., 1843, pl. IV. ii., f. 8; W. Sm., S.B.D., i., p. 50, pl. 16, f. 141*; H.V.H. Type No. 98); **plate 25, fig. 718.**

Very variable in outline and size, in general very similar to *N. gastrum*, from which it differs in possessing an oval-oblong valve with apices somewhat constricted, very obtuse. Striæ reaching throughout to the raphe and central nodule; robust, finely divided transversely, all radiate, the terminal ones very approximate 9 to 10 in 1 c.d.m., the median, very distant, about 5 in 1 c.d.m. Length, 5 to 7 c.d.m. Breadth, at the median portion, 2 to 2·5 c.d.m.

Fresh water—Belgium ? probable. England, France, Holland. Found in many fossil deposits.

N. capitata Ehr. (Inf., p. 185, n. 240, pl. 13, f. 20*; Schumann, 1862-69, f. 34*); **plate 25, fig. 719** *a.b.*

Valve small, oblong, inflected in the median portion, abruptly inflated at the apices, which are rostrate not capitate. Striæ distinctly punctate, radiate, 5 to 7 in 1 c.d.m., not reaching to the raphe, and leaving a rather large hyaline area round the central nodule. Length, 2 to 4 c.d.m.

Fresh and brackish water.—Throughout Europe.

We give the description and particulars as to the dispersion of *N. capitata* according to the authors. We reproduce (fig. 719*a*) the figure which Ehrenberg gives of his form in the "Mikrogeologie" and (fig. 719*b*) that of Schumann, which authors refer to it, although it is absolutely different.

We have not in any of our collections a form referred by any serious diatomist to *N. capitata Ehr.* We therefore only insert the *N. capitata Ehr.* to record our opinion that it ought to be erased from our Catalogues, since it is impossible to know what form Ehrenberg had in view.

N. dicephala W. Sm.! (S.B.D. i., p. 53, pl. 17, f. 157; H.V.H. Atl., pl. 8, f. 33 and 34*, H.V.H. in Types No. 43, 343, 382, 481); **plate 3, fig. 138.**

Valve narrow, linear, with apices rostrate-capitate; striæ much shortened round the central nodule, radiate up to the apices of the valve, and about 9 to 11 in 1 c.d.m. Length 2·5 to 4 c.d.m. Breadth, 1 to 1·25 c.d.m.

Only differs from *N. Anglica Ralfs* previously described by the linear form of the valve.

Fresh water.—Ard. Liég. (De Wild.).—England, Scotland, Ireland.

N. apiculata Breb.! (Diat. Cherb., f. 5*, non W. Sm.); **plate 25, fig. 720.**

Valve narrowly linear-lanceolate with rostrate apices. Striæ radiate, very robust 9 or 10 in 1 c.d.m., reaching to the raphe and almost touching the central nodule, around which they are more radiate and more distant. Girdle face narrow, constricted at the median portion and showing the striæ radiate. It is this which distinguishes the *N. apiculata* from *N. cancellata*, of which, in other respects, it has all the appearance. Length, 5 to 7 c.d.m. Breadth, 1 c.d.m.

Marine.—England, France. Found probably on other shores washed by the North Sea.

N. Kützingiana H.L. Sm.! (Spec. Typ., No. 287, A.J.Q.M., 1878. *N. arenicola Grun.!* 1882; Foss. Diat., pl. 30, f. 76-77*); **plate 25, fig. 721.**

Valve linear-elliptic, narrow, very gently inflated at the median portion; striæ radiate, about 20 in 1 c.d.m., but the median much more distant. Length of valve, 1·5 to 2 c.d.m. Breadth, 0.5 c.d.m.

Marine.—France, England.

IV. All the Striæ perpendicular to the raphe.

N. directa W. Sm.! (S.B.D., i., p. 56, pl. 18, f. 172*; sub *Pinnularia*; in Type No. 394); **plate 25, fig. 722.**

Valve linear-lanceolate, infinitesimally attenuate up to the acute apices. Striæ about 7 in 1 c.d.m., exactly perpendicular to the raphe, which they almost touch. Length, 6 to 9 c.d.m.

Marine.—England (W. Sm. !). Scotland (W. Arn. !). Ireland (O'Meara). This diatom is not common, but will certainly be found in other parts of the North Sea.

var. subtilis. (*Pinn. subtilis* Greg., Clyde, p. 488, pl. 9, f. 19*); **plate 25, fig. 723.**

More rhomboidal and at the apices more acute than the type form; 9 or 10 delicate costæ in 1 c.d.m.

Marine—Coast of Scotland (Lamlash Bay, Greg.).

N. Northumbrica Donk. (Q.J.M.S., 1861., i., n.s., p. 9., pl. 1., f. 5; id., Brit. Diat., p. 54, pl. 8, f. 1*; in H.V.H.'s Types of Syn., Nos. 13, 116, and 369); **plate 25, fig. 726.**

Valves narrowly lanceolate, with apices attenuate-acute. Striæ about 7 or 8 in 1 c.d.m., very delicate and perpendicular to the raphe, the median somewhat coarser and more distant. Central nodule opaque, very conspicuous. Girdle face very broad, subquadrangular, somewhat concave from the sides of the valve. Length of valve, about 5·5 to 6·5 c.d.m. Breadth, somewhat more than 1 c.d.m.

Marine.—England, Ireland, France.

B. Terminal nodules distant from the apices of the valve.

1. *Valve with equal sides.*

N. superimposita Ad. Schm. (Nordsee, p. 90, pl. 2, f. 34*), **plate 25, fig. 724.**

Valve lanceolate or sublanceolate, with apices rounded, more or less capitate, with longitudinal median portion considerably super-elevated, in such a manner as to simulate a second smaller valve placed on the lower. Striæ robust, radiant, shortened, 4 or 5 in 1 c.d.m., not reaching to the raphe, and leaving a considerable stauroform hyaline space round the central nodule. Length, 9·5 to 11·5 c.d.m.

Marine.—North Sea (Hvidingsoe, A. Schm.).

N. compressicauda Ad. Schm. (Nordsee, p. 91, pl. 2, f. 35; Atl., pl. 46, f. 62*), **plate 25, fig. 725.**

Valve broadly lanceolate elongated, with apices obtuse, compressed; striæ robust, finely divided crosswise, distant, about 5 in 1 c.d.m, radiant at the median portion of the valve, perpendicular at the apices, not reaching to the raphe; those in the middle distant; central nodule surrounded by a rounded hyaline area. Length, 11 to 12 c.d.m. Breadth, 2·25 c.d.m.

Marine.—North Sea at Sölsvig (Ad. Schm.).

2. *Valve with somewhat eccentric structure.*

N. Cesatii Rab. (Süssw. Diat., p. 39, pl. 6, f. 89—*Cymbella?* H.V.H. Atl., pl. 8 f., 35*; in Types No. 47, 484, etc.), **plate 3, fig. 143.**

This diatom, which is perhaps a Cymbella, has very narrowly lanceolate valves and terminal nodules, considerably distant from the apices of the valve.

Fresh water.—Berg. (Delogne), England.

N. inæquilatera Lag. (Diat Spitzb., 1873, p. 33, pl. 2, f. 10*—*Cymbella subæqualis W. Sm.*), **plate 25, fig. 727.**

Valve lanceolate, narrow, with somewhat unequal margins, apices rostrate-capitate. Transverse striæ radiate, rather fine, 12 to 14 in 1 c.d.m.. Length of valve, 3 to 4 c.d.m. Breadth, about ·75 to 1 c.d.m. Girdle face with straight margins, not inflated at the median portion.

Fresh water—England (Balfour and W. Sm.). Spitzbergen (Lagerstedt). Will probably be found elsewhere.

III. Didymæ.

A. *Valves having both beads and costæ.*

- Valves furnished with robust costæ throughout its extent.
  - Intercostal beads very small, difficult to be seen.
    - Median costæ reaching up to the margin of the valve; two rows of beads between the costæ . . . **N. Crabro.**
    - Median costæ not reaching up to the margin of the valve; a single row of beads between the costæ . . **N. interrupta.**
  - Intercostal beads very coarse with smaller beads interposed **N. Beyrichiana.**
- Valves with costæ more distant at the constriction . . **N. splendida.**

AA. Valves having either beads or irresolvable costæ.

I. Valves with large quadrangular central nodule prolonged into horns along the raphe.

a. VALVES REALLY MONILIFORM OR APPARENTLY SO IN CONSEQUENCE OF THE PRESENCE OF LONGITUDINAL COSTÆ.

- Valves distinctly moniliform.
  - Valves robust, with coarse beads, very visible.
    - Striation identical over all the valve and not interrupted at the median portion.
      - Valves small, very slightly constricted; sulci straight, with beads not very distinct . **N. didyma.**
      - Valves very large, conspicuously constricted; sulci dilated near the central nodule, with very distinct beads . . . **N. bomboides.**
    - Striation interrupted at the median portion.
      - Striation interrupted by a narrow band . . . . **N. Weissflogii.**
      - Median portion of the valve hyaline, with some isolated beads; beads on the margin of the valve conspicuously longer than the others . **N. Bombus.**
  - Valves small, with delicate beads . . . . . **N. vacillans.**

aa. VALVES NOT MONILIFORM, WITH COSTÆ MORE OR LESS IRRESOLVABLE.

- Valves distinctly constricted at the median portion.
  - Costæ showing fine transverse striæ in oblique light . . **N. constricta.**
  - Costæ more or less irresolvable into coarse beads.
    - Costæ not crossed by longitudinal sulci.
      - Striæ robust, 6-8 in 1 c.d.m. . **N. Entomon.**
      - Striæ fine, approximate, 11-12 in 1 c.d.m. . . . . **N. incurvata.**
    - Costæ crossed by longitudinal sulci.
      - A longitudinal sulcus in the middle of the breadth of the striæ . . . . . **N. lineata.**
      - A longitudinal sulcus following the margins of the valve . **N. subcincta.**
      - Three longitudinal sulci . **N. Chersonensis.**
- Valves linear-elliptic, not constricted or scarcely constricted in the middle = *N. contigua* (*A. Schm.*) *Cl.* . . .
  - Sulcus surrounding the raphe, very broad and tracing the outline of the central nodule . **var. Eudoxiæ.**
  - Sulcus narrower, interrupted round the central nodule . . . . . . **var. Eugeniæ.**

II. Valves with a small central nodule, striæ only present at the margin of the valve . . . . **N. musca.**

A. Valve furnished with robust costæ.

a. Two rows of small beads between the costæ.

N. Crabro Ehr. (Mikr., pl. 19, f. 29.; H.V.H., pl. 9, f. 1, 2*; Type No. 101), **plate 3, fig. 144.**

Valve sub-elliptic, constricted or not constricted at the median portion. Raphe surrounded by a narrow hyaline zone; central nodule square, very robust. Sulci narrow, very approximate to raphe, almost straight, slightly inflexed in the middle and at the apices. Costæ convergent at the median portion, radiate at the apices, about 3.5 to 4 in 1 c.d.m., and between each of which are found two rows of small beads. Length, 8 to 12 c.d.m.

Marine.—Ostend (Deby). Blankenberghe (H.V.H.). England (Norm., Stolt.). Scotland, Ireland (O'Me.). Probably throughout the coasts of the North Sea.

N. Crabro is excessively variable and all the forms are connected by infinitesimal transitions; Prof. Cleve also considers, as simple varieties, the numerous forms which have been raised by authors into the rank of species.

The forms which we give (fig. 144) consist of the *var. Pandura* (*N. Pandura Breb., N. Crabro Donk.*) on the right, and the *var. multicostata* (*N. multicostata Grun., N. crabro Ad. Schm.*) on the left.

a.a. A single row of beads visible between the costæ.

N. interrupta Kütz. (Bac., p. 100, pl. 29, f. 93; H.V.H. Atl., pl. 9, f. 7 and 8*; Type No. 103); **plate 3, fig. 145.**

Valve deeply constricted, with suborbicular lobes. Raphe surrounded by a rather broad hyaline zone. Sulci more distant from the raphe, almost straight. Costæ not reaching to the margin of the valve at the constricted portion, about 4.5 in 1 c.d.m., straight at the median portion of each lobe, convergent at the median portion of the valves, radiate at apices. A single row of beads, visible with difficulty between the costæ. Length, 7 to 8 c.d.m.

Marine—Ostend (Deby). Antwerp (Scheldt). On all the shores of the North Sea.

N. Beyrichiana Ad. Schm. (Ad. Sm. Atl., pl. 69, f. 16 and 17*); **plate 25, fig. 728.**

Valve elliptic, with apices sub-cuneate, obtuse, constricted at the median portion. Central nodule large, quadrangular. Sulci broad, showing a row of small beads near the raphe. Costæ very robust, scarcely radiate, 4.5 to 5 in 1 c.d.m. Intercostal intervals showing coarse beads intermixed with smaller beads. Length of valve, 10 to 14 c.d.m. Breadth, 3 to 5 c.d.m.

Marine—Scheldt, between Antwerp and the sea (H.V.H.) Very rare.

This form has been again reported on our coasts, and belongs to warmer regions. Possibly it may have been brought by a ship. Prof. Cleve refers *N. Beyrichiana* to *N gemmatula Grun.*, of which it should be only a variety.

N. splendida Greg. (T.M.S., 1856, iv., p. 44, pl. 5, f. 14; H.V.H. Atl., pl. 9, f. 4*; in Type No. 104), **plate 26, fig. 729.**

Valve elongate, panduriform. Striæ 11 to 12 in 1 c.d.m., formed of coarse beads, separated from the raphe by a broad sulcus, either smooth or furnished with rudimentary beads. Central nodule quadrangular, surrounded by 4 or 5 robust costæ. Length, 12 to 15 c.d.m.

Marine.—Scotland. Ireland, and probably elsewhere.

var. Puella Ad. Schm. (Schm. Atl., pl. 12, f. 13*), **plate 25, fig. 730.**

Valve small, narrow, only showing 2-3 rows of longitudinal costæ. Length, 6 to 10 c.d.m. Breadth, 1·5 to 2·5 c.d.m.

Marine.—North Sea.

AA. Valve either furnished with beads or furnished with costæ.

N. bomboides Ad. Schm. (N.S. Diat., p. 85, pl. 1, f. 2; H.V.H. Atl. Supp., f. 19*; in Type No. 74, etc.), **plate 3, fig. 146.**

Valve elliptic, gently constricted at the median portion. Raphe surrounded by a narrow hyaline area. Sulci broad, abruptly dilated at the median portion. Striæ straight at the constricted portion, then becoming gradually more and more radiate, 4 or 5 in 1 c.d.m., formed of very large beads, subquadrangular, and almost touching one another, in such a way that the entire surface of the valve somewhat resembles the paving of a street. Length, about 11 c.d.m.

Marine.—Potter's clay at Ostend (Deby); Blankenberghe (H.V.H.); Shores of the North Sea.

N. didyma Ehr. (Kütz. Bac., p. 100, pl. 4, f. 7; H.V.H. Atl., pl. 9, f. 5 and 6; Suppl. f. 20 at another focus*; Type No. 102), **plate 3, fig. 147.**

Small, median constriction scarcely pronounced; sulci straight. Striæ approximate, about 8 in 1 c.d.m. Length, about 5·5 c.d.m.

Marine.—Antwerp (Scheldt), Ostend, Blankenberghe; England (Stolt., Kitton, Comber, W. Sm.; Norm.). Rather common throughout Europe.

N. Weissflogii A. Schm. (Uber *N. Weissflogii* and *N. Grundleri* in Giebel's Zeitschr, 1873; H.V.H. Atl. Suppl., f. 21), **plate 3, fig. 148.**

This beautiful species, very similar to *N. didyma*, differs from it essentially by its strange constriction, by the band not being moniliform in the middle of the valve and by the arrangement of the beads near this band, and of which the entirety forms a St. Andrew's Cross. Striæ about 7 in 1 c.d.m. Length about 4·5 to 5 c.d.m.

Marine.—Blankenberghe; rather rare.

N. Bombus Ehr. (Abh., 1844; H.V.H. Atl. Suppl., f. 22*; in Type No. 104), **plate 3, fig. 149.**

Rather large; valve deeply constricted with subcordate lobes; raphe surrounded by a broad hyaline zone, with sulci showing small beads in irregularly curved rows. Striæ 6 in 1 c.d.m. with coarse beads; those on the margin of the valve elongate and much larger than the others. Median portion of the valve hyaline, showing only some large isolated beads. Length, about 8 c.d.m.

Marine.—Blankenberghe (rare). Found in France, England, Scotland, Ireland and Norway.

N. vacillans Ad. Schm. (Atl., pl. 8, f. 61; H.V.H. Atl., plate 9, f. 9*), **plate 3, fig. 150.**

Very small, valve narrowly elliptic, gently attenuate at the median portion. Central nodule large, raphe surrounded by a narrow hyaline zone. Sulci approximate to raphe, almost straight, feebly flexed towards the exterior round the central nodule. Striæ finely punctate transversely, feebly radiate, about 16 in 1 c.d.m. Girdle face constricted in the middle. Length, about 2 c.d.m.

Marine.—Ostend (H.V.H.); very rare.

The above form constitutes *N. vacillans forma minuta.* The true type is from 4 to 6 c.d.m. in length.

N. constricta Grun. (Verh., 1860, p. 535, pl. 3, f. 18; in H.V.H. types No. 103; *N. musca Donk.; N. Donkinii* Ad. Schm. Atl., pl. 12, f. 63*), **plate 26, fig. 731.**

Valve sub-elliptical, feebly constricted at the median portion; with sub-cuneate apices. Central nodule large, quadrangular. Striæ, 7 or 8 in 1 c.d.m., resolvable into beads, feebly radiant. Length, 6 to 15 c.d.m. Breadth at the median portion, 2 to 2·5 c.d.m.

Marine.—North Sea (England! Norway.)

N. Entomon (Ehr.) Ad. Schm. (Nordsee, pl. 1, f. 13*), **plate 26, fig. 732.**

Valve elongated, moderately constricted at the median portion, with tongue-shaped segments. Striæ indistinctly resolvable, 6 to 8 in 1 c.d.m., feebly convergent at the median portion of the valve, radiant at the apices, occupying only three-fifths of the valve. Sulci very broad, showing a row of scattered beads. Nodule quadrangular, very large. Length, 7 to 15 c.d.m. Breadth of segments, 3 to 4 c.d.m.

Marine.—North Sea, etc.

N. incurvata Greg. (T.M.S., 1856, iv., p. 44, pl. 5, f. 14; Ad. Schm. Nordsee, pl. 2, f. 6*), **plate 26, fig. 733.**

Resembles the preceding species, but is much narrower, more elongated, with finer and more approximate striæ, about 11-12 in 1 c.d.m.

Marine.—North Sea.

May this not be a form of the preceding?

N. lineata Donk. (Brit. Diat., p. 8, pl. 1, f. 8; Ad. Schm. Nordsee, pl. 1, f. 17*), **plate 26, fig. 736.**

Valve linear-elliptic, somewhat constricted at the median portion, with rounded apices. Striæ irresolvable, feebly radiant, 9 to 10 in 1 c.d.m., crossed in the middle of their length by a smooth longitudinal line, parallel to the margins of the valve. Raphe surrounded by a broad hyaline area showing one or two rows of feebly visible puncta. Central nodule large, subquadrangular. Length, 4 to 8 c.d.m. Breadth, 2 to 3 c.d.m.

Marine.—North Sea (England! Scandinavia—Cleve).

N. subcincta Ad. Schm. (Atl., pl. 13, f. 41*), **plate 26, fig. 737.**

Valve feebly constricted at the median portion, with apices rounded, sometimes sub-cuneate; striæ somewhat radiant, considerably distant from the raphe; 6 or 7 striæ in 1 c.d.m., indistinctly resolvable and crossed by a long smooth sulcus, approximate to the margin of the valve, the outline of which it follows. Central nodule large, quadrangular. Length, 6 to 9 c.d.m. Breadth, 2·25 to 2·5 c.d.m.

Marine.—North Sea.

N. Chersonensis Grun. (Ad. Schm. Atl., pl. 12, f. 40*), **plate 26, fig. 738.**

Valve parduriform, with sub-cuneate segments. Striæ 8 to 13 in 1 c.d.m., more or less resolvable, continuing in the sulci and approximate to the raphe, feebly radiant, the median straight, more compact than the others. Striæ crossed by 2 to 5 longitudinal lines, more or less arcuate. Central nodule large, quadrangular. Length, 5·5 by 15 c.d.m. Breadth of segments, 1 to 3 c.d.m.

Marine.—North Sea, &c.

N. musca Greg. (Diat. of Clyde, p. 7, pl. 1, f. 6*; Ad. Schm. Nordsee, pl. 1, f. 15*), **plate 26, figs. 734 and 735.**

Valve conspicuously constricted with subtriangular lobes, apices cuneate. Striæ feebly radiant, 7 in 1 c.d.m., occupying only a moiety of the valve, and formed usually of 4 or 5 small beads arranged in two rows, separated by a longitudinal sulcus. Central nodules small, elongated. Raphe surrounded by a very broad hyaline area, dotted here and there with the rudiments of beads. Length, 5 to 6 c.d.m. Breadth, about 2 c.d.m. at the constriction.

Marine.—Scotland, Ireland, Norway.

N. Eudoxia A. Schmidt. (Atl., pl. 8, f. 39 and 40*), **plate 26, fig. 739.**

Valve elliptic, linear, scarcely if at all constricted at the median portion, apices obtuse, rounded. Central nodule large, quadrangular, raphe surrounded by a broad sulcus, showing rudimentary costæ or a line of beads. Costæ robust, slightly radiate, 6 in 1 c.d.m. Length, 7 to 9 c.d.m. Breadth, 2·5 c.d.m.

Marine.—Maritime Scheldt, rare (H.V.H.). Ireland (O'M.), Sölsvig (Ad. Schm).

N. Eugenia Ad. Schm. (Atl., pl. 8, f. 44*), **plate 26, fig. 740.**

Closely allied to the preceding, from which it differs by its size, often very small, by the sulcus surrounding the raphe, which is quite smooth, and by a longitudinal sulcus, which on either side of the valve interrupts the costæ, towards the moiety of the length. Costæ robust, about 5 or 6 in 1 c.d.m. Breadth, 6 to 9 c.d.m.

Marine.—Rare : Maritime Scheldt ; Blankenberghe.

Prof. Cleve considers the two preceding forms as simply varieties of *N. contigua Ad. Schm.*, a type form which has not yet been found on our coasts.

IV. Ellipticæ.

- Valves furnished with costæ.
  - Valves showing small beads between the costæ.
    - Two rows of small beads between the costæ.
      - Sulcus approximate to raphe . . . . **N. Smithii.**
      - Sulcus dividing the costæ into two equal parts . **N. nitescens**
    - A single row of beads between the costæ . **N. fusca.**
  - No beads between the costæ.
    - Valves oval, rounded.
      - Costæ straight, continued . . . . **N. suborbicularis.**
      - Costæ more or less interrupted, sometimes forming thick elongated beads, sometimes simply attenuate here and there . **N. notabilis.**
    - Valves strictly elliptic . . . . . **N. advena.**
- Valve moniliform, not furnished with costæ.
  - Nodule very elongate . . . . **N. littoralis.**
  - Nodule quadrangular or rounded.
    - Sulci abruptly flexed from above round the central nodule . . . . **N. elliptica.**
    - Sulci straight or flexed from below near the central nodule ; valve broadly elliptic . **N. oculata.**
- Valve appearing hyaline, with dry objectives. Striation very delicate, moniliform, only becoming visible by means of homogenous objectives of wide aperture . . . . **N. hyalina.**

A. Valve furnished with costæ.

N. Smithii Breb. (in W. Sm. S.B.D., ii., p. 92 ; H.V.H. Atl., pl. 9, f. 12 ; Supp., f. 23* ; Type No. 104), **plate 4, fig.** 151 *a,b.*

Valve oblong or linear-elliptic, sometimes somewhat constricted in the middle, with apices broadly rounded, somewhat subcuneate. Central nodule large, quadrangular ; terminal nodules not reaching to the apex of the valve ; raphe surrounded by a rather broad hyaline zone. Sulci enlarged in the middle of the valve, diminishing infinitesimally cuneate near the apices. Costæ feeble, 5 in 1 c.d.m., separated by two rows of small beads. Length, about 9 to 10 c.d.m.

Marine.—Antwerp (Scheldt), Blankenberghe. Througnout the North Sea coasts.

This Navicula assumes very different forms. That described above is the one most frequently found at Blankenberghe and Antwerp, where it is rare.

Much more frequently found is an elliptic form represented in H.V.H.'s Atl. Supp., f. 23 (plate 4, fig. 151*b*), and which constitutes the *D. Major* of Prof. Cleve. The most essential character of *N. Smithii* is the double row of beads found between the costæ.

var. æstiva. (*N. æstiva Donk.* in H.V.H 's Type of Syn., No. 104).

Differs from the type form with which it is generally accompanied by its more regularly elliptic form and its finer striation.

Marine.—Coasts of England.

var. scutellum. (*N. scutellum O'Meara*, in H.V.H.'s Atl., pl. 9, f. 11), **plate 4, fig. 152.**

Very small; valve suborbicular elliptic; striæ about 8 in 1 c.d.m., perpendicular to the raphe at the median portion, then becoming more and more radiate. Length, about 3 c.d.m. Breadth, 2·5 c.d.m.

Marine.—Blankenberghe (H.V.H., very rare). Ireland (O'M.).

Observ.—When I drew the figure in the Atlas I did not possess the excellent homogenous objectives which have since been invented, and I was consequently unable to recognize the true nature of the striation. Since then I have found that there exists two rows of excessively delicate beads between the striæ, and consequently I refer this form, which appears to be the *N. scutellum* of *O'Meara*, to *N. Smithii.*

N. nitescens Greg. (Diat. of Clyde, p. 15, pl. 1, f. 16*), **plate 26, fig. 747.**

Valve elliptic-lanceolate, with apices subobtuse. Transverse striæ, 8 in 1 c.d.m, cut by the sulcus almost in the middle of their length. Intercostal spaces showing two rows of small beads well marked in the portion of the valve exterior to the sulcus; rudimentary and little visible in the internal portion. Length, 5 to 8·5 c.d.m. Breadth, 2 to 3.5 c.d.m.

Marine—and also found in the stomachs of marine animals. Coasts of England, Scotland, Norway, etc.

N. fusca Greg. (*N. Smithii var. fusca Greg.* Diat. of Clyde, p. 14, pl. 1, f. 15; H.V.H. Atl. Supp., f. 24*; Type No. 105), **plate 4, fig. 153.**

This diatom is distinguished from *N. Smithii* by its generally somewhat smaller size, and because it has only a single row of rather large beads between the costæ.

Marine.—Blankenberghe (rare)—England, Scotland, Denmark.

Prof. Cleve distinguishes the following forms in *N. fusca* from the North Sea :—

var. norvegica Cl. (*N. fusca Ad. Schm.* Atl., pl. 7, f. 2-3*), **plate 26, fig. 741.**

Valve broadly elliptic ; 10 costæ and 10 longitudinal puncta in 1 c.d.m.

var. subrectangularis Cl. (*N. fusca Ad. Schm.* Atl., pl. 7, f. 4*), **plate 26, fig. 742.**

Very large, subrectangular ; 8·5 to 13 c.d.m. in length ; 8 costæ and 8 longitudinal puncta in 1 c.d.m.

var. Gregorii Cl. (*N. Smithii, var. fusca Greg.*), Diat. of Clyde, pl. 9, f. 15*), **plate 26, fig. 743.**

Elliptic, subrectangular. Length, 17 c.d.m. ; 7 costæ and 7 longitudinal puncta in 1 c.d.m.

var. delicatula Ad. Schm. (Atl., pl. 7, f. 7-8*), **plate 26, fig. 744.**

Elliptic. Length, 7 to 13 c.d.m. ; 7 to 10 longitudinal costæ and 10 to 15 longitudinal puncta in 1 c.d.m.

var. tenuipunctata Cl. (*N. fusca*, H.V.H. in Syn. Suppl., f. 24*), **plate 4, fig. 153.**

6 to 9 costæ and 12 to 18 longitudinal puncta in 1 c.d.m.

var. hyperborea. (*N. hyperborea Grun.*, Verh., 1860, p. 531, pl. 1, f. 16*), **plate 26, fig. 745.**

Sulci abruptly curved round the central nodule ; 7 costæ in 1 c d.m.

Marine.—Bohuslan (Sweden, Grun.) Blankenberghe, H.V.H.

forma excisa. (*N. excisa Ad. Schm.*, Nordsee, pl. 2, f. 9*), **plate 26, fig. 746.**

Valve gently constricted at the median portion ; 9 costæ in 1 c.d.m.

Marine.—North Sea.

N. suborbicularis Greg. (Diat. of Clyde, p. 15, pl. 1, f. 17* ; in H.V.H.'s Types, No. 197), **plate 26, fig. 748.**

Valve small, broadly oval-suborbicular. Costæ robust, 6 in 1 c.d.m. ; terminated by a large bead, not showing small beads in the intercostal spaces. the Central nodule large, quadrangular, elongated. Sulci very attenuate near central nodule, which they touch. Length, 4 to 5·5 c.d.m. Breadth, 2·5 to 3·5 c d.m.

Marine.—Blankenberghe (H.V.H.). England, various localities. Norway.

var. coffeæformis Ad. Schm. (Schm. Atl., pl. 8, f. 6*), **plate 26, fig. 749.**

Smaller and much more delicate in all its parts. Striæ, 8 to 12 in 1 c.d.m., feeble, delicate. Horns of nodule scarcely arcuate.

Passes into the type by every gradation.

Marine.—North Sea.

N. notabilis Grev. (T.M.S., 1863, iii., p. 18, pl. 1, f. 9; Sch. Atl., pl. 8, f. 46-47*), **plate 26, fig. 750.**

Valve oval-elliptic, with sulci scarcely attenuate near the median portion. Costæ robust, 10 in 1 c.d.m., not showing small beads in the intercostal spaces, interrupted by two broad and deep depressions, one at the middle of their length, the other between their apices and the sulcus. Marginal costæ in addition interrupted by one or two narrow sulci in a manner to simulate beads. Length, 3 c.d.m. Breadth, about 2 c.d.m.

Marine.—Not yet found in Europe.

var. expleta Ad. Schm. (Nordsee, p. 88, pl. 2, f. 11; Atl., pl. 8, f. 48-50*), **plate 26, fig. 751.**

The median depression of the costæ disappears, and these are transformed into a series of false puncta forming longitudinal lines in zig-zag.

Marine.—Maritime Scheldt (H.V.H.). Hvidingsoe (Ad. Schm.). English Channel. Estuary of Shannon, Ireland

The form found in the Scheldt is less oval and more subquadrangular than the type form figured by Dr. A. Schmidt.

N. advena Ad. Schm. (Atl., pl. 8, f. 29*; H.V.H.'s Types No. 197), **plate 26, fig. 752.**

Valve longly linear-elliptic, sometimes somewhat constricted at the median portion. Costæ 9 in 1 c.d.m., delicate, parallel, continuing into the sulci. Central nodule of medium size, with straight horns, approximate.

North Sea.—Scotland (Cumbrae !)

var. parca. (Ad. Schm. Atl., pl. 8, f. 20, 21, 22*), **plate 26, fig. 753.** Smaller and more delicate; valve longly elliptic.

Marine.—North Sea.

AA. Valve moniliform, not furnished with costæ.

N. littoralis Donk. (Brit. D., p. 5, pl. 1, f. 2; H.V.H. Atl. Supp., f. 25*, in Type No. 104), **plate 4, fig. 154.**

Valve oval. Nodule very elongate. Raphe not surrounded by a hyaline area. Sulci completely straight, and quite approximate to the raphe. Striæ 14 in 1 c.d.m., perpendicular to the raphe at the median portion, becoming more and more radiate near the apices. Length, about 4 to 5 c.d.m.

Marine.—Blankenberghe (very rare), England.

N. oculata Breb! (in Desm. ed., 1854, No. 110; H.V.H. Atl., pl. 9, f. 10*), **plate 4, fig. 155.**

Valve linear-oblong, with broadly rounded apices. Central nodule subquadrangular; raphe surrounded by a narrow hyaline zone; sulci approximate to raphe, straight, gently incurved near the central nodule; striæ finely punctate, straight at the median portion, then becoming little by little radiate, 17 in 1 c.d.m. Length, 2·5 to 2·5 c.d.m. Breadth, about ·75 c.d.m.

Fresh water.—Brussels (Botanical Gardens, Delogne), France.

N. elliptica Kütz. (Bac., p. 98, pl. 30, f. 55; H.V.H. Atl., pl. 10, f. 10*; Type No. 107), **plate 4, fig. 156** (first figure).

Valve oval-elliptic or oblong-elliptic. Raphe robust, surrounded by a rather broad hyaline area, abruptly enlarged round the central nodule; sulci very approximate to the raphe, following the outline of the hyaline zone; striæ formed of coarse puncta, straight at the middle of the valve, and becoming little by little radiate near the apices, 11 in 1 c.d.m. Length, 2·5 to 3·5 c.d.m. Breadth, 1·3 to 1·5 c.d.m.

Fresh and brackish water.—Rather common throughout Europe.

var. ovalis Hilse, plate 4, fig. 156 (second figure).

Valve elliptic; central nodule very large, rounded; striæ fine, 13 to 19 in 1 c.d.m., formed of puncta arranged in irregular longitudinal rows. Length, 3·5 to 4 c.d.m. Breadth, 2 to 2·5 c.d.m.

var. oblongella Naeg. (H.V.H. Atl., pl. 10, f. 12*, in Type No. 108), **plate 4, fig. 157.**

Small, very elongate, about 16 striæ in 1 c.d.m. Length, 2 c.d.m. Breadth, ·75 c.d.m.

var. minima (H.V.H. Atl., pl. 10, f. 11*; *Nav. Puella Cl.*), **plate 4, fig. 158.**

Very small, being little more than 1 c.d.m. in length.

N. hyalina Donk. (Q.J.M.S., 1861, p. 10, pl. 1, f. 6; Brit. Diat., p. 5, pl. 1, f. 1; Ad. Sch. Atl., pl. 70, f. 1-4*), **plate 26, fig. 754.**

Valve linear elliptic, with obtuse apices. Raphe placed in a deep sulcus, abruptly attenuate near the central and terminal nodules. Striæ excessively delicate, 20 in 1 c.d.m., appearing marginal in axial illumination, and irregularly bordered near the internal margin with coarse dots; between these dots and the median sulcus the valve is depressed, and in this depression the striæ are less marked, and are only apparent with oblique illumination. Length, up to 6 c.d.m. Breadth, 2·5 c.d.m. Valve excessively delicate, apparently hyaline under the best dry objectives.

Marine.—Very rare? On the sands at the coast at Cresswell and Boulmar (England; Donkin). Cumbræ (Scotland, Coll. W. Arnott in Coll., H.V.H.).

V. Lyratæ.

Valve with coarse puncta.	Sulci more or less divergent, equally broad throughout		**N. Lyra.**
	Sulci straight or somewhat convergent, much broader at their median portion than at the apices .		**N. spectabilis.**
Valve with fine puncta; sulci strongly convergent.	Blank space surrounding the raphe, with median apices clavate		**N. forcipata.**
	Blank space surrounding the raphe, with median apices not clavate.	Central nodule surrounded by a narrow hyaline area; sulci not reaching to the apex of the valve .	**N. abrupta.**
		Central nodule surrounded by a broad hyaline area; sulci reaching almost to the apices . .	**N. pygmæa.**

A. Striæ formed of coarse granules.

N. Lyra Ehr. (Kütz. Bac., p. 94, pl. 28, f. 55; H.V.H. Atl., pl. 10, f. 1 and 2*; Type No. 110), **plate 4, fig. 161.**

Valve broadly elliptic, with apices often somewhat diminuate subrostrate. Raphe surrounded by a narrow hyaline zone, dilated into a stauros round the central nodule. Striæ formed of coarse puncta, about 7 to 9 in 1 c.d.m., more and more radiate from the median portion, and interrupted on each side of the raphe by a sulcus, the bottom of which is generally smooth, but where the striæ continue sometimes more feebly, incurved at the middle where it rejoins the stauroneiform hyaline space, in such a manner that the entire smooth spaces have the appearance of a lyre. Length, 11 to 12 c.d.m. Breadth, about 5 c.d.m.

Marine.—Blankenberghe (rare). Found on all the North Sea coasts.

N. spectabilis Greg. (Diat. of Clyde, p. 9, pl. 1, f. 10*), **plate 27, fig. 757.**

Probably only a form of the preceding, from which it differs essentially in that the sulci are at least twice as broad, and are finely dotted.

Marine.—Not yet found in Belgium. Scotland, Ireland, France, Sölsvig, Cuxhaven, Marstrand.

AA. Valves with finely punctate striæ.

N. abrupta Greg. (*N. Lyra var. abrupta Greg.* Diat. of Clyde, p. 14, pl. 1, f. 14; H.V.H. Atl., pl. 10, f. 4*; in Type No. 104), **plate 4, fig. 162.**

Differs from the preceding by the valves being regularly oval, with apices never diminuate, and by the sulci always recurved on the side of the raphe, and abruptly terminated at a certain distance from the apices. Striæ about 10 in 1 c.d.m. in my specimen, which appears to be smaller than usual. The valve appears colourless when dry.

Marine.—Very rare.—Washing of mussels (Deby.). England, Scotland, Bahnsie.

N. forcipata Grev. (Q.J.M.S., 1859, vii., p. 83, pl. 6, f. 10 and 11; H.V.H. Atl, pl. 10, f. 3; in Type No. 104), **plate 4, fig. 163.**

Differs from *N. Lyra* by its smaller size, its striæ approximate and finely granulate, and especially by the clavate enlargement (which is characteristic) of the median apices of the raphe. Striæ fine, about 15 in 1 c.d.m. Valve brown when dry.

Marine.—Rather common. Scheldt at Antwerp, Blankenberghe. England, Scotland, France.

N. pygmæa Kütz. (Spec. Alg., p. 77; *N. minutula W. Sm.*; H.V.H. Atl., pl. 10, f. 7*, in Types No. 9, 11, 77, 95, 99, 192, etc.), **plate 4, fig. 164.**

Small, valve narrowly elliptic. Raphe surrounded by a hyaline zone, narrow, very much enlarged quite round the central nodule. Striæ very fine, about 26 in 1 c.d.m., becoming gradually radiate from the middle of the valve, interrupted on each side of the raphe by a sulcus strongly incurved at the median portion, and of which the apices rejoin the raphe somewhat before reaching the apex of the valve. Length, 2·25 to 4·5 c.d.m. Breadth, 1 to 1·25 c.d.m.

Brackish water.—Antwerp, Blankenberghe; England (Kitton), France.
Fresh water.—Louvain (P.G.).

VI. Hennedyeæ.

Margins of valve with coarse beads; sulci with coarse scattered beads .	**N. prætexta.**
Margins of valve with coarse beads; sulci finely dotted, showing in the middle an arc formed by rows of 5 to 6 coarse beads . .	**N. Sandriana.**
Margins of valve with fine beads; sulci smooth or finely dotted .	**N. Hennedyi.**

N. prætexta Ehr. (Acad., Berlin, 1840, p. 20; H.V.H. Atl., pl. 9, f. 13*), **plate 4, fig. 159.**

Valve broadly elliptic. Raphe surrounded by a very narrow hyaline zone, enlarged in the form of a stauros near the central nodule. Normal striation in the form of two bands, one at the margin of the valve, the other running the length of the raphe formed of coarse granules with an intermediate space occupied by a broad depression, the bottom of which is irregularly granulated; normal striæ, straight in the middle of the valve, then gradually radiate 6 or 7 in 1 c.d.m. Girdle face quadrangular, oblong, deeply constricted at the central nodule, girdle face showing six longitudinal lines of fine granules, of which the four interior are arranged in pairs. Length, 7 to 9 c.d.m. Breadth, 5·5 c.d.m.

Marine.—Blankenberghe, Scheldt at Antwerp (rare). Scotland, England, Ireland (O'Me.). France, Denmark, Holland.

N. Hennedyi W. Sm. (S.B.D., ii., p. 93; H.V.H. Atl., pl. 9, f. 14; Type No. 109), **plate 4, fig. 160.**

Valve oval; raphe surrounded by a very narrow hyaline zone, enlarged into a stauros near the central nodule; striæ finely granular 10 in 1 c.d.m., gradually radiate from the middle of the valve, interrupted on each side by a crescent-shaped depression, the bottom of which is smooth or very finely dotted. Length, about 6 to 7 c.d.m. Breadth, about 4 c.d.m.

Marine.—Very rare. Blankenberghe. England, Scotland, Ireland, and on all the North Sea coasts.

var. clavata (*N. clavata Greg.*, T.M.S., 1856, iv., p. 46, H.V.H. Atl., pl. 5, f. 17).

Differs from the type form by the apices gently subrostrate, and by the depression, which is very narrow.

Marine.—Blankenberghe; very rare. England, Scotland, Ireland.

var. nebulosa (*N. nebulosa Greg.*, Diat. of Clyde, p. 68, pl. 1, f. 8; Ad. Schm. Atl., pl. 3, f. 14*), **plate 27, fig. 755.**

Differs from the type form by less obtuse apices, finer striæ (12-14 in 1 c.d.m.), which only occupy a narrow marginal band right round the valve. Length, 6 to 9 c.d.m.

Marine.—Not yet found in Belgium, where however it will be. Scotland (Greg.), Ireland (O'M.), Sölsvig (A. Schm.), Marstrand (H.V.H.).

N. Sandriana Grun. (in Wien. Verh., 1863, p. 153, pl. 13, f. 5*), **plate 27, fig. 756.**

Differs essentially from *N. Hennedyi* in the fact that the sulci are finely dotted, and presenting in the middle a longitudinal arc formed by rows of 5 or 6 coarse beads. The valve is also larger and more broadly rounded than in *N. Hennedyi*; the striæ are marginal, and those near the raphe more distant (10 in 1 c.d.m.), and formed of coarser beads. Length, about 10 c.d.m. Breadth, 6 c.d.m.

Marine.—Scheldt and Blankenberghe (H.V.H.); Bahusec (Lagerst.); St. Brieuc (France) and Sölsvig (A. Schm); Ireland (O'M.).—This diatom, one of the most beautiful forms of the North Sea, is not excessively rare.

VII. Asperæ.

Hyaline space forming a band with cuneate apices, girdle face with almost straight margins; angles very rounded	**N. aspera.**
Hyaline space rounded, not cuneate; girdle face with concave margins, angles not rounded	**N. Clepsydra.**

N. aspera Ehr. (*Stauroptera aspera Ehr.*, Amer., p. 134, pl. 1, I., f. 12, etc.; *Stauroneis pulchella W. Sm.*; H.V.H. Atl., pl. 10, f. 13, and Supp., f. 27*; in Type No. 101, etc.), **plate 4, fig. 165.**

Valve linear-lanceolate or elliptic-lanceolate, with apices obtuse or subacute. Raphe surrounded by a narrow hyaline zone, dilated into a hyaline cuneate band, not reaching the margins of the valve, round the central nodule, which is round, very large, but visible with difficulty. Valve apparently covered with coarse puncta, but which with the best objectives are found to be very fine striæ, interrupted in their length, finely divided transversely, regularly radiate up to the apex of the valve, 9 to 10 in 1 c.d.m. Girdle face broad, elongate, with apices truncate, rounded and in the median portion constricted. Length, 10 to 18 c.d.m. Breadth, about 2·5 c.d.m.

Marine.—Antwerp (very rare), Blankenberghe, Ostend. England, Scotland, and probably on all the North Sea Coasts.

N. Clepsydra Donk. (Q.J.M.S., 1861, i., n.s., p. 8, pl. 1, f. 3*), **plate 27, fig. 759.**

Differs from the preceding species by finer striæ, 10 to 12 in 1 c.d.m., by the circular hyaline space which surrounds the central nodule, and by the girdle face being much more deeply constricted at the median portion.

Marine.—Sand of seashore. England, Scotland; France.

My group, *Asperæ*, corresponds with the genus *Trachyneis* of Prof. Cleve, a genus which appears to me to be well founded, but I have not provisionally admitted it here, in order not to interfere too much with the order adopted in the Synopsis.

VIII. Stauroneideæ.

Stauroneiform appearance caused by a hyaline space.	Hyaline space narrow, striæ radiate.	Apices capitate ; puncta interrupted here and there . .	N. **Tuscula.**
		Apices not capitate ; stauroneiform space showing an isolated bead .	N. **mutica.**
	Hyaline space excessively broad ; valve linear-elliptic ; striæ perpendicular to the raphe . .		N. **Pinnularia.**
Stauroneiform appearance, caused by more distant median striæ.	Valve lanceolate, neither rostrate nor undulate		. N. **crucicula.**
	Valve tri-undulate, with apices apiculate-rostrate		. N. **integra.**
	Valve linear-subelliptic . . .		. N. **subinflata.**

A. Stauroneiform appearance caused by a hyaline space.

a. Hyaline space narrow, valve with radiate striæ.

* PUNCTA FORMING IRREGULAR LONGITUDINAL LINES.

N. Tuscula Ehr. (*Stauroneis punctata Kutz.*, Bac., p. 106, pl. 21, f. 9. ; H.V.H. Atl., pl. 10, f. 14 ; Type No. 111), **plate 4, fig. 166.**

Valves elliptic, with apices strongly rostrate-capitate. Raphe surrounded by a narrow hyaline zone, dilated round the central nodule into a pseudo-stauros irregularly subdivided. Striæ 7 or 8 in 1 c.d.m., becoming radiate from the middle of the valve, finely divided transversely and with frequent interruptions, the entirety forming irregular longitudinal lines. Length, about 8 c.d.m. Breadth, 2·5 c.d.m.

Fresh and brackish water.—Antwerp (H.V.H.) Orval (Del.) England (Wm. Sm. and W. Arnott), and probably elsewhere.

** PUNCTA NOT FORMING LONGITUDINAL LINES.

N. mutica Kutz. ! (*Stauroneis Cohnii Hilse* ; H.V.H. Atl., pl. 10, f. 17* ; Type No. 113), **plate 4, fig. 167.**

Valve elliptic or elliptic-lanceolate. Raphe surrounded by a narrow hyaline zone, which, round the central nodule, is dilated into a pseudo-stauros, on one of the sides of which a coarse isolated bead is seen. Striæ radiate with well marked puncta, 15 to 18 in 1 c.d.m. Length, 1 to 2 c.d.m. Breadth, about ·7 c.d.m.

Brackish water.—Piles in the Scheldt at Antwerp. Ostend, etc. England (Kitton, Norman). Ireland (O'M.) and probably throughout Europe.

var. **Goeppertiana.** (H.V.H. Atl., pl. 10, f. 18, Type No. 114), **plate 4, fig. 168.**

Valve regularly lanceolate.

Laeken, near Brussels (Del.).

var. **undulata.** (H.V.H. Atl., pl. 10, f. 20c., in Type No. 148), **plate 4, fig. 169.**

Margins feebly undulate.

Not yet found in Belgium.

var. **quinquenodis** (H.V.H. Atl., pl. 10, f. 21, in Type No. 146), **plate 4, fig. 170.**

Valve showing three strong inflations on each side.

Groenendael (Del.).

var. **ventricosa.** (H.V.H., pl. 4, f. 1*b*., *Stauroneis ventricosa Kutz.*), **plate 4, fig. 171.**

Valve with apices rostrate-capitate.

Not yet found in Belgium.

a a. Hyaline space very broad, valve with striæ perpendicular to the raphe.

N. Pinnularia Cleve. (Sv. och Norsk D., 1868, p. 224, pl. 4, f. 1-2* ; *N. quadratarea Ad. Schm.*), **plate 27, fig. 758.**—See under (I) Pinnulariæ, page 167.

AA. Stauronciform appearance caused by the median striæ being distant from one another.

N. crucicula (W. Sm.). (*Stauroneis W. Sm.*, S.B.D., i., p. 60, pl. 19, f. 192 ; H.V.H., pl. 10, f. 15* ; Type No. 112), **plate 4, fig. 172.**

Valve broadly lanceolate or lanceolate-elliptic, with apices obtuse, somewhat constricted ; striæ almost touching the raphe, slightly shortened near the central nodule. Median striæ straight, more robust and more distant, and producing, under insufficient magnification, the appearance of a stauros ; the others about 16 or 17 in 1 c.d.m., fine, compact, delicately punctate, more and more radiate as they are distant from the median. Length, about 4·5 c.d.m. Breadth, 1·5 c.d.m.

Brackish water.—Antwerp (Scheldt), Blankenberghe. England, Ireland, Denmark.

var. **protracta Grun.** (Arct. D., p. 35, pl. 2, f. 38 ; H.V.H. Atl. Supp., f. 27* ; in Type No. 99), **plate 4, fig. 173.**

Valve linear lanceolate, with apices broadly rostrate. Striæ 18 to 21 in 1 c.d.m. Length, 2·25 to 3·5 c.d.m.

Brackish water.—Austruweel near Antwerp (H.V.H.). Ard. Liége. (De Wild.). Cheshire, England.

N. integra W. Sm. (S.B.D., ii., p. 96; H.V.H. Atl., pl. 11, f. 22*; in Type No. 55), **plate 4, fig. 174.**

Valve lanceolate elliptic, margins with 3-7 undulations, apices abruptly rostrate-apiculate. Raphe surrounded by a narrow hyaline zone; median striæ straight, distant, producing a pseudo-stauros under low magnification, then radiate, 23 in 1 c.d.m. Length, about 3 c.d.m. Breadth, about 1 c.d.m.

Slightly brackish water.—Antwerp, Blankenberghe. England, Scotland, Ireland, Holstein.

This may possibly be, according to Grunow (Arc. Diat., p. 36), only a simple variety of *N. crucicula*, which is a protean form analogous to *N. mutica*.

N subinflata Grun. (in Cleve Vega, p. 470, pl. 37, f. 50*), **plate 27, fig. 760.**

Valve linear, more or less elliptic, somewhat inflated at the median portion with obtuse, rounded apices. Striæ almost perpendicular to raphe, 19 in 1 c.d.m.; the two or three central ones somewhat shortened and very distant. Girdle face rectangular with connecting zone showing fine longitudinal lines. Length of valve, 2·5 to 4 c.d.m. Breadth, 8 mill. d.m.

Marine.—Norway, Grip; Cape Wankerema.

var. elliptica.—Valve more elliptic (Adriatic, Cleve and Möll Diat. No. 210).

IX. Palpebrales.

Valve with hyaline zone very elongate, lanceolate . . . . . . **N. palpebralis.**

N. palpebralis Breb. (in W. Sm., S.B.D., i., p. 50, Supp. pl. 31, f. 273; H.V.H. Atl., pl. 11, f. 9*; Type No. 116), **plate 4, fig. 175.**

Valve broadly elliptic-lanceolate, with apices acute, slightly mucronate; striæ radiate, rather robust, not punctate, marginal, leaving round the raphe a broad hyaline space, lanceolate in form. Striæ vigorous, about 10 in 1 c.d.m. Breadth, 4·5 to 5 c.d.m. Length, 7·5 c.d.m.

Marine.—Ostend, Blankenberghe (H.V.H.). Mouth of the Scheldt (Thomson). On all the North Sea Coasts.

var. obtusa (H.V.H. Atl., pl. 11, f. 8*), **plate 4, fig. 176.**

Apices somewhat constricted, very obtuse.

Marine.—Blankenberghe.

var. angulosa. (*N. angulosa Greg.*, H.V.H. Atl., pl. 11, f. 10*; in Type No. 116), **plate 4, fig. 177.**

Hyaline area very small, angular.

Marine.—Scheldt at Antwerp; Blankenberghe. England (Donkin), Scotland (Gregory), Ireland (O'M.).

var. minor Grun. (H.V.H. Atl., pl. 11, f. 11*), **plate 4, fig. 178.**

Much smaller than the type form, scarcely 2·5 c.d.m. in length, 10 or 11 striæ in 1 c.d.m.

Marine.—Ostend.

var. Barklayana Greg.? (*N. Barklayana Greg.?* H.V.H. Atl., pl. 11, f. 12*), **plate 4, fig. 179.**

Valve with margins almost straight, abruptly attenuate.

Marine.—Blankenberghe.

var. semiplena. (*Pinnularia semiplena Grev.*).

Valve linear-elliptic, narrow, very elongate. Marginal striæ vigorous, 10 in 1 c.d.m. Length, about 8 c.d.m. Breadth, about 2 c.d.m.

Marine.—Blankenberghe (H.V.H.). Coasts of Scotland (Gregory), and probably elsewhere.

Observ.—The striæ of *N. palpebralis* in my plates have erroneously been drawn punctate, and so described in my Synopsis. In 1882 I fell into the same error as my predecessors—W. Smith, Grunow, etc. Recent study, with the aid of better objectives, has proved to me that they are in reality *irresolvable costæ*.

X. Abbreviatæ.

Valve with considerable hyaline space, rounded, abruptly diminuate . . .	Striæ delicate, feebly radiate .	**N. brevis.**
	Striæ robust, strongly radiate .	**N. elegans**

N. brevis Greg. (Diat. of Clyde, p. 6, pl. 1, f. 4; H.V.H. Atl., pl. 11, f. 19*), **plate 4, fig. 180.**

Valve elliptic, with apices diminuate-rostrate, rostrum very broad. Raphe surrounded by a rather broad hyaline zone, dilating round the central nodule into a considerable hyaline space, rounded, abruptly diminuate. Striæ radiate, finely punctate, 14 in 1 c.d.m.

Marine.—Washing of mussels (Deby). Very rare form. England, Scotland (Greg.), Finmark, Bahusie.

var. elliptica (H.V.H. Atl., pl. 11, f. 18*; = *C. brevis var. vexans Cl.*), **plate 4, fig. 181.**

This form, with rounded apices, not diminuate-rostrate, is much commoner than the type form. It is found in brackish water, but has not yet been found in Belgium.

N. elegans W.Sm. (S.B.D., i., p. 49, pl. 16, f. 137*), **plate 27, fig. 761.**

Valve lanceolate, with apices diminuate, sub-acute. Central nodule surrounded by a considerable hyaline area. Striæ not reaching to the raphe, radiate, undulate; apparently costiform, very vigorous, 6 or 7 in 1 c.d.m. Length, 7 to 11 c.d.m. Breadth, 3 to 3·5 c.d.m.

Brackish water.—Not yet found in Belgium. Rather common in England. Marstrand! (Sweden).

XI. Perstriatæ.

- Valve without two lunate sulci near the central nodule.
  - Apices not produced rostrate.
    - Median striæ alternately long and short.
      - Valve large, elliptic, oval, or subquadrangular.
        - Apices elongate, rostrate . . **N. humerosa.**
        - Apices very gently diminuate, not rostrate . . **N. latissima.**
      - Valve small, suborbiculate . . **N. scutelloides.**
    - Striæ not alternately long and short.
      - Valves with coarse puncta.
        - Apices somewhat rostrate.
          - Valve with rounded hyaline space . **N. granulata.**
          - Valve with narrow elongated pseudo-stauros . **N. Scandinavica.**
        - Apices sub-acute . . **N. marina.**
        - Valve regularly elliptic.
          - Scattered puncta in centre of valve . **N. Baileyana.**
          - Striæ with distant puncta . . **N. fraudulenta.**
      - Valve with fine puncta, valve regularly elliptic . **N. Scutum.**
  - Apices produced, rostrate . . . . . . **N. pusilla.**
- Valve having two lunate sulci near the central nodule . . **N. Schumanniana.**

I. Valve without lunate sulci near the central nodule.

a. Apices not produced rostrate.

a'. MEDIAN STRIÆ ALTERNATELY LONG AND SHORT.

N. humerosa Breb. (in W.Sm., S.B.D., ii., p. 93; H.V.H. Atl., pl. 11, f. 20*; Type No. 117), **plate 4, fig. 182.**

Valve linear-elliptic, with apices somewhat abruptly constricted, attenuate. Raphe surrounded by a narrow hyaline zone, somewhat dilated transversely round the central nodule. Striæ distinctly granular, radiate, the median ones of unequal length, rather distant, the others very compact, about 9 in 1 c.d.m. Length, 5 to 7 c.d.m. Breadth, 2·5 to 3 c.d.m.

Marine.—Blankenberghe (H.V.H. ; P. Petit). Great Britain (common), and probably on all the North Sea shores.

This species, says Donkin (Brit. D.), is very variable in size and outline. The dry valve is colourless.

N. latissima Greg. (T.M.S., 1856, iv., p. 40, pl. 5, f. 4; Ad. Schm. Atl., pl. 6, f. 7*), **plate 27, fig. 762.**

Differs from the preceding by its larger size, its more rounded form, and its apices very slightly diminuate, not rostrate. Length, 10 c.d.m. Breadth, 5·5 c.d.m.

Marine.—Scheldt ; Blankenberghe (H.V.H.). England, Scotland, Denmark, Finmark, Sweden.

N. scutelloides W. Sm. (Q.J.M.S., 1856, iv., p. 4, pl. 1, f. 15*), **plate 27, fig. 763.**

Valve small, suborbicular. Striæ moniliform, strongly radiate, very distant, 7 or 8 in 1 c.d.m., reaching to the raphe.

Fresh water.—Not yet found in Belgium. England, Scotland, Ireland, Bahusie.

aa'. MEDIAN STRIÆ NOT ALTERNATELY LONG AND SHORT.

b. VALVE WITH COARSE PUNCTA.

N. granulata Breb. Ms. (H.V.H. Atl., pl. 11, f. 15*; in Types Nos. 74, 94, 116, 339, 369, 523, 549, 550), **plate 4, fig. 183.**

Valve broad, elliptic or linear elliptic, with median portion sometimes slightly constricted, apices abruptly attenuate, shortly rostrate. Raphe surrounded by a narrow hyaline zone, enlarged transversely round the central nodule. Striæ radiate, 8 in 1 c.d.m., composed of very coarse puncta. Dry valve of a purple blue colour. Length, 6 to 9 c.d.m. Breadth, 2·5 to 4·5 c.d.m.

Marine.—Ostend, Blankenberghe. England, Scotland, Ireland, France.

var. maculosa. (*N. maculosa Donk.*, Br. Diat., p. 25, pl. 5, f. 1*), **plate 27, fig. 767.**

Valve linear-elliptic, narrow; apices narrowly rostrate. Length, 6·5 c.d.m. Breadth, 2 c.d.m.

Marine.—England (Donk.), usually in company with *N. humerosa*.

N. Scandinavica (Lag.) Ad. Schm. (sub *Stauroneis* in Sälltv. Bohuslan, p. 47; Ad. Schm. Nordsee, pl. 1, f. 29*), **plate 27, fig. 764.**

Valve lanceolate, with apices produced-subrostrate. Striæ radiant, reaching to the raphe, about 10 to 11·5 in 1 c.d.m., with strong puncta, shortened near the central nodule, where they leave a stauroneiform space, narrow, elongate. Length, 6·5 to 10·5 c.d.m. Breadth, 3 to 3·5 c.d.m.

Marine.—Bahusie (Lag.). North Sea (Ad. Schm.).

Note.—Most authors have confounded this species with *N. lacustris Greg.* According to authentic specimens of Gregory in our possession, *N. lacustris* is a form almost typical of *N. Placentula Ehr.* (Syn., pl. 8, f. 28).

N. Baileyana Grun. (in Ad. Schm. Atl., pl. 6, f. 26*; *N. granulata Bail. nec Breb.*), **plate 27, fig. 765.**

Valve elliptic or elliptic oval; striæ strongly granular, about 8 in 1 c.d.m. with approximate granules at the margin of the valve, but becoming scattered as they approach the raphe. Raphe sometimes enlarged and accompanied by a hyaline area, equally enlarged on each side of the valve. Central nodule elongated, surrounded by a stauroneiform hyaline area, more or less elongate, narrow. Length, 5 to 8 c.d.m. Breadth, 2·5 to 3·5 c.d.m.

Marine.—North Sea (Hvidingsoe, Ad. Schm.; Bahusie Cl.).

N. fraudulenta Ad. Schm. (in Atl., pl. 70, f. 60*), **plate 27, fig. 766.**

Valve regularly elliptic; striæ not reaching to the raphe, 10 in 1 c.d.m. at the middle of the valve, somewhat radiant, formed of rather strong granules, distant, leaving a small hyaline area round the central nodule. Length, about 3 c.d.m. Breadth, almost 2 c.d.m.

Marine.—North Sea (Sölsvig, Ad. Schm.).

N. marina Ralfs. (in Pritch. Inf., p. 903; H.V.H. Atl., pl. 11, f. 16*; Type No. 118), **plate 4, fig. 184.**

Valve broadly oval, with sub-acute apices. Raphe surrounded by a narrow irregular hyaline zone, somewhat enlarged round the central nodule. Striæ radiate, 10 or 11 in 1 c.d.m., formed of very coarse puncta. Length, 6 to 7 c.d.m. Breadth, 2·5 to 3·5 c.d.m.

Marine? (Brackish water, according to Donkin).—Very rare; Washings of mussels (Deby).—England, Ireland, France.

b. VALVE WITH FINE PUNCTA.

N. Scutum Schumann. ? (Preuss. D., p. 188, f. 45; H.V.H. Atl., pl. 11, f. 14*), **plate 4, fig. 185.**

Valve narrowly elliptic, with apices not attenuate. Raphe surrounded by a hyaline zone rather broad, irregular, enlarged round the central nodule. Terminal nodules robust. Striæ feebly radiate, finely granular, 16 in 1 c.d.m. Length, 3 c.d.m. Breadth, 1 c.d.m.

Fresh water.—Very rare? Manage (P.G.), Prussia, Spitzbergen.

aa. Apices produced rostrate.

N. pusilla W. Sm. ! (S.B.D. i., p. 52, pl. 17, f. 145; H.V.H. Atl., pl. 11, f. 17*; Type No. 119), **plate 4, fig. 186.**

Valve varying from broadly oval to elliptic-lanceolate, with apices produced rostrate, rostrum truncate. Raphe surrounded by a small hyaline zone enlarged round the central nodule; striæ distinctly granular, the median often of unequal length, distant, about 10 in 1 c.d.m., the following ones more compact, less robust, about 14 in 1 c.d.m., radiate. Length, 3·5 to 4·5 c.d.m. Breadth, about 2 c.d.m.

Brackish water.—Antwerp, England, Ireland, Denmark.

II. Valve having two lunate sulci near the central nodule.

N. Schumanniana Grun. (*N. Trochus* (*Ehr*) ? ? ? *Schumann* Preus. D., p. 189, pl. 2, f. 52; H.V.H. Atl., pl. 11, f. 21* = Coloneis Cl), **plate 4, fig. 187.**

Valve narrowly elliptic, with median portion strongly inflated; raphe surrounded by a feeble hyaline zone, conspicuously enlarged round the central nodule, and showing there, on each side of the nodule, in the longitudinal direction, a deep lunate sulcus; striæ radiate, about 16 or 17 in 1 c.d.m. Length, about 3 c.d.m. Breadth at the median inflation, 1 c.d.m.

Fresh water.—Rare. Antwerp (P.G.), Brussels (Delogne).

XII. Johnsonieæ.

N. Johnsonii (W. Sm.)! (*Pinnularia Johnsonii W. Sm.*, S.B.D., i., p. 58, pl. 19, f. 179; H.V.H. Atl. Supp., f. 28*), **plate 4, fig. 188.**

Valve very elongate, linear, gently inflated at the median portion and at the apices; raphe not surrounded by a hyaline area; longitudinal and transverse striæ delicate, cutting one another at right angles, equally distant, about 20 in 1 c.d.m. Length, 13 to 14 c.d.m. Breadth at the median portion, 1 c.d m.

Brackish water.—Not yet found in Belgium. England, Ireland, France.

var. Belgica H.V.H. (H.V.H. Atl. Supp., f. 29*), **plate 4, fig. 189.**

Much smaller than the type form and with very pronounced inflations. 24 striæ in 1 c.d.m. Length, 6 to 7 c.d.m. Breadth at the central inflation, 0·75 c.d.m.

Brackish water.—Ostend (Charles Petit).

XIII. Crassinerves.

Valve lanceolate, with apices not rostrate-capitate .	. **N. cuspidata.**
Valve with apices rostrate-subcapitate . . .	**N. ambigua.**
Valve rostrate-subcapitate, showing transverse thickenings .	. **forma craticula.**

N. cuspidata Kütz. (Bac., p. 94, pl. 11, f. 24 and 37; H.V.H. Atl., pl. 12, f. 4*), **plate 4, fig. 190.**

Valve broadly lanceolate, with apices gently inflated, not rostrate; transverse striæ gently radiate, almost perpendicular to raphe, fine, reaching almost to the raphe, 14 in 1 c.d.m. Longitudinal striæ fine and more compact. Length, about 9 c.d.m. Breadth, 2·3 c.d.m.

Fresh water.—Common throughout Europe.

var. halophila Grun. (H.V.H. Atl. Supp., f. 30*; in Type No. 12), **plate 4, fig. 191.**

Narrow, very small: about 5 c.d.m.; striæ delicate, about 16 in 1 c.d m., radiate near the median portion, convergent at apices.

Brackish water.—Blankenberghe.

N. ambigua Ehr. (Amer., 1843, p. 129, pl. II. 2, f. 9; H.V.H. Atl., pl. 12, f. 5*; Type No. 121), **plate 4, fig. 192.**

Differs from the preceding, of which it is probably only a variety, by its smaller size, and its apices which are rostrate-capitate. Length, 6 to 7 c.d.m. Breadth, 1·5 c.d.m.

Fresh water.—Common throughout Europe.

forma craticula. (H.V.H. Atl., pl. 12, f. 6*; Type No. 122), **plate 4, fig. 193.**

Valve showing transverse thickenings.

There is shewn in fig. 193, on the right moiety of the specimen, the fine striæ which only exist on the surface of the valve, and on the left robust striæ, strongly radiate, which are found in a deeper layer, probably on the interior surface of the valve.

Mixed with the type form, but rare. Louvain and Manage (P. G.).

Note.—The forms above described were included by my late excellent friend Mr. de Brébisson in his genus Van Heurckia. The examination which I have made with better objectives than those in existence at the time de Brébisson published his Work, has convinced me that the raphe is simple, and that therefore these forms cannot be included in the said genus.

XIII *bis*. Fusiformes.

N. fusiformis Grun. (M.M.J., 1877, xviii., p. 178, pl. 195, f. 11*), **plate 27, fig. 768.**

Valve narrowly lanceolate, infinitesimally attenuate up to acute apices. Transverse striæ, 33 in 1 c.d.m. Longitudinal striæ, 36 in 1 c.d.m. Raphe thick, very distinct, central nodule indistinct. Length, 11 to 15 c.d.m.

Marine.—Hitherto only found in Honduras.

var. ostrearia (Gaill.) H.V.H. (*N. fusiformis var. ostrearia Grun.* in H.V.H. Syn., pl. 14, f. 33*). **plate 27, fig. 769.**

Valve small; transverse striæ, 36 in 1 c.d.m., excessively delicate, scarcely visible. Length, 6·25 to 7·25 c.d.m. Breadth, 6 to 7 mill. d.m.

Marine.—North Sea. Sweden and probably other places.

This form lives in oyster beds and colours the oysters green.

By the side of *N. fusiformis* are placed two forms not very well known, which Prof. Cleve includes in his group *Naviculæ Entoloiæ* and which are distinguished from the *Fusiformes* by their lanceolate axial area. They are :—

N. inornata Grun. (Arc. Diat., p. 124, pl. 3, f. 56*), **plate 27, fig. 770.**

Valve fusiform, convex. Striæ delicate, almost parallel, 19 to 21 at the middle of the valve, 23 or 24 in 1 c.d.m. at the apices, leaving a longitudinal area, narrow, lanceolate, and appearing to be crossed by two longitudinal lines, which however are illusory. Length, 5 to 9 c.d.m. Breadth, about 1 c.d.m.

Marine.—English Channel. Finmark. Bahusie.

N. fusoides Grun. (Arc. Diat., p. 46, without figure).

Valve narrow, linear-lanceolate, with apices more or less obtuse. Axial area narrow. Striæ, 21 to 25 in 1 c.d.m., gently radiant, crossed by two true longitudinal lines. Length, 5 to 12 c.d.m. Breadth, 7 to 12 mill. d.m.

Marine.—Bahusie (Grun.).

XIV. Sculpteæ.

Valve with apices rostrate, no median depression forming a pseudo-stauros	**N. sculpta.**
Valve with apices rostrate-capitate, with median depression simulating a pseudo-stauros	**N. sphærophora.**

N. sculpta Ehr. (Mikr., pl. X. 1, f. 5; H.V.H. Atl., pl. 12, f. 1*; Type No. 123), **plate 4, fig. 194.**

Valve elliptic, with tapering apices, then longly rostrate, rostrum obtuse. Raphe surrounded by a considerable hyaline zone. Striæ feebly radiate, 15 to 16 in 1 c.d.m., formed of coarse puncta, interrupted near the raphe by a broad depression of the valve in such a manner as to leave against it only a single row of granules. The depression also continues—but not so deep—near one of the margins of the valve in the form of a unilateral, indistinct, pseudo-stauros. Length, 7 to 8 c.d.m. Breadth, 2·5 c.d.m.

Fresh and brackish water.—Rare. Parck near Louvain (P.G.), Blankenberghe. England, Ireland, France, Norway.

N. sphærophora Kütz. (Bac, p. 95, pl. 4, f. 17; H.V.H. Atl., pl. 12, f. 2 and 3*; Type No. 124), **plate 4, fig. 195.**

Valve elliptic-lanceolate, with apices rostrate-capitate. Raphe surrounded by a considerable hyaline area. Striæ, 16 in 1 c.d.m., gently radiate, granular, interrupted by narrow longitudinal depressions and by a broad transverse depression, forming a very conspicuous pseudo-stauros. Length, 5·5 to 8 c.d.m. Breadth, 1·75 to 2 c.d.m.

Fresh water.—Not very common. Antwerp. Brussels (Delogne). Found throughout Europe.

Probably only a variety of the preceding.

XV. Serianteæ.

Valve lanceolate, sometimes subrhomboidal, with subacute apices .	. **N. serians.**
Valve lanceolate, narrow, with apices rostrate-capitate . .	. **N. exilis.**
Valve cruciform	. **N. follis.**

N. serians Breb. (in Kütz. Bac., p. 92, pl. 30, f. 23; H.V.H. Atl., pl. 12, f. 7*; in Type No. 125), **plate 4, fig. 196.**

Valve lanceolate. Raphe surrounded by a rather broad hyaline zone, somewhat dilated round the central nodule, which is coarse and round. Striæ fine, about 24 in 1 c.d.m., feebly radiate, formed of elongate beads which, by being arranged at some distance apart, appear like irregular longitudinal lines. Length, 6 to 8 c.d.m. Breadth, 1·5 c.d.m.

Boggy pools.—Rare. Calmpthout (Deby); Tête de Flandre at Antwerp (H.V.H.); Ard. Liég. (De Wild.). England, Scotland, Ireland, France.

var. brachysira. (*N. brachysira Breb.*, H.V.H. Atl. Supp., f. 126*; Types Nos. 126 and 127), **plate 4, fig. 197.**

Valve subrhomboidal, with subacute apices.

Fresh water.—Cornimont, Bouillon (Del.).

N. exilis Grun. (in H.V.H. Atl., pl. 12, f. 11 and 12*; Type No. 128), **plate 4, fig. 198.**

Valve lanceolate, narrow, with apices rostrate-capitate. Striation, both in structure and direction, analogous to that of *N. serians*, to which it is allied by infinitesimal gradation (see H.V.H. Atl., pl. 12, f. 10); about 30 striæ in 1 c.d.m. Length, 2·3 to 3 c.d.m. Breadth, about 0·5 c.d.m.

Fresh water.—Ard. Liég. (De Wild.). Ireland.

N. follis Ehr. (Inf., 1838, p. 179; Mikr., pl. XVI. 1, f. 14; Donk. Br. D., p. 44, pl. 6, f. 15*; in Type No. 274), **plate 27, fig. 771.**

Valve small, cruciform, with costæ incurved and gently inflated, apices obtuse. Puncta forming unint rrupted lines in zig-zag in axial illumination, but reduced in oblique illumination to fine striæ, radiate, irregularly punctate, about 25 in 1 c.d.m. Raphe thick, central nodule elongate, surrounded by a rhomboidal hyaline space. Length, about 4 c.d.m. Breadth at central inflation, 2 c.d.m.

Fresh water.—Rare. Near Heigham, Norfolk (Kitton). Loch. Kinnord (Davidson). Loch Oich, fossil deposit (Donkin). Loch Canmor, Scotland (Coll. Weissfl. !) Frico, nr. Christiansund, Norway (Coll. W. Arnott !).

XVI. Formosæ.

Striæ everywhere marginal		. . . . .	**N. formosa.**
Striæ not marginal.	Zone feebly dilated round the central nodule.	Valve narrowly elliptic .	**N. Liburnica.**
		Valve oval, elliptic .	**N. latiuscula.**
	Zone very dilated round the central nodule.	Dilatation in form of rounded area .	**N. permagna.**
		Dilatation very considerable, subquadrangular . .	**N. amphisbæna.**

N. formosa Greg. (T.M.S., 1856, p. 42; H.V.H. Atl., pl. 11, f. 2*; in Type No. 105 = *Caloneis formosa var. Holmiensis Cl.*), **plate 5, fig. 199.**

Valve linear, elliptic, with apices somewhat attenuate obtuse. Raphe surrounded by a broad hyaline zone, elliptic lanceolate; terminal nodules robust, central nodule lateral. Marginal striæ robust, finely divided transversely, somewhat radiate, crossed by a narrow sulcus rather distant from the margins, about 10 in 1 c.d.m. Length, about 14 c.d.m. Breadth, about 3 c.d.m.

Marine and brackish water.—Scheldt at Antwerp. England, Scotland, Ireland, Denmark, Bahusie.

N. Liburnica Grun. (Wien. Verh., 1860, p. 547, pl. 1, f. 25; H.V.H. Atl., pl. 11, f. 3*; Type No. 133 = *Cal. formosa Cl.*), **plate 5, fig. 201.**

Differs from the preceding by its subacute apices, its smaller size, narrow hyaline zone, and its more approximate striæ (12 in 1 c.d.m.). Length, 9 to 10 c.d.m. Breadth, 2 c.d.m.

Marine.—Blankenberghe (H.V.H.). Ireland (O'M.). Yarmouth, England (Kitton).

N. latiuscula Kütz. (Bac., p. 93, pl. 5, f. 11: *N. patula W. Sm.!* S.B.D. i., p. 49, pl. 16, f. 182; H.V.H. Atl., Supp. pl., pl. B., f. 29*b**; Type 906), **plate 5, fig. 200.**

Valve broadly oblong or elliptic lanceolate with apices obtuse, rounded. Striæ finely punctate, 14 in 1 c.d.m., not reaching to the raphe, scarcely radiate; raphe surrounded by a hyaline area inflated at the central nodule, which is elongated, somewhat arcuate. Length, about 15 c.d.m. Breadth, about 3 c.d.m.

Fresh and brackish water.—Antwerp, Tête de Flandre (H.V.H.). Found throughout Europe.

N. permagna Bailey. (Smithson. Contrib., 1850, Bail. Micros. Observ. in Georgia, S. Carolina and Florida, p. 40, pl. 2, f. 28, 38; T.M.S., 1866, vi., n.s., p. 127, pl. 12, f. 18-21; H.V.H. Atl., pl. 11, f. 1*; Type No. 134), **plate 5, fig. 202.**

Valve broadly lanceolate, with subacute apices. Central nodule lateral, terminal nodules robust. Raphe surrounded by a broad hyaline zone dilated into a round area at the median portion. Striæ fine, about 12 in 1 c.d.m., radiate, finely divided transversely and interrupted near the margin of the valve by a rather broad depression, of which the margins have the appearance of double sulcus. Length, about 14 c.d.m. Breadth, 4 c.d.m.

Brackish water.—Rare, Antwerp (H.V.H.). The type form does not appear to have yet been found in any other part of Europe. The *forma parva* has been found at Schleswig, and a var. by Kitton at Breydon, Norfolk, England.

N. amphisbæna Bory. (Encyclop. Method., 1824; H.V.H. Atl., pl. 11, f. 7*; Type No. 130), **plate 5, fig. 203.**

Valve broadly elliptic, with apices strongly rostrate capitate. Central nodule lateral, terminal nodules robust. Raphe surrounded by a considerable hyaline zone, dilated in the middle of the valve into a broad space lanceolate-subquadrangular. Striæ radiate, about 14 in 1 c.d.m., finely divided transversely, interrupted by a rather broad submarginal sulcus. Length 6 to 7 c.d.m. Breadth, 2·25 c.d.m.

Fresh or somewhat brackish water.—Antwerp, &c. Throughout Europe.

var. subsalina. (H.V.H. Atl., pl. 11, f. 6*; Type No. 131), **plate 5, fig. 204.**

Apices gently acuminate, not rostrate capitate.

Brackish water.—Banks of the Scheldt at Antwerp. England.

forma major. (H.V.H. Atl., pl. 11, f. 4*), **plate 5, fig. 205.**

Much larger, valve lanceolate, infinitesimally attenuate as far as the apices, which are very gently acuminate. Length, 10 c.d.m. Breadth, about 3 c.d.m.

Brackish water.—Scheldt at Antwerp.

var. Fenzlii. (H.V.H. Atl., pl. 11, f. 5*), **plate 5, fig. 206.**

Valve broader, with apices scarcely acuminate.

XVII. Limosæ.

No pseudo stauros, valve with three well marked inflations		**N. limosa.**
A pseudo stauros	Valve with three inflations slightly marked	**N. ventricosa.**
	Valve linear, without inflations	**N. fontinalis.**

N. limosa Kütz. (Bac., p. 101; H.V.H. Atl., pl. 12, f. 18*; Type No. 135: *Caloneis Silicula* (*Ehr.*) *Cl.*); **plate 5, fig. 207.**

Valve narrow, linear, with three undulations, equal, feeble, with rounded apices. Raphe surrounded by a lanceolate hyaline zone, somewhat enlarged at the median portion. Central nodule somewhat lateral; terminal nodules robust. Striæ 16 or 17 in 1 c.d.m., somewhat convergent at the median portion, feebly radiate at the apices, crossed by a narrow sulcus approximate to the margins of the valve, the outlines of which it follows. Length, 7 to 8 c.d.m. Breadth, about 1·5 c.d.m.

Fresh water—Louvain (P.G.). Laviot (Del.), Antwerp (H.V.H.) Ard. Lieg. (De Wild.). Probably not rare, for it has been found throughout Europe.

var. gibberula. (*N. gibberula Kütz.*; H.V.H. Atl., pl. 12, f. 19*; *Caloneis Silicula* (*Ehr.*) *Cl. var. gibberula*); **plate 5, fig. 208.**

Smaller, valve with more marked inflations, apices cuneate. Length, 4·5 to 5 c.d.m.

Like the preceding, throughout Europe.

N. ventricosa (Ehr. ?) Donkin. (Br. D., p. 74, pl. 12, f. 7; H.V.H. Atl., pl. 12, f. 24*; *Cal. Silicula* (*Ehr.*) *Cl. var. ventricosa*), **plate 5, fig. 209.**

Differs from *N. limosa* by its inflations being scarcely noticeable, its finer striæ, 18 to 20 in 1 c.d.m., and by the stauroneiform hyaline area which surrounds the central nodule. Length, about 6 c.d.m. Breadth, 1·25 c.d.m.

Fresh water.—Antwerp, etc.—As in the preceding.

var. minuta. (H.V.H. Atl., pl. 12, f. 26*); **plate 5, fig. 210.**

Very small (2·5 c.d.m. in length), with more marked inflations; pseudo stauros broader, and apices somewhat cuneate, 21 striæ in 1 c.d.m.

Fresh water.—Louvain (P.G.). Ard. Lieg. (De Wild.).

N. fontinalis Grun. (H.V.H. Atl., pl. 12, f. 33*: *Caloneis fasciata (Lag.) Cleve*); **plate 5, fig. 211.**

Valve linear, with rounded apices. Raphe surrounded by a lanceolate hyaline zone, enlarged at the middle of the valve into a very broad pseudo-stauros. Striæ feebly radiate, 24 to 26 in 1 c.d.m., crossed by a sulcus almost marginal. Length, about 2·5 c.d.m. Breadth, 0·5 c.d.m.

Fresh water.—Brussels (Delogne).

XVIII. Affines.

Raphe with median apices curved like a crook, subparallel, with elongated puncta, interrupted near the margins by a deep sulcus . . . **N. Iridis.**

N. Iridis Ehr. (Kütz. Bac., p. 92, pl. 28, f. 42, *N. firma W. Sm.;* H.V.H. Atl., pl. 13, f. 1*), **plate 5, fig. 212.**

Valve linear elliptic, with rounded apices. Raphe with median apices curved like a crook, in opposite directions, surrounded by a hyaline zone dilated transversely round the central nodule, which is placed somewhat obliquely; terminal nodules robust. Striæ fine with elongated puncta, about 16 in 1 c.d.m, subparallel, somewhat oblique, interrupted near the margins by a deep sulcus, which terminates at the anterior part of the terminal nodules. Length, 10 to 17 c.d.m. Breadth, 2·25 to 3 c.d.m.

Fresh water.—Pleinevaux (Delogne), Ard. Liég. (De Wild.). England, Ireland, Germany, Finland (Cleve), etc.

var. amphigomphus Ehr. (H.V.H. Atl., pl. 13, f. 2*; in Type No. 67), **plate 5, fig. 213.**

Smaller, with cuneate apices.

Fresh water.—Ard. Liég. (De Wild.). England, Ireland.

var. firma Kütz. (in H.V.H.'s Type No. 67).

Differs from the preceding form in the apices, being rounded and not cuneate. All intermediate forms are found in the same gathering. The striæ (in Type No. 136) have often an oblique direction.

Fresh water.—This variety as well as the following are found here and there throughout Europe.

var. amphirhynchus Ehr. (H.V.H. Atl., pl. 13, f. 5*), **plate 5, fig. 214.**

Valve linear, narrow, with apices broadly and longly rostrate, rostrum slightly inflated at the apex.

Fresh water.

var. dubia Ehr. (H.V.H. Atl. Supp., f. 32*; in Type No. 79), **plate 5, fig. 215.**

Valve linear, short, rather broad, with apices broadly rostrate, rostrum not inflated. 20 striæ in 1 c.d.m. Length, 3·75 c.d.m. Breadth, about 1 c.d.m.

Fresh water.—La Hulpe (Del.).

var. undulata Grun. (H.V.H. Atl., pl. 13, f. 6*), **plate 5, fig. 216.**

Differs from the *amphirhynchus* in its margins being tri-undulate.

Fresh water.—Rather rare? Antwerp.

var. affinis. (H.V.H. Atl., pl. 13, f. 4*; Type No. 136), **plate 5, fig. 217.**

Valve linear, with apices more or less rostrate capitate.

Fresh water.

var. producta. (H.V.H. Atl., pl. 13, f. 3*), **plate 5, fig. 218.**

Valve elliptic, with apices strongly rostrate capitate.

Fresh water.

Many of these forms are often met with together. The Revd. P. A. Gautier has observed that in all these forms, after death, the endochrome divides into four parts; during life the commencement of a division can even be observed in the middle of the endochrome. *N. Iridis* and its various forms constitute the genus *Neidium* of Messrs. Pfitzer and Cleve.

XIX. Lineares.

Striæ extending over the whole valve .	Margins straight, apices rounded . . .	**N. Liber.**
	Margins excavated at the median portion . .	**var. bicuneata.**
Striæ interrupted by a pseudo-stauros .	Pseudo-stauros very broad ; 13-16 in 1 c.d.m ; sulcus conspicuous	**N. consimilis.**
	Pseudo-stauros narrow, 19-21 striæ in 1 c.d.m. ; sulcus less visible	**N. æmula.**

N. Liber W. Sm. (S.B.D., i., p. 48, pl. 16, f. 133; H.V.H. Atl., pl. 12, f. 36* ; Type No. 137), **plate 5, fig. 219.**

Valve linear narrow, with rounded apices. Raphe with a hyaline and but slightly marked zone. Central nodule surrounded by a small rounded hyaline area; terminal nodules somewhat distant from the apices, curved like a comma. Striæ fine, parallel, about 18 in 1 c.d.m., crossed by a longitudinal sulcus flexed towards the margin at the median portion. Length, about 8 c.d.m. Breadth, 1.5 c.d.m.

Marine.—Washings of mussels (Deby.) Blankenberghe, Scheldt (H.V.H.). England (W. Sm., Kitton, Comber, Norman). Ireland (O'Meara), and probably on all the North Sea Coasts.

var. linearis. (H.V.H. Atl., pl. 12, f. 35), **plate 5, fig. 220.**

Much smaller and narrower. Length, 5.5 c.d.m. Breadth, about 1 c.d.m.

var. bicuneata Grun. (*N. maxima Greg.*, Q.J.M.S., 1856, iii., p. 41, pl. 4, f. 19 ; T.M.S., 1856, iv., p. 39, pl, 5, f. 2*), **plate 35, fig. 910.**

Differs from the type form by its greater breadth, by its sides being somewhat excavated at the median portion, and its apices somewhat cuneate.

Valves large, broadly linear, oblong, with margins gently excavated at the median portion, apices cuneate, obtuse. Transverse striæ 13-14 in 1 c.d.m., reaching to the raphe, parallel, crossed by a sulcus at the middle of their length. Length, 10 c.d.m. Breadth, 2 to 2.5 c.d.m.

Marine.—Scotland (Gregory, Donkin), Ireland (O'Meara).

Mr. Grunow believes that this form ought to be considered as a variety of *N. Liber.*

N. consimilis Ad. Schm. (Nordsee Diat., p. 91, pl. 2, f. 46*), **plate 27, fig. 773.**

Has been found in the North Sea by Dr. A. Schmidt. It is distinguished from *N. Liber* by stronger striæ (13 to 16 in 1 c.d.m.), interrupted in the median portion of the valve by a very broad hyaline space stauroneiform, and again by more robust sulci.

N. æmula Ad. Schm. (Nordsee, p. 91, pl. 2, f. 47*; *N. subdivisa Grun.*, Arc. Diat., p. 29, pl. 1, f. 20), **plate 27, fig. 772.**

Is only differentiated from *N. consimilis* by its smaller size, by its striæ being more approximate (19 to 21 in 1 c.d.m.) and by the marginal sulcus being less apparent.

This form has been recorded from Normandy and the Baltic.

XX. Americanæ.

Striæ marginal throughout, and much shortened at the median portion of the valve	**N. Americana.**

N. Americana Ehr. (Mikr., pl. II. 2, f. 16; H.V.H Atl., pl. 12, f. 37*; Type No. 138), **plate 5, fig. 221.**

Valve linear oblong, with rounded apices, slightly constricted near the middle. Raphe robust, surrounded by a hyaline zone, occupying the moiety of the valve and further dilated round the central nodule, which is robust and marked by one or two pore-like puncta near its lower third. Marginal striæ feebly radiate, finely punctate, 16 in 1 c.d.m. Length, about 9·5 c.d.m. Breadth at the median constriction 2·5 c.d.m., at the broadest portion 2·75 c.d.m.

Fresh water.—Very rare. Antwerp (Belleroche !), Ireland (O M.), Loch Kinnord, Scotland (Davidson).

XXI. Bacilleæ.

Valve linear, without any considerable inflations.	Terminal nodules straight, not prolonged laterally . .	No pseudo-stauros, terminal nodules surrounded by a considerable hyaline area	**N. Bacillum.**
		A pseudo-stauros, terminal nodules without any considerable hyaline area	**N. bacilliformis.**
	Terminal nodules straight, comma-like . . .		**N. subhamulata.**
	Terminal nodules curved laterally like a crook . .	Valve broadly linear, central nodule surrounded by a considerable hyaline area	**N. pseudo-bacillum.**
		Valve narrowly linear, often very feebly inflated at the median portion; no considerable hyaline area	**N. lævissima.**
Valve inflated in the middle and at the apices.	Striæ almost submarginal, no false stauros, terminal nodules curved like a crook unilaterally . .		**N. Hebes.**
	Striæ extending up to the raphe—a false stauros—terminal nodules curved like a crook bilaterally . .		**N. Pupula.**

N. Bacillum Ehr. (Mikr., pl. 15, A., f. 38; H.V.H. Atl., pl. 13, f. 8*; in Type No. 548), **plate 5, fig. 222.**

Valve linear, with apices rounded, thickened, smooth. Raphe surrounded by a very narrow hyaline area, slightly enlarged round the central nodule and at the apices of the valve. Striæ slightly radiate, finely granular, 14 in 1 c.d.m. at the median portion of the valve, and about 17 at the apices. Length, 5·5 c.d.m. Breadth, 1·5 c.d.m.

Fresh water.—Here and there throughout Europe.

forma minor. (H.V.H. Atl., pl. 13, f. 10*), **plate 5, fig. 223.**

Smaller and narrower, dimensions amounting to not more than about a moiety of the preceding. Striæ finer, 16 in 1 c.d.m. at the middle, 20 at the apices of the valve.

Fresh water.—Brussels Botanical Gardens (Delogne).

N. bacilliformis Grun. (in Cl. and Gr. Arct. D., 1880, p. 44, pl. 2, f. 51; H.V.H. Atl., pl. 13, f. 11*), **plate 27, fig. 774.**

Valve linear, with apices rounded. Raphe surrounded by a hyaline zone, very narrow, enlarged into a stauros round the central nodule. Striæ feebly radiate, convergent towards the apex of the valve, 10 to 15 in 1 c.d.m. Length, 3·5 to 4·5 c.d.m. Breadth, about 1 c.d.m.

Fresh water?—Ard. Liég. (De Wild.). Hickling, Norfolk, England (Kitton); Dover, England (Grun.).

N. subhamulata Grun.! (H.V.H. Atl., pl. 13, f. 14*) **plate 5, fig. 225.**

Valve linear, somewhat inflated at the median portion, with rounded apices. Raphe surrounded by a very slight hyaline zone, somewhat dilated round the central nodule. Terminal nodules comma-shaped. Striæ somewhat radiate, very feeble, about 26 in 1 c.d.m. Girdle face with undulated margins. Length, 2 c.d.m. Breadth, somewhat more than ·5 c.d.m.

Fresh water.—Brussels (Delogne).

N. pseudo-Bacillum Grun.! (H.V.H. Atl., pl. 13, f. 9*), **plate 5, fig. 224.**

Differs from *N. Bacillum* by its larger hyaline area, its terminal nodules prolonged laterally like a comma on each side and its finer striæ, 21 in 1 c.d.m. in the middle, and 24 at the apices of the valve. Length, 4·5 c.d.m. Breadth, about 1·5 c.d.m.

Fresh water.—Louvain (P.G.). Ard. Liég. (De Wild.).

N. levissima (Kütz. ?) Grun. (H.V.H. Atl., pl. 13, f. 13*), **plate 27, fig. 775.**

Valve linear, with rounded apices, at the median portion often somewhat inflated, striæ slightly radiate-convergent, not reaching to the raphe, 13 in 1 c.d.m. at the median portion of the valve, 20 in 1 c.d.m. near the apices. Length, about 3 c.d.m. Breadth, ·75 c.d.m.

Fresh and brackish water.—Ard. Liég. (De Wild.) England, France.

N. Hebes Ralfs. (in Pritch. Inf., p. 896; *N. obtusa W. Sm.*, S.B.D., i., p. 50, pl. 16, f. 140*; H.V.H. Type No. 75), **plate 27, fig. 776.**

Valve oblong elliptic, contracted towards the apices which are inflated, rounded, sometimes subtruncate. Striæ 12 to 14·5 in 1 c.d.m., submarginal, punctate, leaving round the raphe a considerable hyaline area, which is further dilated round the central and terminal nodules. Length, about 6 c.d.m. Breadth, 2 c.d.m.

Fresh water.—Ireland (W. Sm.; O'M.). Scotland (Donkin; W. Sm.).

N. Pupula Kütz. ! (Bac., p. 93, pl. 30, f. 40; H.V.H. Atl., pl. 13, f. 15-16*), **plate 5, fig. 226.**

Valve linear, inflated at the median portion and at the apices, which are rounded. Raphe surrounded by a narrow hyaline zone, abruptly enlarged into a pseudo-stauros round the central nodule. Terminal nodules prolonged laterally. Striæ radiate, fine, 21 to 24 in 1 c.d.m. Length, 1·6 to 3·6 c.d.m. Breadth, ·5 to 1·0 c.d.m.

Fresh water.—Louvain (P.G.), Antwerp. France.

XXII. Minutissimæ.

I. Frustules not united into bands.

- Valve with coarse striæ simulating costæ . . . . N. **incerta.**
- Striæ delicate.
  - Valves having a pseudo-stauros.
    - Valve somewhat inflated at the median portion . . **N. Seminulum.**
    - Valve not inflated.
      - Valve linear-elliptic . . . **N. minima.**
      - Valve elliptic . . . . **N. atomoides.**
  - Valve without a pseudo-stauros.
    - Valve lanceolate.
      - Valve lanceolate, narrow, striæ radiate, very distinct . . . . . **N. Falaisensis.**
      - Valve lanceolate, rather broad, striæ scarcely radiant, the median more apparent.
        - Marine: 24—30 striæ in 1 c.d.m. . . . **N. Bahusiensis.**
        - Fresh water: 36 striæ in 1 c.d.m. . . . **N. minuscula.**
      - Valve rather broad, striæ radiate, alternately long and short at the median portion of the valve, apices obtuse . . . . **N. cocconeiformis.**
      - Valve very narrow, striæ parallel, apices not subrostrate . . . . **N. Bulnheimii.**
    - Valve not lanceolate.
      - Valve deeply constricted at the median portion . **N. binodis.**
      - Valve not constricted.
        - Valve inflated at the median portion . **N. perpusilla.**
        - Valve not inflated.
          - Valve linear elongate . **N. lepidula.**
          - Valve elliptic, sublanceolate . . **N. exilissima.**
          - Valve elliptic, suborbiculate . . **N. Atomus.**

II. Frustules united in bands.

- Valve with median and terminal portions inflated . . . . **N. contenta.**
- Valve not so.
  - Valve linear-elliptic, with margin furnished with coarse, distant beads . **N. Gallica.**
  - Valve linear, inflated in the middle, without coarse beads at the margin **N. Flotowii.**

I. Frustules not united in long bands.

a. Valve furnished with costæ.

N. incerta Grun. ! (H.V.H. Atl., pl. 14, f. 43*), **plate 5, fig. 227.**

Valve linear lanceolate, with apices somewhat produced; striæ in form of robust costæ, reaching almost to the raphe, somewhat distant, about 15 in 1 c.d.m. Length, 1·5 c.d.m. Breadth, ·6 c.d.m.

Marine.—Blankenberghe.

a a. **Valve without costæ.**

b. VALVE FURNISHED WITH A PSEUDO-STAUROS

N. Seminulum Grun. ! (H.V.H. Atl., pl. 14, f. 9*; Type No. 143), **plate 5, fig. 228.**

Valve almost linear, with median portion inflated, apices obtuse rounded; striæ radiate, rather robust, punctate, 20 in 1 c.d.m., reaching almost to the raphe, much shortened near the central nodule, where their limited length produces a stauroneiform blank space. Length, about 1.5 c.d.m. Breadth ·4 c.d.m.

Fresh water.—Brussels (Delogne).

N. minima Grun. ! (H.V.H. Atl., pl. 14, f. 15*; Type No. 142), **plate 5, fig. 229.**

Valve linear, with rounded apices; striæ radiate, 26 in 1 c.d.m, reaching to the raphe, the median ones much shortened, and considerably more distant. Length, 1·5 c.d.m. Breadth, ·45 c.d.m.

Fresh water.—Brussels, in a water bottle (Del.).

N. atomoides Grun. ! (H.V.H. Atl., pl. 14, fig. 11*; in Type No. 219), **plate 5, fig. 230.**

Valve elliptic; striæ fine, feebly radiate, 27 to 30 in 1 c.d.m., reaching almost to the raphe, but shortened near the central nodule, where they form a pseudo-stauros of greater or less length. Frustules often united into a band of 3 or 4. Length, about ·8 c.d.m. Breadth, about ·4 c.d.m.

Fresh water.—Antwerp, in an aquarium, where the species has been maintained for several years.

Prof. Cleve makes this form a simple variety of *N. minima.*

b b. VALVE WITHOUT PSEUDO-STAUROS.

N. Atomus Nægeli. (H.V.H. Atl., pl. 14, f. 24*; Type No. 149), **plate 5, fig. 231.**

Valve elliptic, feebly silicious; raphe robust; striæ fine, strongly radiate, about 30 in 1 c.d.m. Length, ·4 to ·8 c.d.m. Breadth, ·25 to ·4 c.d.m.

Humid positions.—Brussels (Delogne), Antwerp.

N. Falaisensis Grun.! (H.V.H. Atl., pl. 14, f. 5*; in Type Nos. 127 and 348), **plate 5, fig. 232.**

Valve narrowly lanceolate, apices subrostrate; striæ rather robust, about 20 in 1 c.d.m., not quite reaching to the raphe, and leaving around the central nodule a small rounded hyaline area. Length, about 2·5 c.d.m.

Fresh water.—Bouillon (Del.).

N. minuscula Grun. (in H.V.H. Syn., pl. 14, f. 3*), **plate 27, fig. 777.**

Valve lanceolate, with subrostrate apices; striæ reaching to the raphe, scarcely radiant, about 36 in 1 c.d.m., the median ones somewhat distant, and consequently more distinct. Length, about 1·25 to 1·75 c.d.m. Breadth, about 0·5 c.d.m.

Fresh water.—Ditch at Kiel, near Antwerp (H.V.H.).

N. Bahusiensis Grun. (in H.V.H. Syn., pl. 14, f. 2*), **plate 27, fig. 778.**

Differs from the preceding by its larger size (1·5 to 2·0 c.d.m. in length), its more vigorous striation (24 to 30 striæ in 1 c.d.m.), and its habitat (salt water).

Sweden.—(Lysekl, Grun.).

N. cocconeiformis Greg. (Q.J.M.S., 1856, iv., p. 6, pl. 1, f. 22; H.V.H. Atl., pl. 14, f. 1*; Type No. 140), **plate 27, fig. 779.**

Valve small, lanceolate, inflated at the median portion with obtuse apices. Raphe bordered by a narrow hyaline area, somewhat dilated round the central nodule. Striæ very finely radiate, convergent, 28 to 30 in 1 c.d.m. at the apices of the valve, 18 in 1 c.d.m. round the central nodule; the latter alternately long and short. Length, about 3·5 c.d.m. Breadth, 1·25 c.d.m. at the median inflation.

Fresh water.—Scotland, Ireland, etc.

N. Bulnheimii Grun.! (H.V.H. Atl., pl. 14, f. 6*a**), **plate 5, fig. 233.**

Valve very narrowly lanceolate, with subacute apices; striæ feeble, parallel, about 30 in 1 c.d.m. The two median striæ more vigorous than the others. Length about 2 c.d.m.

Marine? Not yet found in Belgium.

var. Belgica Grun.! (in Type No. 113).

Valves somewhat more obtuse, with girdle face broader and connecting zone finely striated lengthwise.

Marine.—Ostend.

N. exilissima Grun. ! (H.V.H. Atl., pl. 14, f. 30*; in Type No. 141), **plate 5, fig. 234.**

Valve linear-subelliptic; striæ fine, radiate, about 40 1 c.d.m., the median ones somewhat more distant, details indistinct even with homogeneous objectives, and in Prof. H. L. Smith's yellow medium. Length, from ·5 to 1·0 c.d.m.

Fresh water.—Groenendael (Delogne); Ard. Liég. (De Wild.).

N. binodis (Ehr., 1840) W. Sm. (S.B.D., i., p. 53, pl. 17, f. 159; H.V.H. Atl. Supp., f. 33*; in Type No. 71), **plate 5, fig. 235.**

Valve oblong, strongly constricted at the median portion, apices rostrate capitate; striæ reaching almost to the raphe, feebly radiate, very delicate, about 30 in 1 c.d.m. Length, about 2·5 c.d.m. Breadth at the constriction, ·5 c.d.m.

Fresh water.—Manage (P.G.), Rouge-Cloître (Del.), Antwerp. Great Britain.

N. lepidula Grun. ! (H.V.H. Atl., pl. 14, f. 42*; *Caloneis lepidula Cl.*), **plate 5, fig. 236.**

Valve narrowly linear, apices rounded. Central nodule surrounded by a considerable hyaline area. Striæ reaching almost to the raphe, parallel, fine, 27 to 30 in 1 c.d.m. Length, about 2 c.d.m. Breadth, ·6 c.d.m.

Fresh water.—Groenendael (Delogne).

N. perpusilla Grun. (Ueber neue, etc., 1860, p. 552, pl. 2, f. 7; H.V.H. Atl., pl. 14, f. 22, 23*), **plate 35, fig. 911.**

Valve minute, oblong, with rounded apices, inflated at the median portion. Transverse striæ very delicate, subparallel, indistinct. Length, 1·25 c.d.m. Breadth, ·5 c.d.m.

Fresh water.—Rouge Cloître (Delogne), Scotland. Ireland (O'Meara).

II. Frustules united in long bands (Diadesmis).

* **Valve with border furnished with coarse distant beads.**

N. Gallica (W. Sm.) H. Van Heurck. (H.V.H. Atl., pl. 14, f. 39*; Type No. 47), **plate 5, fig. 237.**

Valve linear-elliptic or linear, with median portion somewhat inflated, apices obtuse rounded, presenting throughout the length of the margin an appearance of coarse beads. Raphe surrounded by a slight hyaline zone, somewhat dilated near the central nodule. Striæ gently radiate, very fine, distant, about 28 in 1 c.d.m. Frustules with girdle face quadrangular, united into long filaments. Length, ·8 to 1·5 c.d.m. Breadth, about ·3 c.d.m.

Fresh water.—Brussels (Delogne). England, France.

** Valve with margin not furnished with coarse beads.

N. Flotowii Grun. ! (H.V.H. Atl., pl. 14, f. 41*; Type No. 48), **plate 5, fig. 238.**

Valve linear, with apices rounded, median portion inflated. Raphe surrounded by a considerable hyaline zone, and much dilated at the median portion. Striæ radiate, fine, 35 in 1 c.d.m. Length, 1·5 c.d.m.

Fresh water.—Frahan (Del.).

N. contenta Grun. ! (H.V.H. Atl., pl. 14, f. 31*, sub. n. *N. trinodis*; Type No. 146), **plate 5, fig. 239.**

Valve linear, inflated at the median portion and at the apices. Raphe surrounded by a considerable hyaline zone, only just a little dilated near the central nodule. Striæ very delicate, almost parallel, about 36 in 1 c.d.m. Length ·7 to 1 c.d.m. Breadth, ·2 to ·025 c.d.m.

Humid positions.—In a slate quarry at Rochehaut (Del.)

var. biceps. (H.V.H. Atl., pl. 14, f. 31*b**), **plate 5, fig. 240.**

Differs from the type form by the central inflation, which is very slight or absent.

Groenendael (Delogne).

Observ.—The group "*Minutissimæ*" is not a natural group. The species included in it ought to be incorporated in the other groups previously mentioned. If all these forms, which have nothing in common but their small size, are allowed to remain grouped, it is only to facilitate comparison and consequently the determination of the different species.

B. Naviculæ not free. Frustules naviculoid, inclosed in tubes or gelatinous-mucous fronds.

Sub-genus II.—Schizonema.

Frustules naviculoid, generally feebly silicious, enclosed in mucous tubes which simulate the higher algæ. Habitat: marine.

I agree with Mr. Grunow that it is preferable to preserve distinct the *Naviculæ* belonging to the old genus *Schizonema* on account of the character impressed on the species by the abundant formation of coleoderm. I do not attach any importance to the form of the fronds, and in my classification of species I follow the same order as that employed for other *Navicula*. All the *Schizonema* can, in my opinion, be reduced to a very small number of type forms, and I only describe those, of whose existence as species there can be no doubt.

ANALYSIS OF SPECIES.

Costæ resolvable.	Valve quite small, being only 1 c.d.m. in length		**S. corymbosum.**
	Valve of several c.d.m. in length.	Valve large, central nodule surrounded by a considerable hyaline area .	**S. Smithii.**
		Valve small, central nodule without any hyaline area . . .	**S. molle.**
No costæ, valve striated.	Valves furnished with an obvious pseudo-stauros .		**S. crucigerum.**
	No pseudo-stauros.	Valve with strong puncta, not forming longitudinal lines . . .	**S. Grevillei.**
		Striæ fine, with divisions forming longitudinal lines . . .	**S. ramosissimum.**

I. Radiosæ.

N. (S.) Smithii C. Agardh. (H.V.H. Atl., pl. 15, f. 33; Type No. 154), **plate 5, fig. 241.**

Valve lanceolate, with apices somewhat produced rostrate. Raphe surrounded by a very narrow hyaline zone dilated round the central nodule into a rounded area. Striæ finely divided transversely, of unequal length round the central nodule; the median ones radiate, the terminal convergent, about 13 in 1 c.d.m. Length, about 6 c.d.m. Breadth, 1·3 c.d.m.

Marine.—Mouth of the Scheldt (V. de Bosch). England, Scotland, Ireland, etc.

N. (S.) molle W. Sm.! (S.B.D., i., p. 77, pl. 58, f. 365; H.V.H. Atl., pl. 15, f. 24*), **plate 27, fig. 780.**

Valve lanceolate, with subacute apices. Striæ, about 14 in 1 c.d.m., slightly radiant, reaching to the raphe. Length, 3 to 4 c.d.m.

Marine.—North Sea. England (Exmouth; Coll. W. Sm.).

N. (S.) corymbosum Ag. (Syst., p. 11; H.V.H. Atl., pl. 15, f. 21*), **plate 27, fig. 780** ***bis*****.**

Valve excessively small, elliptic lanceolate, with apices obtuse rounded. Striæ radiant, almost straight, reaching to the raphe, 20 or 21 in 1 c.d.m. Length, 1 c.d.m. Breadth, about 0·25 c.d.m.

Marine.—Coasts of Northern Europe.

II. Stauroneideæ.

N. (S.) crucigerum W.Sm. ! (S.B.D., ii., p. 74, pl. 56, f. 354, and pl. 57, f. 356; H.V.H. Atl., pl. 16, f. 1*; Type No. 151), **plate 5, fig. 242.**

Valve lanceolate acute; central nodule prolonged up to the margins of the valve into a stauros, which is covered with two striæ more robust than the others. Striæ reaching almost to the raphe, 24 in 1 c.d.m., almost parallel, finely divided transversely, with divisions simulating delicate longitudinal striæ. Length, about 7 to 8 c.d.m. Breadth, about 1 c.d.m.

Marine.—Scheldt at Antwerp. Blankenberghe. England, Scotland, Ireland.

The photograph has not reproduced the stauros as it is found in the original figure. In the figure in my Synopsis the valve appears without a stauros.

III. Perstriatæ.

N. (S.) Grevillei Agardh. (Consp., p. 19; H.V.H. Atl., pl. 16, f. 2*; Type No. 152), **plate 5, fig. 243.**

Valves rather broadly lanceolate, with obtuse apices; striæ reaching almost to the raphe, strongly punctate transversely, the 3 or 4 median ones straight, very distant, the others approximate, about 20 in 1 c.d.m., gently radiate up to the apex of the valve. Girdle face quadrangular, with rounded apices, compressed at the median portion; connective membrane with numerous longitudinal striæ. Length, 3 to 7 c.d.m. Breadth, about 1·5 c d.m.

Marine.—Ostend (Westendorp, n. 896 and 897), Blankenberghe. England, France, Denmark, Heligoland.

Later researches, after the publication of the Atlas to my Synopsis, has proved that the *Navicula Delognei* (pl. 11, f. 13) ought to be considered as a form of *S. Grevillei.*

N. (S.) ramosissimum C. Agardh. (Consp., p. 22; H.V.H. Atl., pl. 15, f. 4*; Type No. 153), **plate 5, fig. 244.**

Valves lanceolate, with apices very slightly produced, subobtuse; striæ about 14 in 1 c.d.m., reaching almost to the raphe, gently radiate, finely divided transversely, with divisions simulating longitudinal striæ. Length, about 5 c.d.m.

Marine.—Blankenberghe. England, France, Bahusie.

var. setaceum Kütz. (*S. setaceum Kütz.*), H.V.H. Atl., pl. 15, f. 13*), **plate 5, fig. 245.**

Differs from the preceding by shorter valves, and striæ more strongly radiate. Length, about 2·5 c.d.m.

Marine.—Blankenberghe. France, Bahusie.

Sub-genus III.—Dickieia.

Navicula enclosed in foliaceous fronds. Marine habitat.

N. ulvacea (Berk.) H.V.H. (*Dickieia ulvacea Berkeley* in Kütz. Bac., p. 119; Sp. Alg., p. 109; H.V.H. Atl., pl. 16, f. 10*), **plate 27, fig. 781.**

Valves elliptic, with apices obtuse rounded. Raphe surrounded by a very narrow hyaline area, dilated into a false stauros at the median portion; striæ 16 in 1 c.d.m., radiate, robust, finely divided transversely. Length, 8·5 to 12·5 c.d.m. Breadth, 2·5 to 3·5 c.d.m. Frustules scattered in gelatinous leaf-like fronds.

Marine.—Aberdeen, Scotland (Dickie !), Ireland (O'M.).

N.B.—The *Dickieia pinnata Ralfs* and *D. Dansei Thw.* are not entered here, the first is a *Schizonema* and the second a *Mastogloia*.

The genus *Navicula* is very vast, and includes at least 1,000 forms. It is therefore conceived that authors, especially those who have had to describe the forms of the whole world, have endeavoured to simplify these difficulties by arranging forms into a certain number of groups which they have elevated into the rank of genera. Some of these genera have been admitted into the present work, but it is still necessary to make a few remarks about others, and to indicate their characters. They will be found here in alphabetical order.

Alloioneis Schumann. (1867). Naviculæ rhomboidal in transverse section. Valves showing long striæ on one side of the raphe and shortened striæ on the other. About half a dozen exotic forms belong to this section.

Anomæoneis Pfitzer. (1871, Ueber Bau., etc.). This group corresponds with my group of *Sculptæ*.

Caloneis Cleve. (1891, in Le Diatomiste, i., p. 66). Valve with striæ not punctate or indistinctly punctate, and crossed by lines or longitudinal bands. Prof. Cleve includes in this group all the species belonging to my divisions: *Abbreviatæ*, *Formosæ*, *Limosæ*, and *Lineares*.

Craticula Grun. (1868, Novara, p. 20). This genus was based on certain anomalous valves showing transverse thickenings in the interior, such as *Navicula ambigua forma craticula*. Mr. Grunow himself has now abandoned this genus.

Diadesmis Kütz. (1844). This genus comprises certain Naviculæ found united in long bands, such as *N. gallica*, *Flutowii*, and *contenta*.

Diploneis Ehr. (1840), created for Naviculæ with the valve constricted in the median portion: *N. didyma*, *Bombus*, *bomboides*, etc.

This genus has been revised by Prof. Cleve, who, however, bases it on the peculiar form of nodule which is laterally prolonged into robust silicious horns surrounding the raphe. My group of *Didymæ* are included in the genus *Diploneis*, with the exception of *N. Musca*.

Falcatella Rabh. (1853, Suss.-Diat.) an unaccepted genus and a medley of forms with arcuate valves belonging to different genera: *Navicula*, *Synedra*, *Nitzschia*.

Libellus Cleve. (1873, D. of Arctic Sea). Naviculæ whose connective membrane is plicate so as to imitate an accumulation of pages in a book. The *N.* (*Schizonema*) *Grevilleï* and *N. Bulnheimii* form part of this genus as well as five other British species as follows:—

ANALYSIS OF SPECIES.

- Valve furnished with a pseudo-stauros . . . . **N. simulans.**
- Valve without a pseudo-stauros.
  - Valve narrowly linear . . . . . . **N. plicata.**
  - Valve not narrowly linear.
    - Valve very narrowly acute-lanceolate; very small form . . . . . . **N. Bulnheimii.**
    - Valve rather large.
      - Median striæ more distant than the others . . . **N. (S.) Grevillei.**
      - Striæ not thus and valve only seen with difficulty in consequence of the length of the sutural zone.
        - Frustules simulating an Amphora; sutural zone with very numerous continuous pleats . **N. complanata.**
        - Sutural zone very broad, with very numerous pleats, apparently interrupted in the middle . **N. Hyalosira.**
      - Valve very convex, distinct; median striæ not more distant; zone with numerous pleats . . **N. rhombica.**

N rhombica Greg. (Q J.M.S., 1855, iii., p. 40, pl. 4, f. 16 ; Donk. Brit. Diat., pl. 9, f. 1*), **plate 27, fig. 783.**

Valve rhombic, lanceolate, strongly convex, with apices acuminate, sub-acute. Transverse striæ finely punctate, the median ones somewhat radiate, the others sub-parallel, 16 to 16·5 c.d.m. Length, about 7 c.d.m. Breadth, about 1·5 c.d.m.

Prof. Cleve considers that this form does not essentially differ from *N.* (*Schiz.*) *Grevillei.*

Marine.—England, Scotland, Ireland, Denmark.

N. simulans Donk. (Brit. Diat., p. 60, pl. 9, f. 3*), **plate 27, fig. 784.**

Valve linear, with parallel margins, apices cuneate. Striæ very fine, leaving a stauroneiform blank space. Girdle face with apices truncate, rounded angles, somewhat constricted at the median portion. Length, 6 to 7·5 c.d.m. Breadth, 1·5 c.d.m.

Marine.—Newbiggin, Northumberland (Donkin).

We give the above description according to Donkin, but we have not seen any authentic specimens. Donkin and other authors connect with this form *Amphiprora constricta W. Sm.* This is an error : the forms from Prof. Smith's herbarium are not those of a Navicula.

N. plicata Donk. (Brit. Diat., p. 59, pl. 9, f. 2*), **plate 28, fig. 787.**

Valve narrow, linear, with subcuneate apices. Striæ fine, 20 in 1 c.d.m., not reaching quite to the raphe. Girdle face broad, linear, with apices truncate, angles rounded, constricted at the median portion with the connecting zone showing numerous pleats. Length, 8 or 9 c.d.m. Breadth of the valve, 1·5 c.d.m., and of the girdle face, 3 c.d.m.

Marine sands.—Warkworth, Northumberland (Donkin).

N. complanata Grun. (*Amphora complanata Grun.* ; Hedwigia, vi., p. 25 ; Ad. Schm. Atl., pl. 26, f. 45*), **plate 27, fig. 785.**

Valve linear lanceolate, acute ; striæ 18 or 19 in 1 c.d.m. Length, 3·5 c.d.m. Breadth, 0·5 c.d.m. Girdle face rectangular, showing very numerous pleats ; breadth, 3·5 c.d.m.

Marine.—Finmark, Sweden (H.L. Sm., Type No. 612 !).

N. Hyalosira Cleve. (in Le Diat., i., p. 77, pl. 12, f. 11*), **plate 27, fig. 786.**

Valve convex, thin, lanceolate, rostrate or with rounded apices; striæ punctate, 29 in 1 c.d.m. Frustule quadrangular, connecting zone with numerous pleats. Length, about 2 c.d.m. Frustule feebly silicious.

Marine.—Mouth of the Tay, Scotland (Cleve and Möller, No. 309 !) Cresswell, Northumberland, England (Deby.).

Neidium Pfitzer. (1871. Ueber Bau und Entw. d. Bac., p. 39).

This very natural group corresponds to my *Affines*; it is based on the form of the endochrome, on the apices of the raphe near the central nodule being turned in opposite directions, on the striation of the valve being often oblique, and on this striation being frequently interrupted by one or more longitudinal sulci.

Pinnularia Ehr. (1840). Valve furnished with costæ and not striæ. This genus corresponds to my group *Pinnulariæ*. Former authors also included in it the *Radiosæ*, whose striæ could not then be resolved into beads.

Rhaphidodiscus Th. Christian (1887, in the Journal "The Microscope," p. 67).

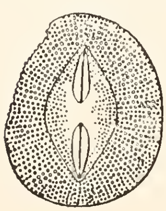


Fig. 33.
Disciform *Navicula*.

This genus is, according to Mr. Deby, based on the accidental position of a *Navicula* in a valve of *Melosira*. It is also perhaps founded on a disciform *Navicula*, such as that represented in Fig. 33 at the side. This figure, which corresponds very well with that of Mr. Christian, is drawn from one of my photographs, and reproduces a valve found by Mr. Weissflog in material from Naparima in the island of La Trinité, Antilles.

Lately, Prof. Brun, having been good enough to lend me the photographs and preparations which he received from Mr. Christian, I have been able to assure myself that the Naparima diatom in no way differs from that of Mr. Christian's specimen, which is a genuine Navicula. Mr. Deby's explanation is the only one that satisfactorily explains the figure published by Mr. Christian. We have reproduced this as figure 913 on plate 35.

Schizostauron Grun. (1867, in Hedwigea, p. 28).

A genus containing eight species, all from the South of Europe, or Extra-European. Round the central nodule is a blank space, stauroneiform (or a true stauros?), bifurcated into a St. Andrew's cross.

Stauroptera Ehr. (1843).

Group including all forms possessing a pseudo-stauros.

Stictodesmis Grev. (1863), South Pac. Diat., p. 30.).

Based on the craticular state of the valve, analogous to *Craticula*. Fig. 34 represents *Stictodesmis Australis Grev.*, the most common form of this genus.

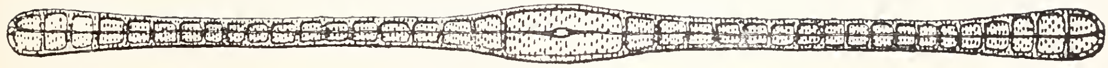


Fig. 34.—*Stictodesmis Australis Grev.*

The Navicula which has given occasion for the creation of *St. Australis* appears to be the *N. Johnsonii* or an allied form.

Trachyneis Cleve (in litteris, 1893), a genus which corresponds with our *Asperæ*, and comprises *N. aspera* and *Clepsydra.*

? ? Cyclophora Castr, 1878.

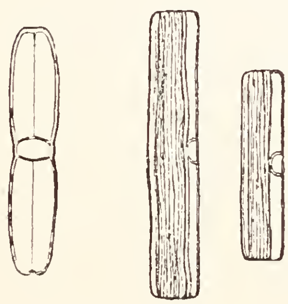


Fig. 35.—*Cyclophora n. sp.*

Frustules with girdle face plicate, showing in girdle view a semi-annulus on the visible part of one valve. Frustules in chains.

C. tenuis Castr. (Atti. Acc. pont. N. Linc., XXXI., and Diat. Chall., 1886, p. 58).

Valve linear, very narrow, somewhat attenuate near the apices, which are obtuse rounded, bearing a large annulus at the median portion. Raphe delicate, terminated by round nodules somewhat distant from the apices, central nodule indistinctly surrounded by an elliptic annulus. Striæ rectangular, very delicate, the transverse ones about 40 in 1 c.d.m. reaching to the raphe. Girdle face rectangular. Sutural zone with numerous fine pleats, bearing a semi-annulus on the margin of the valve. Length, 4 to 7 c.d.m.

Marine.—Ancona, Naples (Castr.!). Philippine Islands.

The above figure represents the valve of a *Cyclophora* in a preparation by Mr. Weissflog, from the Labuan Islands (Vega Expedition), which differs considerably from *C. tenuis* by its length, median constriction and terminal nodules, which are nearer the apices and by the absence of any central nodule. Subsequent researches ought to show if this is really a new form, which is probably the case. The entire characters of *Cyclophora* prove this form to belong to the Navicular tribe. Count Castracane has of late years withdrawn the name of *Cyclophora,* and given to the above *C. tenuis* that of *Diatoma hyalina forma Cyclophora.* The pleats of the connecting zone and the presence of a true raphe does not allow me to adopt Count Castracane's latest opinion. I do not, however, believe that in the *C. tenuis* we are dealing with a true genus, but only with a craticular state of a Naviculoid form; however, the species of Mr. Weissflog may belong to another genus.

GENUS 8.—RHOICONEIS GRUN., 1863.

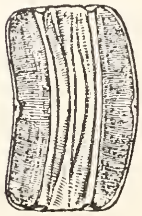


Fig. 36.
Rhoiconeis Garckeana Grun.

Valves flexed, each furnished with a coarse central nodule. Frustules flexed with connecting zone very developed, showing striæ arranged in longitudinal rows.

This interesting genus resembles on first view an *Achnanthes*, but it differs from it in that each of the two valves is furnished with a nodule. It includes a dozen species, none of which live on our shores. The figure above represents *Rh. Garckeana Grun.*, photographed from an original specimen of Mr. Grunow.

GENUS 9.—CYMATONEIS CLEVE, 1894.

(IN SYNOPSIS OF THE NAVICULOID DIATOMS*).

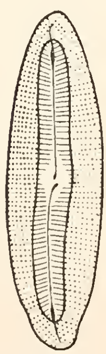


Fig. 37.
Cymatoneis circumvallata.

Valve divided by longitudinal ridges into two or more divisions. Terminal nodules distant from the apices of the valve. Puncta arranged in longitudinal and transverse rows.

This beautiful genus is founded on three forms, which are recognized at first sight, but are all unknown to our shores. *C. sulcata* (Grev.) (*Nav. triundulata Grun.*), lives in the Mediterranean and Tropical Seas. *C. quadrisulcata* (*Grun.*) (*Nav. quadrisulcata Grun.*) has been found in St. Paul's Island, and *C. circumvallata Cleve* is found in the Balearic Islands, Ceylon, Japan, and Labuan.

GENUS 10.—COLLETONEMA (BREB., 1849) H. VAN HEURCK.

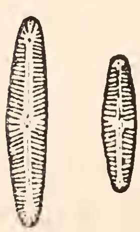


Fig. 38.—*Colletonema lacustre.*

Valve, with structure slightly eccentric; terminal nodules considerably distant from the apices of the valves from which they are separated by very radiate striæ. Frustules enclosed in tubes. Genus forming the connecting link between *Encyonema* and *Navicula*.

Only one species.

C. lacustre (C. Agardh.) H. Van Heurck. (*Schizonema lacustre C. Agardh ! Colletonema subcohærens Thwaites.*—H.V.H. Atl., pl. 15, f. 40* ; Type No. 155), **plate 5, fig. 246.**

Valves lanceolate, gently attenuate, with apices obtuse, sometimes very slightly rostrate, one of the sides of the valve often narrower than the other. Striæ robust, finely divided transversely, veiy radiate at the median portion of the valve, then convergent and becoming again very radiate at the apices, 9 in 1 c.d.m.; more distant and shorter or absent round the central nodule. Length, 3 to 6 c.d.m.

Fresh water.—England (W. Sm.), Sweden. Not yet found in Belgium.

GENUS 11. — VANHEURCKIA BREB., 1868, Char. Emend.

Frustules naviculoid, free, or very rarely enclosed in single file in a membranous tube. Valves with striæ fine, parallel, rarely slightly radiate at the median portion of the valve. Central and terminal nodules linear-elongated between the two branches of a double raphe.

Fig. 39. *Vanheurckia vulgaris.*

Prof. Cleve has re-established the genus *Frustulia* of Agardh to receive Vanheurckia. This proposal appears untenable. Agardh defined his Frustulia (Syst. Alg., 1824, p. 13) as "Frustula acicularia linearia vel cuneata muco obvoluta in corpus lineare aggregata," and in his Conspectus Crit. Diatomacearum (1830, p. 43) he repeats, "Frustula linearia, libera vel muco amorpho immessa, solitaria vel binatim conjuncta." These definitions say practically nothing at all, and accordingly both he and his successors have accumulated in this genus anomalous forms: *Amphora*, *Navicula*, *Synedra*, etc. The genus established by de Brébisson on the other hand has very distinct characteristics, and deserves to be preserved, and more justly so than many others that have been admitted in this work.

The genus includes 5 or 6 species, of which the most beautiful is *V. Lewisiana Breb.*, which is found in America, India, and Guiana.

ANALYSIS OF SPECIES.

Striæ quite parallel, raphe continued over all the valve.	Valve rhomboidal-lanceolate; endochrome yellowish. . .	**V. rhomboides.**
	Valve lanceolate-elongate; endochrome greenish. . . .	**V. viridula.**
Median striæ slightly radiate; raphe interrupted near the central nodule		**V. vulgaris.**

I. Striæ quite parallel: Eu-Vanheurckia.

V. rhomboides Breb. ! (Monog. genus *Vanheurckia*, p. 204 in An. Soc. Phyt. et Mic. de Belg.; H.V.H. Atl., pl. 17, f. 1 and 2*; Type No. 160), **plate 5, fig. 249.**

Valves rhomboidal-lanceolate, attenuate and slightly constricted towards the apices. Raphe double, with threads approximate, continuous. Transverse striæ fine, reaching to the raphes, about 28 in 1 c.d.m., finely moniliform; Endochrome yellowish. Length, 7 to 8 c.d.m.

Fresh water, peat bogs.—Calmpthout (Deby) Ard. Lieg. (De Wild.) England, France, etc.

var. **crassinervis.** (*N. Crassinervia Breb. !—N. Saxonica Rab.*; H.V.H. Atl., pl. 17, f. 4 and 5; Type No. 162), **plate 5, fig 250.**

Size smaller, about 5 c.d.m. Valve with apices more rostrate; striæ very fine and very difficult to resolve, 34 to 35 in 1 c.d.m.

V. viridula Breb. (Soc. cit., p. 203; H.V.H. Atl., pl. 17, f. 3*; Type No. 163), **plate 5, fig. 251.**

Valves rhomboidal-elongated, attenuated with regularity as far as the obtuse apices. Raphe with threads approximate, continuous. Striæ fine, 28 to 30 in 1 c.d.m., parallel, finely moniliform. Endochrome greenish, Frustules sometimes enclosed in tubes. Length, 10 to 11 c.d.m.

Fresh water,—Ard. Lieg. (De Wild.).—France.

II. Median striæ slightly radiant: Pseudo-Vanheurckia.

V. vulgaris (Thwaites) H. Van Heurck. (*Colletonema Vulgare Thw.*; H.V.H. Atl., pl. 17, f. 6*; Type No. 164), **plate 5, fig. 252.**

Valves elliptical-lanceolate, with apices obtuse, slightly contracted-rostrate. Raphe double with narrow threads, then approximate and interrupted near the central nodule which is surrounded by a small hyaline area. Striæ fine, delicate, the median striæ slightly radiate, the terminal parallel, about 34 in 1 c.d.m.; the median striæ more robust, more distant, 24 in 1 c.d.m. and more radiate. Frustules enclosed in tubes generally without branches. Length, about 5 c.d.m. Breadth, about 1 c.d.m.

Fresh water.—Antwerp, Rochehaut (Delogne). Ard. Lieg. (De Wild.)—England, France.

GENUS 12.—STENONEIS CLEVE, 1894.

Fig. 40.
Stenoneis inconspicua.

Valve narrow, with rounded apices. Central and terminal nodules very small, rounded. Raphe indistinct, bordered by two strong ribs or silicious costæ. Transverse striæ fine. Axial area indistinct.

Only one species known.

S. inconspicua Greg. (sub *Navicula* (?) Diat. of Clyde, p. 6, pl. 1, f. 3; Cleve Synop., pl. 5, f. 28*), **plate 28, fig. 789.**

Valve linear, frequently gibbous in the median portion, with apices rounded, obtuse; nodules small, the terminal ones somewhat distant from the apices. Raphe bordered by two strong silicious costæ. Striæ 26 to 1 c.d.m., perpendicular to the raphe throughout, absent at the median portion where there is a broad hyaline transverse band. Length. 5 c.d.m. Breadth, ·75 c.d.m.

Marine.—North Sea (Scotland, Greg., Bahusie, Cleve.).

GENUS 13.—CISTULA CLEVE, 1894.

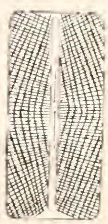


Fig. 41.—*Cistula Lorenziana.*

Valve rectangular, broad. Central nodule very small. Raphe between two strong silicious costæ. Striæ radiant, slightly interrupted by several hyaline longitudinal bands.

Only one species known.

C. Lorenziana Grun. (sub *Navicula* in Verh., 1860, p. 547, pl. 3, f. 3*; Cleve Syn., pl. 1, f. 31), **plate 28, fig. 790.**

Valve rectangular, sometimes somewhat gibbous in the middle and at the apices. Striæ gently radiant, about 17 in 1 c.d.m., composed of elongated dots, arranged in regular longitudinal rows, 12 in 1 c.d.m., flexed in the middle. Length, 4·5 c.d.m. Breadth, 2 c.d.m.

Marine.—South Coast of England (Roper.).

GENUS 14.—AMPHIPLEURA KUTZ., 1844.

Fig. 42.—*Amphipleura pellucida.*

Frustules fusiform. Valves narrowly lanceolate, furnished near each edge with a marginal keel. Central nodule obsolete; the two terminal nodules very elongate.

The genus *Amphipleura* has for a long time been noted as a microscopical test of extreme difficulty, and, until the invention of homogenous objectives, the transverse striæ could not be seen without the assistance of some extraordinary objectives, such as the 1-6th of Tolles, and then it was necessary to employ monochromatic illumination. It was only in 1884, by employing a preparation of silvered *Amphipleura*, that I was able to resolve and photograph this diatom under a silvered aspect. This resolution was for a long time disputed, and as other microscopists were unable to obtain the same resolution, it was thought that I was the victim of an optical illusion. The discovery of the arsenical medium, the 2·4 of Prof. Smith, and especially the construction of the famous objective with an aperture of 1·60, which Messrs. Zeiss placed at my disposal in 1889, enabled me in that year to publish an irreproachable photograph of the *Amphipleura* resolved into beads, and that put an end to all further discussion on the subject.

The genus *Amphipleura* includes four or five well-established species, only one of which, and that the most delicate, lives in our regions. The *Amphipleura Lindheimeri*, the most beautiful and largest species, inhabits America, but a variety (*A Lindheimeri var. Truanii H. V.H.*), has been found in Spain.

A. pellucida Kütz. (Bac., p. 103, pl. 3, f. 52, and pl. 30, f. 84; H.V.H. Atl., pl. 17, f. 14, 15 and A*; Type No. 165), **plate 5, fig. 253.**

Valve narrowly lanceolate, with acute apices. Raphe not interrupted in the median portion of the valve. Central nodule very rudimentary;

terminal nodule very elongated. Transverse striæ only visible with great difficulty, 37 in 1 c.d.m. on an average. Length, 8 to 14 c.d.m.

Fresh water.—Antwerp, Louvain, Brussels.—Sussex (W. Sm.). Norfolk (Kitton). Hull (Norman). Ireland (O'Meara). Scotland (H.L. Sm., Type No. 7).

GENUS 15.—REICHELTIA H.V.H., 1895, in Litt.

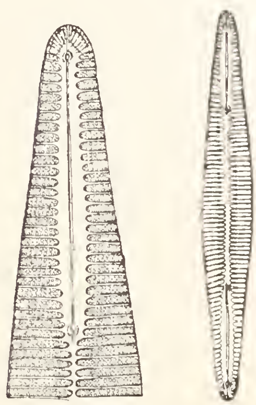


Fig. 43.
Reicheltia nobilis.

Valve lanceolate, slightly gomphonemoid simulating an *Amphipleura*. Girdle face cuneate. A single species, *R. nobilis* (*Reichelt*) *H.V.H.*, found in a fossil state at Hainspach.

This new genus is excessively interesting, and we do not know of any analogous one. The valve displays rather delicate transverse costæ, separated at the median portion by an elongated hyaline space, simulating the terminal nodules of the *Amphipleura*, but in these hyaline spaces there is a delicate bifurcated raphe, like that of the large *Pinnularia*, and terminating at the apex in a nodule, while the other end of the raphe, after having traversed a kind of nodule placed in a small depression is prolonged a little further on. Between the costæ is a double row of very delicate beads, about 20 in 1 c.d.m. About 7·5 costæ in 1 c.d.m. Length of valve, about 9 c.d.m. Breadth at the median portion, about 1 c.d.m.

The figures in the text are from one of my photographs, that of the valve × 600 diameters, and the details of structure × 1000 diameters. This very curious form has the combined characteristics of an *Amphipleura*, *Berkeleya*, and *Gomphonema*. I have been able thoroughly to study it, thanks to the numerous examples which Mr. H. Reichelt has had the kindness to place at my disposal. The photographs have been made with Zeiss objective of 1·60 N.A. The examination made with this objective has enabled me to ascertain that the description given by Mr. Reichelt by means of objectives of less resolving power was defective, and did not correspond with the very curious structure of the valves. I have, therefore, with the assent of Mr. Reichelt, ventured to change the name given by its author, and I have great pleasure in dedicating to him this interesting genus.

GENUS 16.—BREBISSONIA GRUN., 1860.

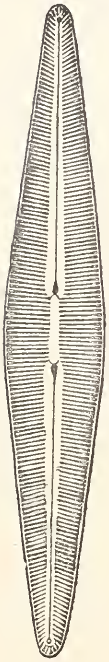


Fig. 44.—*Brebissonia Boeckii.*

Valve with central nodule linear, very elongate ; terminal nodules distant from apices. Frustules pediculate.

Brebissonia Boeckii (Kütz.) Grun.

(1860, Wien, p. 512 ; *Doryphora Boeckii, W. Sm.*, S.B.D. i., p. 77, pl. 24, f. 223 ; H.V.H., Type No. 150).

Valve lanceolate, rhomboidal, with striæ very robust, radiate, 10 in 1 c.d.m., finely divided transversely like those of the *Radiosæ* (*Navicula*). Raphe surrounded by a considerable hyaline area, often narrowed near the central nodule, slightly extended beyond the terminal nodules. Length, 7 to 13 c.d.m. Breadth at the median portion, 2 c.d.m.

Marine. England (W. Sm., Kitton, Norman); Dundee, Scotland (Kitton in Baxter's Coll., No. 3463); Ireland (O'M.); Kiel, Germany (Eulenstein); North Sea, near Christiania (D. Boeck).

GENUS 17.—ROUXIA J. BRUN AND F. HERIBAUD, 1893.

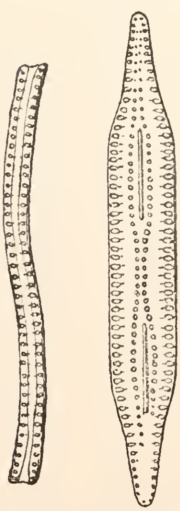


Fig. 45.—*Rouxia Peragalli.*

Valve elongated, linear, with central nodule rudimentary or absent, terminal nodules very elongated, and narrow at the apices. A row of beads round the nodules and the raphe, which is not distinct. Frustule : girdle view sigmoid. A single exotic species.

Rouxia Peragalli J. Brun and F. Hérib.

(Diat. d'Auvergne, p. 156, pl. 1, f. 12).

From Japan.

The authors of the genus place it among the Pseudo-raphidieæ, but as it appears to me to have a greater affinity to the *Amphipleura*, *Berkeleya* etc., I prefer to arrange it near those genera.

GENUS 18.—BERKELEYA (GREV. 1827), H. VAN HEURCK, Emend.

Valves with central nodule sub-divided, divisions more or less separated. Raphe absent between the divisions of the nodule. Frustules naviculoid, enclosed in mucous tubes as in the *Schizonema*.

ANALYSIS OF SPECIES.

Valves sublinear, narrow; striæ quite parallel	About 32 striæ in 1 c.d.m.	**B. fragilis.**
	About 26 striæ in 1 c.d.m.	**B. micans.**
Valves elliptical-lanceolate, median striæ parallel, terminal radiate	. .	**B. Dillwynii.**

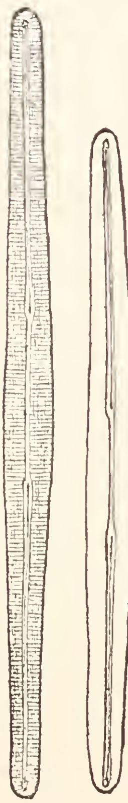


Fig. 46.
Berkeleya fragilis.

B. fragilis Grev. (Scot. Crypt. Flor. pl. 294; H.V.H. Atl., pl. 16, f. 12).

Valves linear, narrow, and very elongated; subdivisions of central nodule rather approximate; striæ quite parallel, delicate, 32 to 40 in 1 c.d.m. Length, about 8 c.d.m. Breadth, about 0·4 c.d.m.

Marine.—Not yet discovered in Belgium. England (Mrs. Griffiths). Scotland (Grev., Arnott), Eulen, Type No. 80. Ireland (O'Meara). France, Brest (Coronan); Cherbourg (Brébisson).

Prof. Cleve makes *B. fragilis* only a variety of the following:—

B. micans (Lyng.) H.V.H. (H.V.H. Atl., pl. 16, f. 11*; Type No. 156), plate 5, fig. 254.

Valves linear, narrow and very elongated; subdivisions of central nodule rather distant; striæ parallel, delicate, 26 in 1 c.d.m. Length, 8 to 9 c.d.m. Breadth, 0·4 c.d.m.

Marine.—Not yet discovered in Belgium, but found in France, Holland and Denmark.

B. Dillwynii (Agardh) H.V.H. (H.V.H. Atl., pl. 16, f. 15*; Type No. 157), plate 5, fig. 255,

Valves elliptical lanceolate, narrow, with divisions of central nodule more or less distant. Median striæ parallel, terminal radiate, delicate, 30 in 1 c.d.m. Length, 1·5 to 3·5 c.d.m. Breadth, 0·4 to 0·6 of c.d.m.

Marine.—Ostend (West. 895 sub. *Schizonema rutilans*). Ostend leg. (Grunow). England (Kitton), Scotland (Eulen, Type No. 81, 82).

GENUS 19.—SCOLIOPLEURA GRUN., 1860.

Frustules free, with valves naviculoid, very convex, slightly twisted spirally so as to render the raphe and connecting zone more or less obliquely-sigmoid.

ANALYSIS OF SPECIES.

Valve with robust costæ, between which are two rows of fine granules .	**S. latestriata.**
Valve with striæ distinctly moniliform, about 10 in 1 c.d.m. ; raphe strongly sigmoid	**S. tumida.**
Striæ difficult to resolve into beads, 15 in 1 c.d.m. ; raphe scarcely sigmoid	**S. Westii.**

S. latestriata (Breb.) Grun. ! (*Amphiprora latestriata Breb. ; Scoliopleura convexa Grun.* ; H.V.H., pl. 17, f. 12* ; Type No. 202), **plate 5, fig. 247.**

Valve linear, narrow, with cuneate apices. Raphe surrounded by a rather considerable hyaline zone, slightly dilated round the central nodule. Costæ robust, about 7 in 1 c.d.m., interrupted near the raphe by a furrow parallel to the hyaline zone. Between the costæ are two rows of granules delicate, alternate, seen with difficulty. Length, about 10 to 15 c.d.m. Breadth, 2·5 c.d.m.

Marine.—Ostend (Deby), England (Kitton), Ireland (O'Meara), France, Bahusie (Sweden).

S. tumida (Breb) Rabenh. (Fl. Eur. Alg., p. 229 ; H.V.H. Atl., pl. 17, f. 11, 13* ; Type No. 201), **plate 5, fig. 248.**

Valve lanceolate, very gently attenuate, with subacute apices. Raphe surrounded by a small hyaline zone, considerably dilated at the median portion. Striæ about 10 in 1 c.d.m. ; those in the centre often unequal in length, radiate, bent, finely punctate. Length, 10 to 16 c.d.m.

Marine.—Antwerp (Scheldt), Ostend, Blankenberghe. Common : England (Kitton), France, Denmark.

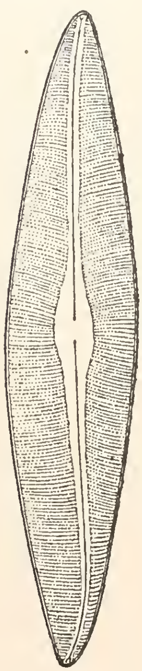


Fig. 47.—*Scoliopleura tumida*.

S. Westii (W. Sm.) Grun. (in Wien Verh., 1860, p. 555 ; *N. Westii W. Sm.*, S.B.D., i., pl. 16, f. 135*), **plate 28, fig. 791.**

Valve elliptical-lanceolate, with sub-acute apices ; raphe scarcely sigmoid, surrounded by a small hyaline area, scarcely dilated round the central nodule. Striæ fine, about 15 in c.d.m., difficult to resolve into beads ; connecting zone scarcely oblique-twisted. Length, 8 to 10 c.d.m.

Marine.—Scheldt (H.V.H.) England (W. Sm.! Kttton). Ireland (O'Meara). France (Brebisson). Denmark, Holland (Van den Bosch).

Note.—Prof. Cleve forms *S. latestriata* into a new genus which he calls *Scoliotropis Cleve*, while the two others remain in the genus *Navicula*.

GENUS 20.—TOXONIDEA DONKIN, 1858.

Valves elongate, convex, with asymmetrical margins ; striæ decussate. Raphe arcuate with its convexity turned towards the convex margin of the valve. Frustules free.

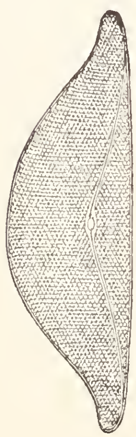


Fig. 48.
Toxonidea insignis.

ANALYSIS OF SPECIES.

Ventral margin straight, dorsal margin very arcuate, valve short thick set . . .	**T. insignis.**
Ventral and dorsal margins feebly curved in opposite directions, valve long, elongate .	**T. Gregoriana.**

T. insignis Donkin (T.M.S., 1858, vi., p. 21, pl. 3, f. 2 ; H.V.H. Atl., pl. 17, f. 10* ; Type No. 168), **plate 5, fig. 256.**

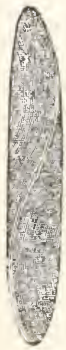
Valve with dorsal margin strongly convex, ventral margin straight, apices strongly produced-rostrate on the dorsal side. Raphe strongly arcuate, dividing the valve into very unequal portions. Striæ decussate, reaching to the raphe, 22 in 1 c.d.m. Length, about 10 c.d.m. Breadth, about 3 c.d.m.

Marine.—Washings of mussels (Deby) Blankenberghe. England (Kitton, Norman, Comber). Scotland (Baxter, Coll., 1794). Ireland (O'Meara), and on all the coasts of the North Sea.

T. Gregoriana Donk. (T.M.S., 1858, vi., p. 19, pl. 3, f. 1 ; Pér., pl. 9, f. 16*), **plate 28, fig. 792.**

Valve very elongated, with apices produced-rostrate, margins slightly flexed in opposite directions ; ventral margin nearly straight. Raphe dividing the valve into two almost equal portions. Striæ decussate, reaching to the raphe, the oblique 19 and the transverse 20 in 1 c.d.m. Length, 22 to 26 c.d.m. Breadth, about 5 c.d.m.

Marine.—Blankenberghe (H.V.H.). England (Kitton, Comber). Ireland (O'Meara), and found, but in small quantities, on all the coasts of the North Sea.



GENUS 21.—DONKINIA RALFS, 1860.

Valve carinated, with keel sigmoid, interrupted at the median portion by the central nodule. Keel not accompanied laterally by projecting lines (or alæ). Frustule strongly constricted at the median portion.

Fig. 49.—*Donkinia recta.*

ANALYSIS OF SPECIES.

Striæ rectangular, the transverse 20, the longitudinal 21 in 1 c.d.m.	**D. recta.**
Striæ decussate, fine, 21-24 in 1 c.d.m.	**D. carinata.**

D. recta (Donkin) Grun. (*Pleurosigma rectum Donk.*, T.M.S., 1858, vi., p. 23, pl. 3, f. 6; H.V.H. Atl., pl. 17, f. 9*; Type No. 194), **plate 5, fig. 286.**

Valve broadly linear, with apices attenuate, subcuneiform-acute. Raphe strongly sigmoid. Striæ reaching to the raphe, rectangular, about 21 in 1 c.d.m. Girdle face strongly constricted at median portion. Length, about 8 or 9 c.d.m.

Marine.—Washings of mussels. England, Ireland (O'Meara). Rather common on all the coasts of the North Sea.

var. angusta H.P. (*Pleurosigma angustum Donk.*). Narrower, with keel more eccentric.

England, Ireland (O'Meara).

var. minuta H.P. (*Pleurosigma minuta Donk.*). Small form of type. Length, about 6 c.d.m.

Rather common.—Ireland (O'Meara).

D. carinata (Donk.) Ralfs (Ralfs in Prit. Inf., p. 921, pl. 8, f. 49*), **plate 35, fig. 912.**

Valve straight, linear-lanceolate, with apices acute, very convex. Raphe very strongly sigmoid. Striæ decussate, fine, 21 to 24 in 1 c.d.m. Length, 12 c.d.m.

Marine.—England, Ireland (O'Meara).

GENUS 22.—PLEUROSIGMA W. Sm., 1853.

Fig. 50.
Pleurosigma Balticum.

Frustules naviculoid, elongated, with valves convex, more or less sigmoid. Raphe more or less sigmoid. Striæ decussate or rectangular, reaching almost to the raphe. Frustules with connecting zone straight, generally free, rarely enclosed in mucous tubes.

The endochrome of *Pleurosigma* presents a peculiar arrangement, to which we have already referred in the introduction [1].

The genus *Pleurosigma* includes numerous forms which inhabit all parts of the world. Prof. Cleve divides it into two genera, reserving the name *Pleurosigma* for forms with decussating striæ, and giving that of *Gyrosigma* to those with rectangular striæ.

The name *Gyrosigma* is the older of the two, having been given by Dr. Hassall. The special study which Professor Wm. Smith made of the group has caused this name of *Pleurosigma* to be preserved in spite of the incontestibly prior right of Hassall.

An excellent monograph of the genus *Pleurosigma*, by Mr. H. Péragallo hás recently been published in "Le Diatomiste." This work includes the genera Pleurosigma, Toxonidea, Donkinia, and Rhoicosigma, and forms a quarto volume of 35 pages, including 10 plates, containing 271 figures. This monograph is indispensable to anyone who wishes to make an exhaustive study of this difficult group, or to determine exotic species.

(1) See page 4.

ANALYSIS OF SPECIES.

- Striæ decussate (cutting one another obliquely in three directions).
  - All the striæ almost equally delicate.
    - Oblique striæ crossing one another at an angle of about 60°.
      - Central nodule not elongated transversely, oblique striæ equally distant throughout
        - Median oblique striæ not flexed.
          - Raphe and valve considerably sigmoid . . . **Pl. angulatum.**
          - Raphe and valve scarcely sigmoid, valve broad, apices obtuse . . . **Pl. rigidum.**
          - Raphe and valve scarcely sigmoid, valve very narrow, apices acute . . **Pl. intermedium.**
        - Median oblique striæ, flexed . . **Pl. affine.**
      - Central nodule elongated transversely; median oblique striæ more distant than the terminal . . . **Pl. naviculaceum.**
    - Oblique striæ crossing one another at an angle of more than 60°.
      - Raphe straight, abruptly curved at apices . . **Pl. speciosum.**
      - Raphe very sigmoid.
        - Valve with obtuse apices . . **Pl. elongatum.**
        - Valve with very acute apices . . **Pl. acutum.**
        - Valve with attenuated apices . . **Pl. naviculaceum.**
      - Raphe with a double flexion . . . . **Pl. marinum.**
  - Transverse striæ delicate, oblique striæ robust.
    - Valve very large, linear-lanceolate, with sub-obtuse apices . . **Pl. formosum.**
    - Valve rather large, very narrowly lanceolate, with acute apices . **Pl. decorum.**
- Striæ rectangular (longitudinal and transverse striæ cutting one another at right angles).
  - Frustules not enclosed in mucous tubes.
    - Longitudinal striæ further apart and consequently more visible than the transverse.
      - In brackish water: Valve short, lanceolate, apices broad, longitudinal striæ 10-11 in 1 c.d.m. . **Pl. Hippocampus.**
      - Marine: Valve short, apices narrow, 7-9 longitudinal striæ in 1 c.d.m. . . . **Pl. littorale.**
      - Fresh water: Valve elongated, narrowly lanceolate, 10-11 longitudinal striæ . . **Pl. altenuatum.**
    - Longitudinal and transverse striæ equally distant.
      - Marine: Valve linear, very elongated . . **Pl. Balticum.**
      - Fresh water: Valves lanceolate-sigmoid . . **Pl. acuminatum.**
    - Longitudinal striæ more approximate and less visible than the transverse.
      - Apices not rostrate produced.
        - Valve very large, transverse striæ very distant, robust . . **Pl. strigilis.**
        - Valve linear-lanceolate, narrow (more than 1 c.d.m.) . . **Pl. Spencerii.**
        - Valve linear, excessively narrow (less than 1 c.d.m.) . . **Pl. tenuissimum.**
      - Apices rostrate produced.
        - Fresh water: Valve broadly lanceolate, rostrum rather broad . **Pl. Parkeri.**
        - Marine: Rostrum broad and short, striæ very fine . . **Pl. distortum.**
        - Marine. Rostrum very narrow.
          - Valve linear-lanceolate; apices very rostrate . **Pl. Fasciola.**
          - Valve very linear-lanceolate; apices extremely rostrate , . **Pl. macrum.**
          - Rostrum inflated at apices . . **Pl. reversum.**
  - Frustules enclosed in mucous tubes, valves short, stubby .
    - Valve very obtuse; raphe appearing strongly sigmoid . . . . . **Pl. eximium.**
    - Valve obtuse; raphe appearing gently sigmoid . **Pl. scalproides.**

I. *Striæ decussate (cutting one another in three directions).*

A. All striæ almost equally delicate.

* OBLIQUE STRIÆ CROSSING ONE ANOTHER IN THE MIDDLE OF THE VALVE AT AN ANGLE OF ABOUT 60°.

Pl. angulatum W. Sm. (S.B.D., i., p. 65, pl. 21, f. 205; H.V.H. Atl., pl. 18, f. 2, 3, 4*; Type No. 169), **plate 6, fig. 257.**

Valve broadly lanceolate, gently flexed, sigmoid, with median part slightly angular. Raphe feebly sigmoid. Striæ decussate, having the same direction throughout the surface of the valve, 18 to 20 in 1 c.d.m., the transverse striæ slightly more approximate than the others. Length, about 15 c.d.m.

Marine.—Common. Antwerp (Scheldt), Blankenberghe, Ostend; Norfolk (Kitton). This species and its varieties are found on all the coasts of the North Sea.

var. Æstuarii. (*Pl. Æstuarii W. Sm.!;* H.V.H. Atl., pl. 18, f. 8*; Type No. 172), **plate 6, fig. 258.**

Differs from the preceding, with which it is often mixed, by its rather smaller size, and its slightly rostrate-produced apices.

var. quadratum. (*Pl. quadratum W. Sm.!;* H.V.H. Atl., pl. 18, f. 1*; Type No. 171), **plate 6, fig. 259.**

Differs from the type form by its larger size, and its more quadrangular shape.

var. major. (H.V.H. Atl., pl. 18, f. 5*), **plate 6, fig. 260.**

Differs from the type form by its much larger size, reaching 22 c.d.m.

Blankenberghe.

var. delicatulum. (*Pl. delicatulum W. Sm.!;* in H.V.H.'s Types No. 74 and 172).

Valve very narrow and infinitesimally attenuate. Striæ 24 or 25 in 1 c.d.m. Length, 16 to 18 c.d.m. Breadth, about 2 c.d.m.

Blankenberghe.—Rare.

var. strigosum. (*Pl. strigosum W. Sm.!*; H.V.H. Atl., pl. 19, f. 2*; Type No. 170), **plate 6, fig. 261.**

Of very considerable size (more than 30 c.d.m.) with margins infinitesimally sigmoid, not angular, with apices sub-obtuse.

This form has not been found in Belgium.—Norfolk (Kitton), Coast of Sussex (W. Sm.), Cheshire (Comber), Humber (Norman), Ireland (O'Meara).

Pl. rigidum W. Sm. (S.B.D., i., p. 64, pl. 20, f. 198; H.V.H. Atl., pl. 19, f. 3*; Type No. 178), **plate 6, fig. 265.**

Valve almost straight, with apices obtuse, sometimes slightly inflated. Raphe robust, straight, with apices just a little flexed, often with a lateral row of points sometimes crossing the central nodule, which is large, rounded. Terminal nodules conical, meeting the margins ; striæ oblique, 17 to 21 in 1 c.d.m. ; the transverse striæ more distant, 16-19 in 1 c.d.m.

Marine and sometimes brackish water.—On all our coasts.

Pl. affine Grun. ! (H.V.H., pl. 18, f. 9* ; Type No. 175), **plate 6, fig. 263.**

Valve lanceolate, without outline infinitesimally flexed, scarcely sigmoid, with apices sub-obtuse. Raphe feebly sigmoid. Striæ 18 to 20 in 1 c.d.m., the median striæ crossing one another at right angles in the form of slightly flexuous lines, the terminal crossing at an acute angle. Length, 10 to 22 c.d.m.

Marine.—Rather rare. Washings of mussels (Deby.), Blankenberghe. England (Kitton). Denmark.

var. Nicobarica. (*Pl. Nicobaricum Grun.*, Novara ; H.V.H. Atl. Supp., f. 34), **plate 6, fig. 264.**

Distinguished from the preceding by a completely straight raphe, and its sides not sigmoid.

Marine.—Ostend (according to Kitton). Blankenberghe (observed very frequently in a gathering from the mud of the second basin made in April, 1884).

Mr. Kitton believes that *Pl. affine* and its *var. Nicobarica* are forms of *Pl. rigidum W. Sm.* ; I, however, think that the flexuous direction so characteristic of the median striæ allows me to make a special type of *Pl. affine.*

var. Normanni. (*Pl. Normanni Ralfs*).

Distinguished from the type form by its more lanceolate shape (more acute) and its rather finer striæ.

England (Kitton, Norman). Ireland (O'Meara).

Pl. naviculaceum Breb. (Diat. Cherb., p. 17, f. 7 ; *Pl. transversale W. Sm.* ; H.V.H. Atl. Supp., f. 35* ; in Type No. 320), **plate 6, fig. 266.**

Valve lanceolate, with symmetrical margins, apices sometimes very slightly turned in contrary directions. Raphe very flexed with strongly eccentric apices. Central nodule very dilated transversely. Transverse striæ 18 or 19 in 1 c.d.m. ; median oblique striæ slightly flexuous, 13 or 14 in 1 c.d.m. ; terminal oblique striæ 16 or 17 in 1 c.d.m. Length, 8 to 12 c.d.m.

Marine.—Blankenberghe. Rare. England, France, Holland, Bahusie, Denmark.

The *Pl. lanceolatum Donk.* approximates closely to the shape of *Pl. naviculaceum*, but differs from it in its striation. The transverse striæ number 20-21, and the oblique 19 in the middle of the valve and 20-21 in 1 c.d.m. at the apices.

Pl. intermedium W. Sm. (S.B.D., i., p. 64, pl. 21, f. 200; H.V.H. Atl., p. 18, f. 6*; Type No. 174), **plate 6, fig. 267.**

Valve lanceolate, narrow, with margins almost straight; raphe scarcely sigmoid. Transverse striæ 21 to 23, oblique striæ 20 to 22 in 1 c.d.m. Length, 15 to 30 c.d.m.

Mr. Grunow remarks that the short are more distinctly sigmoid than the longer specimens.

Marine.—This species has not yet been found in Belgium, but has been frequently so in England, France and Holland. It approaches *Pl. delicatulum*, and may also be considered as a form of *Pl. angulatum*.

var. Nubecula. (*Pl. Nubecula W. Sm.*)

Only differs from the type form by its smaller size and more obtuse apices; the striation is identical.

* * STRIÆ OBLIQUE, CUTTING ONE ANOTHER AT AN ANGLE OF MORE THAN 60°.

Pl. speciosum W. Sm. (Ann. N.H., 1852, p. 5, pl. 1, f. 5; S.B.D., i., p. 63, pl. 20, f. 197; Pérag., pl. 2, f. 16*; H.V.H. in Type No. 170), **plate 28, fig. 793.**

Valve linear-lanceolate, with apices slightly curved, rounded. Raphe straight, parallel to margins, being abruptly bent quite close to the apices. Transverse striæ 19-20, oblique striæ 16-18 in 1 c.d.m. Length, 21 to 39 c.d.m. Breadth, 2·5 c.d.m.

Marine.—England (W. Sm.). Ireland (O'Meara), and probably also other countries.

Pl. elongatum W. Sm. (Ann. N.H., 1852, p. 6, pl. 1, f. 4; S.B.D., i., p. 64, pl. 20, f. 199; H.V.H. Atl., pl. 18, f. 7*; Type No. 173), **plate 6, fig. 262.**

Valve very long and very narrowly lanceolate, with striæ crossing one another at an angle of about 68°. Length, 21 to 38 c.d.m. Breadth, about 3 c.d.m.

Antwerp (Scheldt, where it is rather frequent). Blankenberghe. England (Comber, Norman, Kitton, Stolt.). Ireland (O'Meara) and probably on all the coasts of the North Sea.

In my Synopsis I referred this form to the *angulatum* with which it is closely connected.

Pl. acutum Norm. (Prit. Inf., p. 920; Pér., pl. 3, f. 1, 4*), **plate 35, figs. 914, 915.**

Valve elongate, rather broadly lanceolate, very sigmoid, with very acute apices. Raphe much flexed with eccentric apices. Striæ 20-21 in 1 c.d.m. Length, 16 to 18 c.d.m.

Marine.—England (Norman).

Pl. marinum Donk. (T.M.S., 1858, vi., p. 22, pl. 3, f. 3; Pérag., pl. 3, f. 11*), **plate 28, fig. 794.**

Valve narrow-lanceolate, not sigmoid, with apices slightly tapering rostrate. Raphe having a double flexure in contrary directions between the central nodule and the apices. Oblique striæ 20 to 21·5, transverse 21·5 to 22 in 1 c.d.m. Length, 12 to 15 c.d.m.

Marine.—England (Donkin, Kitton, Comber, Stolt). Ireland (O'Meara). Cherbourg, France (Brebisson).

AA. Transverse striæ delicate, oblique striæ robust; raphe strongly sigmoid.

Pl. formosum W. Sm. ! (S.B.D., i., p. 63, pl. 20, f. 195; H.V.H. Atl., pl. 19, f. 4*; Type No. 177), **plate 6, fig. 268.**

Valve linear-lanceolate, strongly sigmoid, with obtuse apices. Raphe strongly sigmoid, dividing the apices of the valve into two very unequal portions. Transverse striæ rather delicate, 14 to 17 in 1 c.d.m. Oblique striæ very robust, cutting one another at right angles, 10 to 12 in 1 c.d.m. Length very variable, but usually from 35 to 45 c.d.m.

Marine.—Found in fragments in the washings of mussels, Belgium. England, Ireland, France, and probably on all our coasts.

Pl. obscurum W. Sm. (S.B.D., i., p. 65, pl. 20, f. 206*), **plate 28, fig. 795.**

Is distinguished from the preceding, of which it appears to be a miniature form, by its fine striæ, 21 to 25 (according to W. Sm.), and by its very small size, which only reaches from 8·5 to 15 c.d.m.

Marine.—England.

Pl. decorum W. Sm. ! (Loc. cit., p. 63, pl. 20, f. 196; H.V.H. Atl., pl. 19, f. 1*), **plate 6, fig. 269.**

Valve very narrowly lanceolate, strongly sigmoid, with acute apices. Raphe very strongly sigmoid, dividing the apices of the valves into two very unequal portions. Transverse striæ delicate, about 18 in 1 c.d.m.; oblique striæ robust, 13 or 14 in 1 c.d.m., cutting one another at nearly a right angle. Length, about 25 to 30 c.d.m.

Marine—Washings of mussels; more frequent than the preceding, of which, according to Mr. Kitton, it is only a variety. Same localities.

II. Striæ rectangular, cutting one another in only two directions; striæ longitudinal and transverse.

* Frustules not enclosed in a gelatinous tube.

a. LONGITUDINAL STRIÆ MORE DISTANT (AND CONSEQUENTLY MORE DISTINCT) THAN THE TRANSVERSE STRIÆ.

Pl. Hippocampus W. Sm. (S.B.D., i., p. 68, pl. 22, f. 215; H.V.H. Atl., pl. 20, f. 3*; Type No. 179), **plate 7, fig. 270.**

Valve short, rather broadly lanceolate, with apices obtuse, abruptly sigmoid; longitudinal striæ, 10 or 11 in 1 c.d.m., transverse striæ, 15 or 16 in 1 c.d.m., median striæ slightly radiate. Length, 13 to 16 c.d.m.

Brackish water.—Antwerp (Scheldt), Blankenberghe. England (Kitton, Comber, Norm., Stolt.). Ireland (O'Meara). On all our coasts.

Pl. attenuatum W. Sm. (S.B.D., i., p. 68, pl. 22, f. 216; H.V.H. Atl., pl. 21, f. 11*; Type No. 182), **plate 7, fig. 271.**

Only differs from the preceding by its form being slightly thinner (Grunow) and its fresh water habitat. Length, 19 to 25 c.d.m.

Fresh water.—Common and general.

Prof. Cleve unites *Pl. attenuatum W. Sm.* with *Pl. Hippocampus W. Sm.*

var. scalprum (Gaill.) Grun. (Arct. D., p. 55; *Pl. acuminatum Sm. non Grun.*; H.V.H. Atl., pl. 20, f. 4*), **plate 7, fig. 285.**

Slightly broader and not quite so long in proportion as the preceding, and the striæ a little finer. Longitudinal 14 or 15, and transverse striæ 17 or 18 in 1 c.d.m.

Pl. littorale W. Sm. (Ann. N.H., 1852, p. 10, pl. 2, f. 8; S.B.D., i., p. 67, pl. 22, f. 214*), **plate 28, fig. 796.**

Smaller and broader at the median portion, but nevertheless quite distinct, in consequence of the longitudinal striæ being very robust and distant, 7 to 9 in 1 c.d.m; transverse striæ, 15·5 to 17 in 1 c.d.m

Marine.—Coasts of England and France.

aa. LONGITUDINAL AND TRANSVERSE STRIÆ EQUALLY DISTANT.

Pl. Balticum W. Sm. (S.B.D., i., p. 66, pl. 22, f. 207, pl. 23, f. 207, Front. p. 207; H.V.H. Atl., pl. 20, f. 1; Type No. 180), **plate 7, fig. 272.**

Valve attenuate-linear, with apices obtuse-sigmoid. Raphe sometimes a little more and at others a little less sigmoid. Longitudinal and transverse striæ equally distant (sometimes the transverse not quite so close as the longitudinal), about 15 in 1 c.d.m. Length, very variable, 21 to 36 c.d.m.

Marine.—Common. Blankenberghe, Ostend, Antwerp (Scheldt), and everywhere.

var. Brebissonii (*Pl. Scalprum Bréb.;* H.V.H. Atl., pl. 21, f. 6*; Types Nos. 188 and 189), **plate 7, fig. 273.**

Much smaller and more delicate than the type form, slightly more sigmoid, with a raphe dividing the valve symmetrically throughout its length. Striæ about 22 or 23 in 1 c.d.m. Length, 8 to 10 c.d.m.

Marine.—Ostend, Blankenberghe (basin), mixed with the type form and abundant. Antwerp (Scheldt), Liverpool (Stolt.), Yorkshire (Norman), Sussex (W. Sm.).

Prof. Cleve unites *var. Brebissonii* with *P. acuminatum.*

var. Wansbeckii (*Pl. Wansbeckii Donk; Pl. Balticum, var. β W. Sm.*).

Smaller and more acute than the type form, to which it is united by all possible variations, though much smaller; more finely striated, 19 or 20 striæ in 1 c.d.m. (H. Paragallo).

Marine.—Mixed with type form.

Pl. acuminatum (Kütz.) Grun.! nec W. Sm. (Neue o. ung. gek. Alg., 1860, p. 561, pl. 4, f. 6; *Pl. lacustre W. Sm.;* H.V.H. Atl., pl. 21, f. 12*; Type No. 181), **plate 7, fig. 274.**

Valve acute-lanceolate, conspicuously sigmoid. Longitudinal and transverse striæ 17 or 18 in 1 c.d.m. Dry valve yellowish. Length, 13 to 17 c.d.m.

Fresh water.—Common.

Pl. reversum Greg. (Diat. of Clyde, p. 58, pl. 6, f. 105), **plate 28, fig. 797.**

This is a very doubtful species. Only two examples have been seen by Gregory, and no one else has ever seen an example. The valve is inflated at the median portion and at the apices.

aaa. LONGITUDINAL STRIÆ MORE APPROXIMATE THAN THE TRANSVERSE.

a. Valves with apices not rostrate produced.

Pl. strigilis W. Sm. (S.B.D., i., p. 61, pl. 22, f. 208; H.V.H. Atl., pl. 20, f. 2*; Type No. 176), **plate 7, fig. 275.**

Valve very large, narrow, elongate, moderately sigmoid, with sub-acute apices. Raphe slightly flexuous; transverse striæ, 13 to 15, longitudinal striæ, 16 or 17 in 1 c.d.m. Length, 21 to 50 c.d.m.

Marine and brackish water.—Scheldt (H.V.H.) Coasts of England, Ireland, Denmark and probably all the Coasts of the North Sea.

Pl. Spencerii W. Sm. (S.B.D., *partim.*)

Valve narrow, linear-lanceolate or lanceolate with apices more or less sigmoid, obtuse or sub-acute. Transverse striæ, 18 to 22, longitudinal striæ, 20 to 25 in 1 c.d.m. Length, 8 to 13 c.d.m.

Fresh water or slightly brackish water.—The type form and its varieties are met with everywhere.

Constitutes a vast group of rather different forms, but which are united together by all the intermediate forms; the following forms may be distinguished as varieties :—

var. Smithii Grun. ! (*Pl. Spencerii W. Sm.* in S.B.D., i., p. 68, pl. 22, f. 218; H.V.H. Atl., pl. 21, f. 15*; Type No. 186), **plate 7, fig. 276.**

Valves lanceolate-sigmoid. Central nodule small, elongate. Transverse striæ 18·5, longitudinal striæ 21·5 in 1 c.d.m. Length, 8 to 9 c.d.m. Breadth, 1·2 c.d.m.

Fresh and brackish water.—Antwerp; Tête de Flandre (P. Gaut.), mixed in small quantities in a gathering of the *var. curvula*. England (Comber, Kitton, Norman), Ireland (O'Meara).

var. Kützingii Grun. ! (Neue, etc., 1860; H.V.H. Atl., pl. 21, f. 14*; Type No. 187), **plate 7, fig. 277.**

More elongated and broader than the preceding; central nodule elongate, larger. Transverse striæ 20·5, longitudinal striæ 22·5 in 1 c.d.m. Length, 10 to 12 c.d.m. Breadth, 1·3 to 1·5 c.d.m.

Fresh water.—Brussels (Del.). Frequent in Europe, West Indies, etc. (Grun.).

var. acutiuscula Grun. ! (Grun. in H.V.H.'s Type No. 183).

Form and striation as in the last, but slightly shorter, and with more acute apices. Length, 8 to 10 c.d.m. Breadth, 1·2 to 1·25 c.d.m.

Fresh water.—Brussels (Del.).

Prof. Cleve unites the two preceding varieties under the name of *Pl. Kutzingii.*

var. nodifera Grun. ! (Arct. D., p. 59; H.V.H. Atl., pl. 21, f. 13*; Type No. 184), **plate 7, fig. 278.**

Central nodule elongated, with an oblique hyaline area; longitudinal striæ 22 or 23, transverse striæ 17 to 20 in 1 c.d.m; the median ones slightly radiate. Length, 6 to 10 c.d.m.

Fresh water.—Brussels (Del.).

var. curvula Grun. ! (Arct. D., p. 60; H.V.H. Atl., pl. 21, f. 3-5*; Type No. 185), **plate 7, fig. 279.**

Narrow, linear, scarcely lanceolate. Transverse striæ 21 to 22·5 in 1 c.d.m.; longitudinal striæ 24 or 25 in 1 c.d.m. Length, 8 to 12 c.d.m. Breadth, 0·9 to 1·1 c.d.m.

Brackish water.—Tête de Flandre (Scheldt) at Antwerp (P. Gaut).

Pl. tenuissimum. W. Sm. (S.B.D. i., p. 67, pl. 22, f. 213*), **plate 28, fig. 798.**

Very small, excessively narrow, feebly sigmoid, with very acute apices. Longitudinal striæ, 24; transverse striæ, 18 or 19 in 1 c.d.m. Length, 14 c.d.m. Breadth, 0·7 c.d.m.

Marine.—Essex (W. Sm.), Liverpool (Comber; Stolt.), Hull (Norman), England. Ireland (O'Meara).

aa. Valves with apices rostrate produced.

Pl. Parkeri Harrison. (Q.J.M.S., 1860, p. 104; H.V.H. Atl., pl. 21, f. 10*; Type No. 190), **plate 7, fig. 280.**

Valve rather broadly lanceolate, with acute apices, longly acuminate rostrate, rostrum broad. Raphe dividing the apices of the valve into unequal moieties. Transverse striæ about 19 in 1 c.d.m. Longitudinal striæ about 22 in 1 c.d.m., forming, near the middle of the valve, flexed lines, producing ellipses by their intersections. Length, about 8 c.d.m.

Fresh water.—Rare. Pond in the Park at Antwerp. Canal at Hasselt (Van den Born). England.

Prof. Cleve considers this form to be a simple variety of *P. distortum.*

Pl. distortum W. Sm. (Ann. N.H., 1852, p. 7, pl. 1, f. 10; Pérag., p. 8, f. 32*), **plate 28, fig. 799.**

Differs from the last by its feebly tapering rostrate apices and its finer striæ, the longitudinal numbering 28 and the transverse 26 in 1 c.d.m. Length, 6 to 10 c.d.m.

Marine.—England. Ireland.

Pl. Fasciola W. Sm. (S.B.D., i., p. 67, pl. 21, f. 211; H.V.H. Atl., pl. 21, f. 8*; Types No. 191 and 192), **plate 7, fig. 281.**

Valve narrow, lanceolate, with apices longly acuminate-rostrate, strongly sigmoid, rostrum very narrow. Raphe dividing the valve into equal moieties. Striæ rather easily resolved, the longitudinal ones being about 23 and the transverse about 21 in 1 c.d.m. Length, about 10 c.d.m.

Marine.—Antwerp (Scheldt), Blankenberghe. England, Ireland, and on all the coasts of Europe.

var. arcuatum. (*Pl. arcuatum Donk.*).

Differs from the type form by its apices being more suddenly narrowed and moreover flexed, and by its slightly finer striæ.

Marine.—England, Chibburn Mouth, Druridge Bay, Cresswell (Donkin), Firth of Tay, Scotland.

var. prolongatum. (*Pl. prolongatum W. Sm. !*).

Much larger and more elongate than the preceding, apices longly produced, often flexed; transverse striæ 21 to 23, longitudinal striæ finer. Length, 21 to 27 c.d.m. Breadth, 1 to 1·5 c.d.m.

Marine.—Blankenberghe, Antwerp. South Coast of England (W. Sm.).

This form passes to the following form by every possible transition:—

Pl. macrum W. Sm. ! (S.B.D., i., p. 67, pl. 31, f. 276*; H.V.H. Atl., pl. 21, f. 9*), **plate 7, fig. 282,** and **plate 28, fig. 800.**

Valve very narrow, longly lanceolate, with apices feebly sigmoid, rather longly acuminate-rostrate, rostrum narrow. Raphe dividing the valve into equal moieties. Striæ delicate, seen with difficulty, the longitudinal ones being 25 to 28, the transverse 25 to 27 in 1 c.d.m. Length, 21 to 27 c.d.m.

Marine.—Rare: Antwerp (Scheldt), Blankenberghe. Sussex (W. Sm.), Hull (Norman), Cheshire (Comber), Ireland (O'Meara), and probably on all the coasts of the North Sea.

** **Frustules enclosed in gelatinous tubes, valves short, thick set.**

Pl. eximium (Thwaites), H. Van Heurck (*Colletonema eximium Thwaites.* Ann. & Mag., 1848, i., pl. 12F.; pl. 12F; H.V.H. Atl., pl. 21, f. 2*; Type No. 193), **plate 7, fig. 283.**

Valve short, linear, with apices sigmoid, very obtuse. Raphe appearing strongly sigmoid, dividing the valve into equal moieties. Transverse striæ about 23 to 25, longitudinal striæ 27 or 28 in 1 c.d.m. Length, about 5·5 c.d.m.

Marine.—Antwerp (Scheldt). England, Ireland, France.

Pl. scalproides Rab. (Fl. Eur. Alg., p. 241; H.V.H. Atl., pl. 21, f. 1*), **plate 7, fig. 284.**

Valve short, linear-lanceolate, slightly sigmoid, with very obtuse apices. Raphe scarcely sigmoid. Longitudinal striæ about 29 in 1 c.d.m; transverse, about 22, rather more robust than the longitudinal striæ, the median slightly radiate. Length, 6 to 7 c.d.m.

Fresh water.—Not yet found in Belgium. Probably only a form of the last.

GENUS 23.—RHOICOSIGMA GRUN., 1867
Emend H.P. 1891.

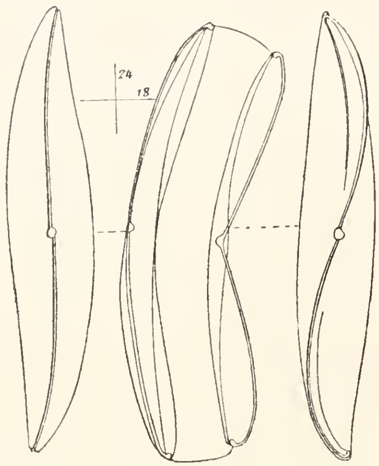


Fig. 51.
Rhoicosigma Oceanicum H.P. (after H. Peragallo).

Frustules more or less torsive, achnanthiform. Valves sigmoid, dissimilar; the upper valve delicate, convex, with raphe straight or gently flexed ; the lower more robust, concave, with raphe very sigmoid and more or less carinate. Striæ decussate or rectangular.

The genus Rhoicosigma includes about 15 species, of which only the two following belong to our latitude. Prof. Cleve does not recognise this genus, but places the species amongst the *Pleurosigma*

ANALYSIS OF SPECIES.

Striæ decussate, frustule arcuate, not achnanthiform . . .	**R. falcatum.**
Striæ rectangular, frustule rather flexed, achnanthiform . .	**R. compactum.**

Rh. falcatum (Donk.) Grun. (Grun. in Hedwigea, 1867; *Pl. falcatum Donkin*; H. Perag., p. 31, pl. 9, f. 25-27*), **plate 28, fig. 801.**

Valves linear, gently sigmoid, with apices obtuse-rounded, decussate, fine; girdle face gently arcuate, but not achnanthiform. Length, 15 to 18 c.d.m. Breadth, 1·5 c.d.m.

Marine.—Cresswell, Northumberland! (Rev. R. Taylor in Coll. W. Arnott, No. 806*b*).

Rh. compactum (Grev.) Grun. (in Cleve D. from West Ind. Arch., 1878, p. 9; *Pl. compactum Grev.*; H. Per., pl. 10, f. 7-8*), **plate 28, fig. 802.**

Valves lanceolate, with sub-acute apices, the upper with raphe straight, not projecting, the lower with raphe projecting very eccentrically on the valve. Transverse striæ 20 to 24 in 1 c.d.m., the longitudinal ones being very fine. Girdle view achnanthiform, rather flexed. Length, about 14 to 18 c.d.m, Breadth, about 3·5 c.d.m.

Marine.—Rather widespread (according to Mr. Peragallo). Bahusie (Lagerstedt),

(Group) Amphiprora Cleve, 1891.

The genus *Amphiprora* was created in 1843 by Ehrenberg in his "Verbreitung und Einfluss, etc.," p. 113, from a form which no one has been able to identify.

Prof. Pfitzer, in 1871, re-arranged the species which authors had up to that time described, and divided them into his *Amphitropis* and *Plagiotropis.*

Prof. Cleve has lately re-constructed the genus in "Le Diatomiste" (1891), by subdividing the forms into a number of very characteristic groups.

In his Monograph on the Naviculaceæ Mr. Cleve adopts the following classification, which we accordingly accept:—

Analysis of Sub-genera.

Girdle view plicate.	Raphe sigmoid		**Amphiprora.**
	Raphe not sigmoid, but bi-arcuate and very eccentric .		**Auricula.**
Girdle view not plicate (Tropidoneis).	Raphe central		**Orthotropis.**
	Raphe eccentric	Keel of both valves running in opposite directions	**Plagiotropis.**
		Keel running in one direction .	**Amphoropsis.**

GENUS 24.—AMPHIPRORA (EHR.) CLEVE, 1891.

Valve carinate, with keel sigmoid through a more or less sinuous line of suture, united to the lower portion of the valve. Axial hyaline area absent, median area absent or small. Central nodule small. Connecting zone with longitudinal plaits.

ANALYSIS OF SPECIES.

Alæ not undulate.	Keel with coarse puncta very slightly produced and very distinct, about 4 in 1 c.d.m.	**A. alata.**
	Keel without coarse puncta ; striæ fine	**A. paludosa.**
Alæ undulate, festooned		**A. ornata.**

A. alata Kütz. (Bac., p. 107, pl. 3, f. 63; H.V.H. Atl., pl. 22, f. 11 and 12*; Type No. 195), **plate 5, fig. 289.**

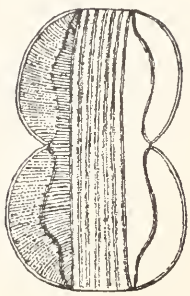


Fig. 52.
Amphiprora alata.

Valve linear elliptic, with apiculate apices. Keel sigmoid, furnished with elongated dots, about 4 in 1 c.d.m., and having on each side a very projecting sigmoid ala. Striæ fine, punctate, about 14 to 16 in 1 c.d.m. Frustule generally torsive in a longitudinal direction, oblong elliptic, deeply constricted at the median portion, with rounded apices, connecting zone showing numerous longitudinal plaits. Length, 5 to 13 c.d.m.

Marine and brackish water.—Antwerp, Blankenberghe, Heyst, England, and on all the coasts of the North Sea.

A. paludosa W. Sm. (S.B.D., i., p. 44, pl. 31, f. 269; H.V.H. Atl., pl. 22, f. 10*; Type No. 196), **plate 5, fig. 290.**

Valve elliptic lanceolate, with apiculate apices. Keel sigmoid. Striæ fine, 19 or 20 in 1 c.d.m. Frustule torsive, with girdle face deeply constricted at the median portion, apices rounded or truncate, connecting membrane with plaits fine, very approximate. Alæ very projecting, forming near the apex a plait, which, when seen in the girdle view, assumes the appearance of an inflexion or undulation. Length, 4 to 8 c.d.m.

Brackish water.—Antwerp, Blankenberghe. England (Comber, Kitton, Stolt., Norm., and W. Sm.) and probably in all our regions.

Observation.—It sometimes happens that a number of striæ become more vigorous than the others, as in the first of the two figures.

var. duplex. (*A. duplex Donk.*, T.M.S., 1858, vi., p. 28, pl. 3, f. 13; H.V.H. Atl., pl. 22, f. 15, 16*; in Type No. 416), **plate 5, fig 292.**

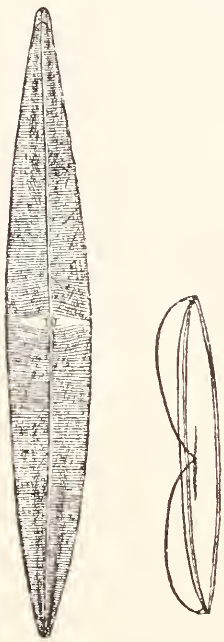
Valve with keel very sigmoid, lateral alæ with inflexion very feeble or absent. Length, 4 to 6 c.d m.

Marine.—Blankenberghe (2nd basin). Rare. England (Comber and W. Sm.). Ireland (O'Meara), and probably in all our regions.

A. ornata Bailey. (Mic. Obs. made in South Carolina, etc., p. 38, pl. 2, f. 15 and 23; H.V.H. Atl., pl. 22 *bis.*, f. 5*), **plate 5, fig. 293.**

Frustules torsive, deeply constricted at the median portion, with alæ gently undulate and festooned throughout their length. Striæ radiate, finely punctate, 20 to 22 in 1 c.d.m. Connecting zone with numerous (8 to 10) well-marked plaits. Length, 4·5 to 8 c.d.m.

Fresh water.—This beautiful and rare species has only been found once in Belgium, and that in scanty numbers, in a single gathering at Antwerp, by Rev. P. Gautier. France (Temp. Perag., No. 258). Not yet found in the British Isles.



GENUS 25.—TROPIDONEIS CLEVE, 1891.

Valve very convex, carinate, with keel not sigmoid, sometimes straight, sometimes oblique. Median pores on the median line very approximate. Axial hyaline area absent; central area absent or small. Striæ parallel, formed of small beads, forming also more or less regular longitudinal lines. Connecting zone simple, without plaits.

Fig. 53.—*Amphiprora maxima.*

Sec. I. ORTHOTROPIS CL., 1891.—*Central keel (straight), girdle face very strongly constricted.*

ANALYSIS OF SPECIES.

A pseudo-stauros round the central nodule; striæ rather robust	**O. maxima.**
No pseudo-stauros; striæ delicate. . . .	**O. lepidoptera.**
A true stauros; valve simulating a *navicula*. . .	**Pseudo-amphiprora stauroptera.**

O. lepidoptera (Greg.) Cleve. (Diat. of Clyde, p. 33, pl. 4, f. 59; H.V.H. Atl., pl. 22, f. 2-3*; Type No. 197), **plate 5, fig. 287.**

Valve lanceolate, with apices acute and slightly apiculate. Central nodule robust. Keel straight. Striæ parallel, fine, 21 in 1 c.d.m. Frustule elongate-linear, oblong, constricted at the median portion, with apices rounded, slightly inflated. Length, 10 to 20 c.d.m.

Marine.—Washings of mussels (Deby.). England (Kitton, Norman). Scotland. Irelan (O'Meara), France ?, Holland.

var. pusilla. (*A. pusilla Greg.*; Diat. of Clyde, p. 32, pl. 4, f. 56, 56*b*; in Type No. 74, very rare), **plate 29, fig. 804.**

Differs from the type form by its smaller size (4 to 6 c.d.m.), and its more approximate striæ (24 in 1 c.d.m , according to Gregory).

Marine.—Rare: Blankenberghe (H.V.H.), Braydon, Norfolk (Kitton), Bangor (Stolt.), Loch Fine, Scotland (Greg.), Ireland (O'Meara).

In his *Diatomaceæ of the Clyde* (p. 33), Dr. Gregory refers to his *A. lepidoptera* a singular form which he figures as plate 4, fig. 59*c* and 60. The same form has been figured by Dr. Ad. Schmidt (Nordsee, pl. 3, fig. 1*), under the name of *Amphiprora obtusa* (plate 29, fig. 803 of this work), and by Mr. Cleve (N.R.D. and Arct. Diat.), under the name of *Navicula arctica Cl.*

In his Synopsis Prof. Cleve has erected it into a special genus, under the name of *Pseudo-amphiprora*. The form we refer to *P. stauroptera*, has its valves elliptic-lanceolate, with obtuse apices, a moderately broad stauros and striæ fine (14 to 18 in 1 c.d.m.), punctate, parallel, and crossed on each side of the raphe by an arcuate line, somewhat constricted near the stauros. Length of the valve, 11 to 13 c.d.m. Breadth, 3 to 3·5 c.d.m.

Marine.—North Sea (Greg.); Finmark (Cleve).

O. maxima Greg. (Diat. of Clyde, p. 35, pl. 4, f. 61; H.V.H., pl. 22, f. 4-5*), **plate 5, fig. 288.**

Valve lanceolate, very slightly attenuate as far as the sub-acute apices, deeply depressed at the median portion, showing a robust arcuate ala on each side of the raphe. Striæ about 14 in 1 c.d.m., leaving a stauroneiform area round the central nodule; distinctly punctate, puncta forming longitudinal lines. Frustules rectangular, very broad, with apices rounded, deeply constricted at the median portion. Length, 11 to 16 c.d.m.

Marine.—Not yet found in Belgium. England (Kitton), Scotland (Greg.), Ireland (O'Meara), Heligoland.

Sec. II. PLAGIOTROPIS PFITZ., 1871.—*Valve with raphe eccentric, girdle face very feebly or not constricted.*

ANALYSIS OF SPECIES.

Valve with margin flexed regularly.	Frustules slightly constricted at the median portion.	Lateral plait conspicuous throughout the length of the valve . .	**Pl. elegans.**
		Lateral plait only well marked on the terminal third of the valve . .	**Pl. Van Heurckii.**
	Frustule without any constriction, only differing from a Nitzschia by the central nodule . . .		**Pl. vitrea.**
Valve with margin abruptly gibbous-inflated at the median portion			**Pl. gibberula.**

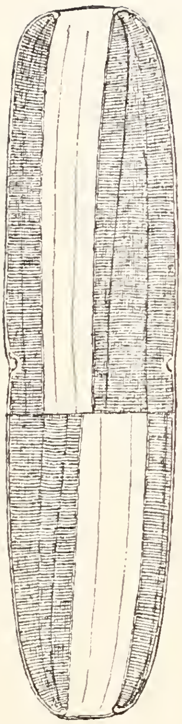


Fig. 54.
Plagiotropis elegans.

Pl. elegans (W. Sm.) Grun. (*Amphiprora elegans W. Sm.*, S.B.D., ii., p. 90; H.V.H. Atl., pl. 22, f. 1 and 6*; Type No. 199), **plate 6, fig. 294.**

Valve lanceolate, narrow, very convex. Lateral plait very visible on the girdle side throughout the length of the valve. Striæ about 13 in 1 c.d.m., very visible, granular, leaving a small hyaline area round the central nodule. Girdle face sub-quadrangular, with rounded apices. Length, 20 to 30 c.d.m.

Marine.—Rare. Washing of mussels (Deby), Blankenberghe (H.V.H.), England (W. Sm.; Kitton), Scotland (Greg.), Ireland (W. Sm.).

Pl. Van Heurckii Grun. (H.V.H. Atl., pl. 22 *bis*., f. 6, 7, 8*; Type No. 198), **plate 6, fig. 295.**

Valve lanceolate, with apices strongly tapering. Lateral plait abruptly arcuate from the third of the valve, and only distinctly visible (in girdle view) on the terminal third of the frustule. Striæ very delicate, about 22 in 1 c.d.m. Girdle face quadrangular, sub-elliptic, with median portion scarcely constricted. Length, about 6 c.d.m.

Marine.—I made an abundant gathering of this interesting species in the spring and autumn of 1882 in the Retaining Basin of Blankenberghe. I had not previously noticed it.

Pl. vitrea (W. Sm.) Grun. (Arct. D., p. 67; H.V.H. Atl., pl. 22, f. 7-9*), **plate 29, fig. 805.**

Valve lanceolate, with keel very eccentric, central nodule rather small, transverse striæ fine, 17 to 19 in 1 c.d.m. Girdle face lanceolate, subtruncate, without any constriction. Length, 7·5 to 10·5 c.d.m. Breadth of valve, 1·5 to about 2 c.d.m. Breadth of frustule, 8·5 to 14·5 c.d.m.

This singular form has all the appearance of a Nitzschia, and on first examination is only distinguished from one by the central nodule being more developed and the absence of dots on the keel.

Marine.—Coasts of England, Scotland, Denmark, France (Calvados), Oldenburg.

Pl. gibberula Grun. (H.V.H. Atl., pl. 22 *bis.*, f. 12, 13* without description), **plate 29, fig. 806.**

Valve lanceolate, narrow, with acute apices and margins abruptly gibbous-inflated at the median portion. Striæ fine, 18 in 1 c.d.m. Girdle face slightly constricted, appearing at first view to be achnanthiform in consequence of the presence of a projecting boss.

Marine.—Firth of Tay (Scotland). Heligoland.

Sec. III. AMPHOROPSIS GRUN. *(in Syn.* 1883).—*Valve with raphe eccentric; keels running in same direction.*

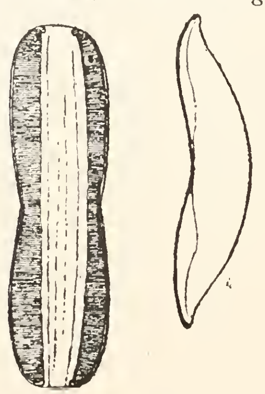


Fig. 55.—*Amphoropsis recta.*

A. recta (Greg.) Grun. (*Amphiprora recta Greg.* T.M.S., 1857, v., p. 56, pl. 1, f. 40; H.V.H. Atl., pl. 22 *bis.*, f. 9-10. Cleve and Möll. Diat.)

Frustules rectangular, gently constricted at the median portion, with rounded angles. Valve strongly unequilateral, without distinct alæ. Transverse striæ 21 to 24 in 1 c.d.m. Length, 8 to 9 c.d.m. Breadth, 2 to 3 c.d.m.

Marine.—Mouth of the Tay, Scotland (Greg.)

GENUS 26.—AURICULA CASTR., 1873.

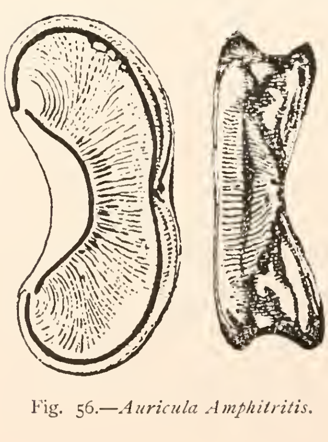


Fig. 56.—*Auricula Amphitritis.*

Valves very convex, extremely asymmetrical; ventral and dorsal portions in different planes. Raphe raised like a keel, not sigmoid, oblique. Keels of the two valves turned on the same side. The two terminal nodules connected by a semi-mammiform elevation. Sutural zone complex.

The genus *Auricula* was created by Count Castracane for a very curious form found in the Island of Lesina in the

Adriatic. Since then various analogous forms have been found, and Prof. Cleve has included in this genus *Amphiprora complexa* and *A. decipiens*.

ANALYSIS OF SPECIES.

Valve in the form of a boat, 20 to 22 striæ in 1 c.d.m. Connecting zone without scattered coarse dots		. **A. decipiens.**
Valve reniform.	Striæ fine, 20 in 1 c.d.m. . . .	. **A. complexa.**
	Striæ robust, 8 in 1 c.d.m. . . .	. **A. Amphitritis.**

A. decipiens (Grun.) (*Amphoropsis decipiens Grun.* in Cl. and M. Diat., No. 309; H.V.H. Atl., pl. 22 *bis.*, f. 11*; *Amphiprora plicata Greg.*, Diat. of Clyde, p. 33, pl. 4, f. 57).

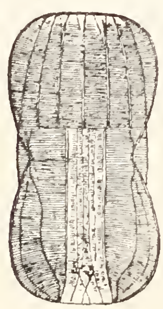


Fig 57.
Amphoropsis decipiens.

Frustule rectangular, somewhat constricted at the median portion; line of juncture sinuous, median area indistinct, striæ 20 in 1 c.d.m. Sutural zone divided, having about three divisions in 1 c.d.m., broad on the dorsal face, narrower on the ventral face, and having about 22 striæ in 1 c.d.m. Length of frustule, 6 to 11 c.d.m. Breadth, 5 c.d.m.

Marine.—Coasts of Scotland (Greg., etc.)!

A. complexa (Greg.) Cl. (*Amphiprora complexa Greg.* in Diat. of Clyde, p. 36, pl. 4, f. 62*), **plate 29, fig. 807.**

Frustule subquadrangular, elongated, with median portion constricted. Valves arcuate, raphe inflexed. Connecting zone having 5 or 6 cuneate segments, semi-lunar, somewhat constricted at the median portion, finely striated, striæ somewhat radiant, 20 in 1 c.d.m., bordered with a row of beads (about 8 in 1 c.d.m.) on the dorsal margin. Frustules: length, 9 to 12 c.d.m.; breadth, about 7 c.d.m.

Marine.—Coasts of Scotland (Greg).

The two following species which Prof. Cleve records from Sweden may perhaps also be found in the North Sea.

A. insecta Grun. (*A. mucronata H. L. Sm.*, Spec. Diat. Typ. No. 38; Am. Q.M.J., 1878, p. 17, pl. 3, f. 9*), **plate 29, fig. 808.**

A. minuta Cleve. (Syn. of the Nav. Diat., p. 21, pl. 1, f. 7-8*), plate 29, fig. 809.

A. Amphitritis Castr. (Diat. e Dalm. c. icone; Pérag Diat. Villefr., p. 85, pl. 2, f. 18, and pl. 5, f. 41).

Characters of the genus. Valve face with ventral margin arcuate, slightly constricted in the median portion with a submarginal raphe edged with a row of beads, abruptly depressed opposite the median nodule. Ventral margin concave, smooth as far as a very conspicuous line which connects the two terminal nodules, which are elongated, narrow. Striæ on the valve face, radiate, bifurcating several times, 16 in 1 c.d.m. Length of valve, 8 to 10 c.d.m. Breadth, 6 c.d.m.

Marine.—Lesina, Adriatic (Castracane). Villefranche Bay, Mediterranean Sea (Peragallo). Balearic Isles (Cleve !).

TRIBE III.—GOMPHONEMEÆ.

Frustules curved in girdle view; nodule or concave valve . .	**Rhoicosphenia.**
All other forms	**Gomphonema.**

GENUS 27.—GOMPHONEMA AG., 1824.

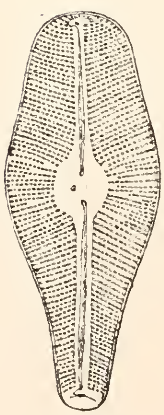


Fig. 58. *Gomphonema geminatum.*

Valve naviculoid, asymmetrical, one of the apices narrower than the other and cuneate. Frustules cuneate in valve view. Parasitic, sessile or stipitate, sometimes enveloped in a mucous mass. Endochrome formed of a single lamina, which rests at the centre on one of the sides of the connecting zone, and covers the two adjacent valves and the other side of the zone, on the middle of which is found the line of separation.

Prof. Cleve dismembers the genus *Gomphonema*, and separates from it three species (*G. Herculanum*, *mamilla*, and *elegans*) to constitute his genus *Gomphoneis.* These three species have, as common characteristics, transverse costæ, between which is found a double row of small alternating beads (as in *N. Smithii*, etc.), and traversed by a marginal sulcus, more or less distinct.

ANALYSIS OF SPECIES.

* *Asymmetrica Grun.* Valve having a rather large isolated dot near one of the sides of the central nodule.

- Median striæ alternately long and short.
  - Valve very large, inflated at the two apices . **G. geminatum.**
  - Valve rather small, not inflated at the lower apex . . . . **G. constrictum.**
- Median striæ not alternately long and short; no large rounded hyaline area.
  - Valve without a hyaline area, slightly stauroneiform.
    - Valve not lanceolate rostrate.
      - Upper apex apiculate.
        - Valve inflated at median portion . **G. acuminatum.**
        - Valve not inflated at median portion . **G. Augur.**
      - Upper apex not apiculate.
        - Median portion and upper apex inflated **G. subtile.**
        - No portion inflated . **G. montanum.**
    - Valve lanceolate-rostrate . . . **G. parvulum.**
  - Valve having a hyaline area, more or less stauroneiform.
    - At least one of the apices of the valve subacute.
      - Valve naviculoid, with the two apices nearly similar . . . **G. gracile.**
      - Valve gomphonemoid, with the two apices dissimilar . . **G. micropus.**
    - The two apices almost equally obtuse.
      - Valve narrow, elongate, length 6 to 8 times its breadth.
        - Valve very large, rather broad . **G. Vibrio.**
        - Valve of medium size or small, narrow . **G. intricatum.**
      - Valve not very elongate, length about 4-5 times its breadth . **G. angustatum.**
- A large round hyaline area . . . . . . **G. ventricosum.**

* * *Symmetrica Grun.* No isolated dot; the two sides of the valve similar.

- Fresh water: Pseudo-stauros very visible; striæ radiate . . . **G. olivaceum.**
- Marine: No pseudo-stauros; striæ sub-parallel . . . **G. exiguum.**

I. Striæ near the nodule alternately long and short, at least on one of the sides of the valve.

G. geminatum (Lyngb.) Ag. (Syst. 1824, p. 12; W. Sm., S.B.D., i., p. 78, pl. 27, f. 235*), **plate 29, fig. 810.**

Valve large, strongly inflated at the median portion, with apices inflated, capitate; the lower apex considerably smaller than the upper. Raphe surrounded by a considerable hyaline area, inflated round the median nodule, and displaying 3 to 5 granules placed unilaterally. Transverse striæ robust, 9 or 10 in 1 c.d.m., strongly granular, radiate, convergent in the middle of the valve, divergent towards the apices, going round the upper terminal nodule, absent round the lower terminal nodule, which terminates in a smooth space. Median striæ dividing dichotomously, and consequently appearing alternately long and short. Length, about 9 to 12 c.d.m. Breadth at median portion, about 3·5 to 4 c.d.m.

Fresh water.—England (Kitton, Comber). Wales (Ralfs); in the Mountains of Scotland, Ireland, Scandinavia, etc.

G. constrictum Ehr. (Abh., 1830; H.V.H. Atl., pl. 23, f. 6*; Type No. 205), **plate 7, fig. 296.**

Valve cuneate, strongly inflated at median portion, with lower apex narrow, margins almost parallel, slightly cuneate, upper apex broad, deeply constricted at the middle, and forming thus an apex broadly capitate, truncate, rounded. Raphe surrounded by a rather broad hyaline zone. Terminal nodules not reaching to the apices. Striæ radiate, alternately long and short round the central nodule, robust, finely divided transversely, 10 to 12 in 1 c.d.m. Length, about 4 to 6 c.d.m.

Fresh water.—Rather common, everywhere.

var. capitatum. (*G. capitatum Ehr.*; H.V.H. Atl., pl. 23, fig. 7*), **plate 7, fig. 297.**

Differs from the preceding by the constriction on the upper portion of the valve being absent or very slight.

Fresh water.—Less common than the preceding.

forma curta. (H.V.H. Atl., pl. 23, f. 8*; Type No. 206), **plate 7, fig. 298.**

Differs from the preceding by its short thick-set form (2 to 3 c.d.m.), and the triangular form of the lower portion of the valve.

Fresh water.—Rather frequent.

II. Median striæ not alternately long and short.

I. No large rounded hyaline area.

a. VALVE WITHOUT A MORE OR LESS STAURONEIFORM HYALINE AREA IN THE MEDIAN PORTION.

b. Valve not lanceolate-rostrate.

c. UPPER APEX APICULATE.

G. acuminatum Ehr. (Inf., p. 217, n. 308, pl. 18, f. 4; H.V.H. Atl., pl. 23, f. 16*); in Types Nos. 10, 18, etc., **plate 7, fig. 299.**

Valve cuneate, inflated in the middle, lower part with almost parallel margins, slightly constricted in the median portion; upper apex dilated, capitate, triangular, obtuse, apiculate. Raphe surrounded by a distinct hyaline zone. Median striæ opposite the unilateral dot very shortened, the others quite equally prolonged, finely punctate, radiate, 10 to 11 in 1 c.d.m. Length, about 3 to 7 c.d.m.

Fresh water.—Rather common everywhere.

var. coronatum. (*G coronatum Ehr*; H.V.H. Atl., pl. 23, f. 15*; in Type No. 220), **plate 7, fig. 300.**

More elongate (7 to 8 c.d.m.), broader and much more constricted at the upper portion.

Fresh water.—Slightly rarer than the preceding.

G. Augur Ehr. (Abh., 1840, p. 17; H.V.H. Atl., pl. 23, f. 29*; Type No. 208), **plate 7, fig. 301.**

Valve cordate-cuneate, with upper apex obtuse-apiculate, lower apex preceptibly attenuate, slighty subrostrate. Raphe with a distinct hyaline zone. Median striæ opposite the nodule very shortened, the others equally prolonged, radiate up to the apices, about 10 in 1 c.d.m. Length, 3 to 5 c.d.m.

Fresh water.—Rather frequent throughout.

var. Gautieri. H.V.H. (H.V.H. Atl., pl. 23, f. 28*), **plate 7, fig. 302.**

Average size much larger (about 5 c.d.m.). Valve broader, margins of upper portion of the valve nearly parallel, very slightly constricted.

Rare.—Louvain Gautier)

cc. UPPER APEX NOT APICULATE.

G. subtile Ehr. (Verb., p. 128, No. 115; H.V.H. Atl., pl. 23, f. 13-14*), **plate 29, fig. 811.**

Exactly the same (with the exception of the upper apiculation, which is absent), as *G. acuminatum*, of which it appears to be a miniature. Transverse striæ radiate, 10 in 1 c.d.m. Length, about 4·5 c.d.m.

Fresh water.—England (Norman), Lough Mourne, Ireland (Greg.) Elgin, Scotland (W. Arnott !)

G. montanum Schumann. (Hoh. Tatra, p. 67, pl. 3, f. 35*b*; H.V.H. Atl., pl. 23, f. 33 and 36*; in Types Nos. 196 and 348), **plate 7, fig. 303.**

Valve sometimes scarcely cuneate, more or less tri-undulate, with apices very gently narrow, produced. Raphe with rather broad hyaline zone.

Median striæ much shortened, the others radiant up to the apices, 9 to 10 in 1 c.d.m. Length, 4 to 8 c.d.m.

Fresh water.—Rare. Alle (Delogne), Ard. Liég. (De Wild.).

var. subclavatum Grun. (H.V.H. Atl., pl. 23, f. 38* ; in Type 196), **plate 7, fig. 304.**

Differs from the type form by the undulations being feebly marked or absent, the valve being often only slightly inflated at the median portion.

Fresh water.—Rare. Namur (P. Gautier), Alle (Del.)

var. commutatum Grun. (H.V.H. Atl., pl. 24, f. 2* ; Type No. 211), **plate 7, fig. 305.**

Differs from the last variety, into which it passes imperceptibly, by its shorter and gently lanceolate form.

Fresh water.—Brussels (Delogne).

bb. Valve rostrate-lanceolate.

G. parvulum Kütz. (Bac., p. 83, pl. 30, f. 63 ; H.V.H. Atl., pl. 25, f. 9* ; in Types Nos. 25, 206, 211, etc.), **plate 7, fig. 306.**

Valve cuneate-lanceolate, with apices rostrate tapering. Striæ nearly reaching to the raphe, the median one much shortened, the others of equal length, radiant, about 14 in 1 c.d.m. Length, 2 to 3 c.d.m.

Fresh water.—Common.

var. lanceolata. (H.V.H. Atl., pl. 25, f. 10*), **plate 7, fig. 307.**

More elongate and more narrowly lanceolate.

var. subcapitata. (H.V.H. Atl., pl. 25, f. 11*), **plate 7, fig. 308.**

With upper rostrum slightly capitate.

Prof. Cleve considers the *G. micropus* described below as a mere variety of *G. parvulum.*

aa. VALVE HAVING NEAR THE CENTRAL NODULE A HYALINE AREA MORE OR LESS STAURONEIFORM.

b. At least one of the apices of the valve sub-acute.

G. gracile Ehr. (Inf., p. 217, No. 307, pl. 18, f. 3 ; *G. naviculoides W. Sm.* ; H.V.H., pl. 24, f. 12, 13, 14* ; Type No. 212), **plate 7, fig. 309.**

Valve lanceolate, rhomboidal, elongate, with apices almost similar. Raphe surrounded by a distinct area, dilated into a kind of pseudo-stauros at the median portion. Nodules slightly distant from the apices. Striæ feebly radiant, about 9 or 10 in 1 c.d.m. Length, 3·5 to 9 c.d.m.

Fresh water.—Mozaive (Delogne). Ard. Liég. (De Wild.). Edinburgh, Scotland (W. Sm.). Holland (Suringar).

var. dichotomum. (*G. dichotomum W. Sm.*; H.V.H. Atl., pl. 24, f. 19, 20, 21*), **plate 7, fig. 310.**

Less naviculoid, upper apex of valve more obtuse and gently constricted; striæ finer, 12 or 13 in 1 c.d.m. Length, 3·0 to 4·5 c.d.m.

Fresh water.—England (Comber, Norman). Scotland (W. Sm.). Ireland (W. Sm.). Sweden. Finland (Cleve).

var. auritum. (*G. auritum A. Braun*; H.V.H. Atl., pl. 24, f. 15*; in Type No. 212), **plate 7, fig. 311.**

Very narrowly lanceolate and less rhomboidal; in the living state furnished with two mucous hyaline horns (see H.V.H. Atl., pl. 24, f. 17*b*).

Fresh water.—Frahan (Delogne). Scotland. Finland, Norway, &c. (Cleve).

G. micropus Kütz. (Bac., pl. 8, f. 12; H.V.H. Atl., pl. 25, f. 4 and 5; pl. 24, f. 46*: Type No. 219, a form passing into *parvulum*), **plate 7, fig. 312.**

Valve lanceolate, feebly gomphonemoid, with lower moiety regularly attenuate as far as the apex, more or less subacute; the upper moiety a little inflated, with apex very slightly rostrate, capitate. Striæ approximate to raphe, feebly radiant, 10 in 1 c.d.m. Length, 2·5 to 3 c.d.m.

Fresh water.—Rather rare? Ard. Liég. (De Wild.). Glasgow, Scotland. France (Brébisson.)

bb. The two apices of valve almost equally obtuse.

G. intricatum Kütz. (Bac., p. 87, pl. 9, f. 4; H.V.H. Atl., pl. 24, f. 28, 29: Type No. 214 [a variety]), **plate 7, fig. 313.**

Valve narrow, almost linear, length about 6 to 8 times the breadth, a little inflated at the median portion. Raphe surrounded by a considerable hyaline zone; nodules distant from the apices. Striæ feebly radiant, 8 to 10 in 1 c.d.m. Length, about 4 to 6 c.d.m.

Fresh water.—Ard. Liég. (De Wild.). England (Comber, Norman). Ireland (O'Meara).

var. vibrio. (*G. vibrio Ehr.*, Verb., p. 128, pl. 2, i., fig. 40; H.V.H. Atl., pl. 24, f. 26 and 27*; Type No. 216), **plate 29, fig. 812.**

Exactly resembles the previous form, from which it only differs in its size being larger, which attains 9 c.d.m., and by the stauroneiform hyaline area being much more distinct.

Quiet fresh water.—England (Norman), Ireland (O'Meara). France, Prussia, and probably others.

G. angustatum Kütz. (Bac., p. 83, pl. 8, f. 4; *G. commune Rab.*; H.V.H. Atl., pl. 24, f. 48, 49, 50*; Type No. 215), **plate 7, fig. 314.**

Valve rather broadly lanceolate, almost regular, length about 4 to 5 times the breadth, with apices obtuse, feebly rostrate sub-capitate. Raphe surrounded by a distinct hyaline zone, with a rather broad stauroneiform blank space. Striæ slightly radiant, 10 or 11 in 1 c.d.m.

Fresh water.—Common.

G. ventricosum Greg. (Q.J.M.S., 1856, iv., p. 12, pl. 1, f. 40; H.V.H. Atl., pl. 25, f. 13*), **plate 8, fig. 314** *bis*.

Valve lanceolate-clavate, very inflated at the median portion, with upper apex inflated obtuse; lower apex obtuse, very narrow; raphe surrounded by a lanceolate hyaline area, enlarged at the median portion and showing in the type form a single asymmetrical dot. Median striæ finely punctate, 11 to 13 in 1 c.d.m. Length, 3·5 to 5·5 c.d.m. Breadth at the median portion, about 1 c.d.m.

Fresh water.—North of Europe: Scotland (Greg.). Norway. Sweden. Finland (Cleve).

var. ornata. Grun. (H.V.H. Atl., pl. 25, f. 14-15).

Distinguished by a semi-circle of dots arranged near the central nodule.

Habitat.—Guatemala. Has been found in a fossil state in Hungary.

G. Sarcophagus Greg. (Q.J.M.S., 1856, p. 13, pl. 1, f. 42; H.V.H. Atl., pl. 25, f. 2*; Type No. 216), **plate 29, fig. 813.**

Grunow made this a variety of *G. angustatum*. It is an extremely remarkable form, recognisable by its sub-paralled sides, narrow apices and very distant striæ, about 8 in 1 c.d.m. Length, about 4 c.d.m.

Fresh water.—Scotland, mixed with the type form (Greg. W. Sm.!), Ireland (O'Meara).

2. A large rounded hyaline area.

G. olivaceum Kütz. (Bac., p. 85, pl. 7, f. 13 and 15; H.V.H. Atl., pl. 25, f. 20, *a* and *b*; Type No. 221), **plate 7, fig. 315.**

Valve lanceolate, feebly gomphonemoid, with apices slightly produced, or a little clavate. Raphe surrounded by a distinct hyaline zone which, in the middle of the valve, by the abbreviation of the median striæ, forms a very visible pseudo-stauros. Striæ radiant, 10 in 1 c.d.m. Length, 2·5 to 3·5 c.d.m.

Fresh water.—Rather frequent, the two forms often mixed together. Belgium, England, Ireland Sweden, etc.

var. vulgaris Grun. (*Sphenella vulgaris Kütz.* ; H.V.H. Atl., pl. 25, f. 21* ; in Type No. 221), **plate 7, fig. 316.**

Smaller and more strongly clavate. Length, 2 to 2·25 c.d.m.

Fresh water.—Common.

G. exiguum Kütz. (Bac., p. 84, pl. 30, f. 58 ; H.V.H. Atl., pl. 25, f. 34 ; in Type No. 356), **plate 7, fig. 317.**

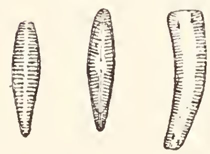
Valves narrowly and regularly cuneate, with upper apex obtuse, a little narrowed. Raphe surrounded by a feeble hyaline zone. Striæ sub-parallel, quite equally approximate to raphe, about 18 in 1 c.d.m. Length, about 1·5 c.d.m.

Marine.—Ostend, mixed with a gathering of *Grammatophora oceanica* (Westendorp), England (Norman), Calvados (Brébisson), Cuxhaven, Denmark, Heligoland.

var. minutissima. (H.V.H. Atl., pl. 25, f. 38* ; in Type No. 536), **plate 7, fig. 318.**

Much smaller than the type form.

Same gathering.



a. *b.* *c.*
Fig. 59.—*Rhoicosphenia curvata.*
a. Upper valve.
b. Lower valve.
c. Frustule.

GENUS 28.—RHOICOSPHENIA GRUN. 1860.

Valves cuneate, dissimilar ; the upper valve having only a pseudo raphe, and without nodules ; the lower valve furnished with a true raphe and nodules. Frustules flexed in girdle view. Endochrome as in the *Gomphonema.*

ANALYSIS OF SPECIES.

Frustule from 2 to 5 c.d.m.	Striæ not marginal . .	. **R. curvata.**
Frustule 1 c.d.m. or more.	Striæ submarginal on upper valve .	. **R. Van Heurckii.**

R. curvata (Kütz.) Grun. (Novara, p. 8 ; H.V.H. Atl., pl. 26, f. 1, 2, and 3* ; Type No. 224), **plate 7, fig. 319.**

Valves cuneate, with upper apex slightly produced obtuse, lower moiety very slightly attenuate to a sub-obtuse point, showing a lumen at each of the apices. Upper valve with striæ parallel, robust, all reaching to the pseudo raphe, 10 in 1 c.d.m. Lower valve with striæ radiate, about 12 in 1 c.d.m. Raphe surrounded by a small hyaline zone, dilated round the central nodule. Length, 1·3 to 4·5 c.d.m.

Fresh water.—Common.

var. marinum. (*G. marinum W. Sm.*; H.V.H. Atl, pl. 26, f. 4; Type No. 225), plate 7, fig. 320.

Differs from the preceding by its size being generally larger, and its marine habitat.

R. Van Heurckii Grun. (H.V.H. Atl., pl. 26, f. 5, 6, 7, 8, and 9*), plate 7, fig. 321.

Very small. Valves broadly lanceolate-subcuneate. Upper valve with striæ radiate, submarginal, 14 or 15 in 1 c.d.m. Lower valve with striæ reaching nearly to the raphe, about 18 in 1 c.d.m. Length, rather less than 1 c.d.m. (·7 to ·9 c.d.m.).

Fresh water.—Very rare? Brussels, Botanical Gardens (Del.).

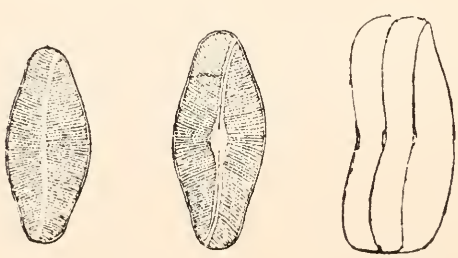
This curious species has been found at Auvergne (Heribaud), and will probably be met with elsewhere.

Tribe IV.—Achnantheæ.

Valve with straight raphe	**Achnanthes.**
Valve with sigmoid raphe	**Achnanthidium.**

GENUS 29.—ACHNANTHIDIUM (KÜTZ) GRUN., 1880.

Valves elliptic, strongly inflated at the median portion. Raphe sigmoid. Upper valve with only a pseudo-raphe; lower valve with a



a. *b.* *c.*

Fig. 60.—*Achnanthidium flexellum.*
a, Upper valve. *b*. Lower valve. *c*, Frustule.

true raphe and nodules. Frustules geniculate in girdle view, solitary or united by threes.

This genus, with the character above given, only embraces a single species.

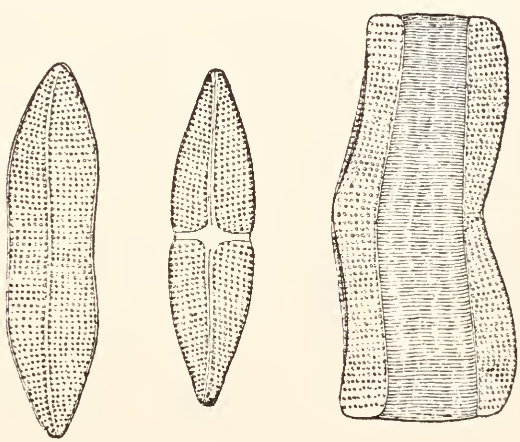
A. flexellum Breb. (in Kütz. Spec. Alg., p. 54; H.V.H. Atl., pl. 26, f. 29, 30, 31*), plate 8, fig. 322.

Characteristics of the genus. Striæ radiate, delicate, finely punctate, 17 in 1 c.d.m., the median alternately long and short, more distant and more strongly marked. Length. 4 to 5 c.d.m.

Fresh water.—Rare. Bergh (Delogne). Env of Louvain (H.V.H.) England (Comber, Kitton), Scotland. Ireland.

GENUS 30.—ACHNANTHES BORY., 1822.

Valves naviculoid, dissimilar, with straight raphe. Upper valve with only a pseudo raphe, and without nodules; lower valve with true



a b. c.

Fig 61.—*Achnanthes brevipes*.
a. Upper valve.
b. Lower valve.
c. Frustule.

raphe, and central and terminal nodules. Frustules geniculate in girdle view; individuals solitary, geminate, or united into bands. Endochrome formed of a single layer, very thick, resting on the internal surface of one of the two valves, so that the other remains free.

ANALYSIS OF SPECIES.

1. *Valves with costæ, between which are two rows of small beads* . . . . . . **A. longipes.**

2. *Valves beaded, without costæ.*

* Lower valve with a stauros.

- Upper valve with raphe usually centric, flexed.
  - Valve with cuneate apices . . . . . **A. brevipes.**
  - Valve with apices obtuse-rounded.
    - Valve constricted, at least at the median portion.
      - Valve constricted only at the median portion, with apices very slightly obtuse-rounded . . . **A. subsessilis.**
      - Valve constricted in the middle and just before the apices which are truncate-rounded . **A. coarctata.**
    - Valve not constricted, regularly elliptic very small . . . . **A. parvula.**
- Upper valve with raphe eccentric, straight.
  - Valve linear sub-elliptic; median striæ shortened . **A. Hungarica.**
  - Valve linear-lanceolate; all the striæ of equal length . **A. affinis.**

** Lower valve without stauros.

a. UPPER VALVE ONLY DIFFERING FROM THE LOWER BY THE ABSENCE OF RAPHE AND NODULES.

- Valves broadly lanceolate or elliptic lanceolate.
  - Apices sub-acute; striæ very robust . . **A. delicatula.**
  - Apices obtuse; striæ delicate . . . **A. Biasolettiana.**
- Valve narrowly lanceolate or linear.
  - Valve with capitate apices . . . **A. microcephala.**
  - Valves with apices not capitate.
    - Central nodule surrounded by a hyaline area . . . . **A. exilis.**
    - Central nodule without hyaline area.
      - Striæ parallel; apices obtuse . **A. linearis.**
      - Median striæ somewhat radiate; apices somewhat rostrate . . . **A. minutissima.**
- Valve longly elliptic, inflated in the middle and at the apices . . **A. trinodis.**

b. UPPER VALVE DIFFERING FROM THE LOWER BY THE PRESENCE ON ONE OF ITS MARGINS OF A HYALINE SPACE IN THE FORM OF A HORSE SHOE . . **A. lanceolata.**

I.—*Valve with costæ, between which are two rows of small beads.*

A. longipes C. Ag. (Syst., p. 1; Consp., p. 58, No. 1; H.V.H. Atl., pl. 26, f. 13, 14, 15, and 16*; Type No. 229), **plate 8, fig. 323.**

Valves linear-elliptic, constricted at the median portion, with apices more or less obtuse, furnished with strong transverse costæ, about 6 in 1 c.d.m., between which are two rows of beads, sometimes opposite, sometimes alternate; upper valve without raphe, having sometimes at the apex a small hyaline area (Grunow); lower valve with a raphe surrounded by a feeble hyaline zone. Central nodule dilated transversely into a narrow stauros. Frustule with connecting zone finely striated transversely, the striæ interrupted by longitudinal plaits. Length, about 5 to 18 c.d.m.

Marine.—Ostend. England (Kitton, Comber, Stolt, Norman), Ireland (O'Meara), Denmark, Norway.

II. *Valve beaded, without costæ.*

*Lower valve with a stauros.

a. UPPER VALVE WITH RAPHE CENTRIC, FLEXED.

A. brevipes C. Ag. (Syst., p. 1, Consp., p. 59, No. 3; H.V.H. Atl., pl. 26, f. 10, 11 and 12*; Type No. 227), **plate 8, fig. 324.**

Valves linear-lanceolate, median portion constricted, apices cuneate; striæ about 7 in 1 c.d.m., composed of 2 to 7 coarse beads; upper valve without raphe, lower valve with raphe surrounded by a distinct hyaline area, increasing in breadth towards the median portion. Central nodule dilated into a rather broad stauros. Connecting zone as in the preceding. Length, 7 to 10 c.d.m.

Marine.—Ostend. England (Kitton, Comber, Stott, Norman). Scotland. Ireland (O'Meara). Probably on all the shores of the North Sea.

A. subsessilis Ehr. (Inf., p. 228, pl. 20, f. 3; H.V.H. Atl., pl. 26, f. 21, 22, 23 and 24*; Type No. 231), **plate 8, fig. 325.**

Differs from the preceding, with which it is connected by intermediate forms, by the obtuse-rounded apex of the valves, its smaller size and its finer striæ, about 10 in 1 c.d.m., formed of 4 to 7 beads. Length, 3 to 5 c.d.m.

Marine.—Antwerp, Ostend. Holland (H.V.H.). England (Kitton, Comber, Stolt, Norman). Scotland. Ireland (O'Meara). Probably throughout the North Sea.

A. parvula Kütz. Bac., p. 76, pl. 21, f. 5; H.V.H. Atl., pl. 26, f. 25, 26, 27, and 28*; Type No. 233), **plate 8, fig. 326.**

Valve elliptic-lanceolate, not constricted at the median portion, the upper having 11-13 plainly punctated striæ in 1 c.d.m., the lower with a rather broad stauros; raphe surrounded with a small hyaline zone having 14-16 punctated striæ in 1 c.d.m. Connecting zone striate and plicate as in the preceding. Length, 1 to 1·5 c.d.m.

Marine.—Ostend (Westendorp, No. 795). England (Norman). Ireland (O'Meara). France Brébisson).

A. coarctata Breb. (In W. Sm., S.B.D., ii., p. 31, pl. 61, f. 379; H.V.H. Atl., pl. 26, f. 17, 18, 19, and 20*; Type No. 230), **plate 8, fig. 327.**

Valves linear elliptic, constricted in the median portion, and slightly so near the apices, which are sub-capitate, sub-truncate, rounded; upper valve with pseudo-raphe very eccentric, striæ distinctly punctate, 12 to 14 in 1 c.d.m., appearing oblique from the median portion; lower valve with a broad stauros, having 13 to 15 striæ in 1 c.d.m. Length, 1 to 4 c.d.m.

Fresh water.—Frahan (Delogne), England (Comber, Norman), Scotland (Baxter Coll., No. 2579), Ireland (O'Meara), France.

aa. UPPER VALVE WITH RAPHE ECCENTRIC, STRAIGHT.

A. Hungarica Grun. (Arct. D., p. 20; H.V.H. Atl., pl. 27, f. 1 and 2*; in Type No. 196), **plate 8, fig. 328.**

Valves linear lanceolate, with apices rounded-obtuse or cuneate; upper valve with striæ almost parallel, the two median shortened; lower valve with radiant striæ finely punctate, about 21 in 1 c.d.m. Raphe surrounded by a narrow hyaline area, somewhat broader about the middle of the valve. Length, 2 to 3 c.d.m.

Fresh water.—Antwerp, Austruweel, and Wilryck, near Antwerp (Gaut.). England!

A. affinis Grun. (Arct. D., p. 20; H.V.H. Atl., pl. 27, f. 39 and 40*), **plate 8, fig. 329.**

Valve linear lanceolate, narrow, with apices obtuse rounded, having 27 to 30 striæ in 1 c.d.m. Upper valve with almost parallel striæ; lower valve with radiant striæ and broad pseudo-stauros. Length, 1·5 to 2·3 c.d.m.

Fresh water.—Brussels (Delogne.)

Lower valve without stauros.

a UPPER VALVE ONLY DIFFERING FROM THE LOWER VALVE BY THE ABSENCE OF NODULE AND RAPHE.

b. Valves broadly lanceolate or elliptic-lanceolate.

A. delicatula Kütz. (Bac., p. 75, pl. 3. f. 21 ; H.V.H Atl., pl. 27, f. 3 and 4* ; Type No. 234), **plate 8, fig. 330.**

Valves broadly lanceolate, with apices very frequently produced, rostrate, subacute, having about 15 robust striæ, feebly radiant in 1 c.d.m. ; lower valve with median striæ shortened ; raphe surrounded by a narrow median zone, somewhat dilated into a rounded area round the central nodule. Length 1 to 2 c.d.m.

Brackish water.—Antwerp (H.V.H., Type No. 11). England (H.V.H., Type No. 234).

A. Biasolettiana Grun. (Arct. D., p. 22 ; H.V.H. Atl., pl. 27, f. 27 and 28* ; Type No. 237), **plate 8, fig. 331.**

Valve lanceolate, with apices rounded, obtuse, median portion inflated, striæ fine, feebly radiant, 22 to 28 in 1 c.d.m. ; lower valve with central nodule surrounded by a small rounded hyaline area. Length. about 1 c.d.m.

Fresh water.—Brussels (Delogne).

bb. Valves narrowly lanceolate or linear.

A. microcephala Kütz. (Bac., p. 75, pl. 3, f. 13 and 19 ; H.V.H. Atl., pl. 27, f. 20-23*), **plate 8, fig. 332.**

Valves very narrowly lanceolate, apices capitate, having 30 to 36 feebly radiant striæ in 1 c.d.m. ; upper valve with all striæ of equal length, except the median, which is somewhat shorter ; lower valve with a much shortened median striæ, leaving an elongated hyaline area near the central nodule Length, 1 to 1·5 c.d.m. Breadth, about ·3 of a c.d.m.

Fresh water.—Groenendael (Delogne), Ard. Liég. (De Wild). England (Comber, Norman) Scotland (Baxter Coll., Nos. 2528, 2904), Ireland (O'Meara). Found almost everywhere.

A. exilis Kütz. (Alg. aq. dulc., 1833, No. 12 ; Bac., p. 76, pl. 21, f. 4 ; H.V.H. Atl., pl. 27, f. 16-19* ; in Type No. 111), **plate 8, fig. 333.**

Valves narrowly lanceolate, apices rounded, subobtuse, striæ somewhat radiate, 26 to 27 in 1 c.d.m. ; the median more robust, more distant (19 to 21 in 1 c.d.m., and more strongly radiant, shortened and leaving an elongated hyaline area, larger in the lower than in the upper valve. Length, from 1·5 to about 3 c.d.m.

Fresh water.—Virton (Delogne). France. England (Comber).

A. minutissima Kütz. (Alg. aq. dulc., No. 75, Bac., p. 75, pl. 13, f. 2 *c*, etc.; H.V.H. Atl., pl. 27, f. 37 and 38*; in Types Nos. 111 and 269), **plate 8, fig. 334.**

Valves very narrowly lanceolate, with apices gently produced, rostrate, obtuse, rounded; striæ delicate, feebly radiant, about 25 in 1 c.d.m., the median shortened. Length, about 1·5 to 2 c.d.m.

Fresh water.—Brussels (Delogne), Ard. Lieg. (De Wild.), France, England.

A. linearis W. Sm. (S.B.D., ii., p. 31, pl. 61, f. 381; H.V.H. Atl., pl. 27, f. 31 and 32*), **plate 8, fig. 335.**

Differs from the preceding, into which it appears to pass, by its valves being more linear, elongated, somewhat produced, rostrate, and its striæ somewhat stronger and sub-parallel, 24 to 27 in 1 c.d.m. Length, 1 to 1·5 c.d.m.

Fresh water.—Brussels (Delogne). Scotland (W. Sm.). England (Kitton). Ireland (O'Meara).

bbb. Valve longly elliptic, inflated at the middle and at the apices.

A. trinodis (Arnott) Grun. (H.V.H. Atl., pl. 27, f. 50, 51, 52*; Type No. 129; *Achnanthidium trinode W. Arn.; Rhoiconeis trinodis Grun.* olim), **plate 28, fig. 788.**

Valve very small, longly and narrowly elliptic-sublinear, inflated at the median portion and at the apices with subequal lobes and rounded apices. Striæ very delicate, 25 to 30 in 1 c.d.m., short, not reaching to the raphe, which is robust. Central nodule elongated. Girdle face semi-flexed at the median portion. Length, about 2·5 c.d.m. Breadth at the median portion, ·6 c.d.m. (6μ.).

Fresh water.—England (Norman), Scotland (W. Sm., W. Arn. !).

aa. UPPER VALVE DIFFERING FROM THE LOWER BY THE PRESENCE, ON ONE OF ITS MARGINS, OF A HYALINE SPACE IN FORM OF A HORSE SHOE.

A. lanceolata Breb. (in Kütz. Spec. Alg., p. 54; H.V.H. Atl., pl. 27, f. 8-11*; Type No. 235), **plate 8, fig. 336.**

Valves elliptic, having 12 or 13 striæ in 1 c.d.m. ; the upper showing on one margin a hyaline space in the form of a horse shoe ; the lower with median striæ much shortened, and forming a pseudo-stauros. Length, ·8 to 2 c.d.m.

Fresh water.—Rather rare. Antwerp, Brussels (H.V.H.), Ard. Liég. (De Wild.). France, England (Comber, Norman), Ireland (O'Meara).

var. dubia. (H.V.H. Atl., pl. 27, f. 12 and 13* ; Type No. 236), **plate 8, fig. 337.**

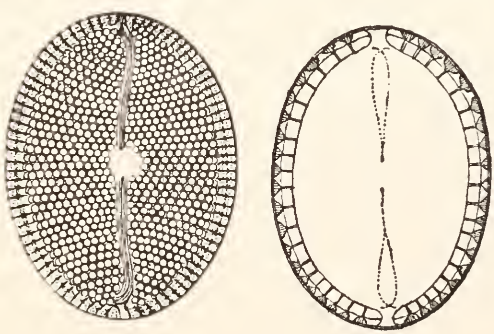
Differs from the type form by its striæ somewhat closer, about 13 to 14 in 1 c.d.m., by its lanceolate form, with produced rostrate apices, and by its somewhat shorter pseudo-stauros. Length, about 1·5 c.d.m.

Fresh water.—Brussels (Delogne).

TRIBE V.—COCCONEIDEÆ.

Valves furnished with short marginal costæ			**Orthoneis.**
Valve without marginal costæ.	Frustules straight on girdle view, raphe eccentric .		**Anorthoneis.**
	Raphe dividing the valve into two equal portions ; girdle face flexed.	Valves simple, dissimilar, the upper having only a pseudo-raphe ; the lower having nodules and a true raphe .	**Cocconeis.**
		The lower valve composed of two layers ; the upper consisting of a framework of robust costæ, that underneath consisting of a normal valve . .	**Campyloneis.**

GENUS 31.—ORTHONEIS GRUN., 1868.—Emend Grun., 1880.



a. *b.*

Fig. 62.—*Orthoneis splendida (Greg.) Grun.*
(*a*) Upper valve.
(*b*) Annulus and direction of raphe on the two valves.

Valves similar, furnished with a marginal crown of short costæ, sometimes without hemispherical layers. Frustules not flexed on the girdle side.

Cleve unites *Orthoneis* with *Mastogloia*. We have two species of this genus.

Valves very large, beads coarse, costal crown entirely surrounding the valve .	**O. splendida.**
Valves small, beads delicate, central nodule dilated into a narrow stauros .	**O. binotata.**

O. splendida (Greg.) Grun. (Nov., p. 15; H.V.H. Atl., pl. 28, f. 1-2*; Type No. 240); **plate 29, fig. 814.**

Valve broadly elliptic, with apices obtuse rounded, narrow crown entirely surrounding the valve. Raphe very robust with apices reflexed on the same side, on one of the valves near the right margin, on the other near the left margin. Striæ feebly radiant, about 6 in 1 c.d.m., formed of coarse beads. Length, 6 to 8 c.d.m. Breadth, about 5 to 6 c.d.m.

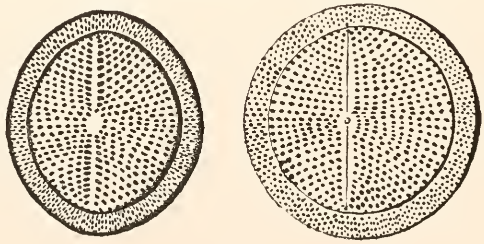
Marine.—Lamlash Bay, Scotland (Gregory).

O. binotata Grun. (Nov., p. 15; H.V.H. Atl., pl. 28, f. 7*; in Type No. 243), **plate 29, fig. 815.**

Valve oval, showing on each side (or more rarely on only one side) a marginal semi-elliptic spot. Central nodule elongated into a narrow stauros. Striæ rather delicate, about 15 in 1 c.d.m.; distinctly punctate, beads forming lines, decussating lines. Length, 3·5 c.d.m. Breadth, 2·25 c.d.m.

Marine.—England. Ireland (O'Meara). Channel Islands.

GENUS 32.—ANORTHONEIS GRUN., 1868. Cleve Emend, 1893.



a. *b.*

Fig. 63.—*Anorthoneis excentrica.*
a. Upper valve. *b.* Lower valve.

Valves suborbicular, furnished with a ring unsymmetrical with the longitudinal axis; frustules with a straight sutural zone, freely wandering.

A single species.

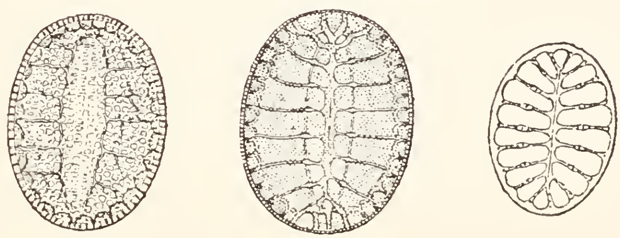
A. excentrica (Donk.) Grun. (Nov., p. 10; *Cocconeis excentrica Donk.*).

Valves suborbicular, furnished with a large marginal ring, finely striated. Valves with robust striæ about 7 in 1 c.d.m., composed of elongated beads forming irregular longitudinal lines. Lower valve furnished with raphe and nodules, the upper having only a pseudo-raphe. Length, about 5 c.d.m. Breadth, 4·5 to 5 c.d.m.

Marine.—England (Donkin, Kitton, Comber). North Wales.

GENUS 33.—CAMPYLONEIS GRUN., 1863.

Upper valve cellular, such structure being wanting in the median portion; lower valve formed of two layers: the upper formed of a



a. *b.* *c.*

Fig. 64.—*Campyloneis Grevillei.*

a. Upper valve. *b.* Lower valve. *c.* Stratum of costæ of ditto.

grating of robust costæ, the lower layer consisting of a normal valve furnished with raphe and nodules, and covered with distinctly punctated striæ.

One species: Characters of genus; terminal nodules distant from apices.

C. Grevillei (W. Sm.) Grun. (*Cocc. Grevillei W. Sm.*; S.B.D., i., pl. 3, f. 35; H.V.H. Atl., pl. 28, f. 10-12*; Type No. 243), **plate 8, fig. 344.**

Upper valve with small cells, those in the portion without structure, elongated; striæ of lower valve about 18 in 1 c.d.m. Length, 4 to 6 c.d.m.

Marine.—England (Grev., Shadbolt, Kitton, Norman). Jersey (Arnott).

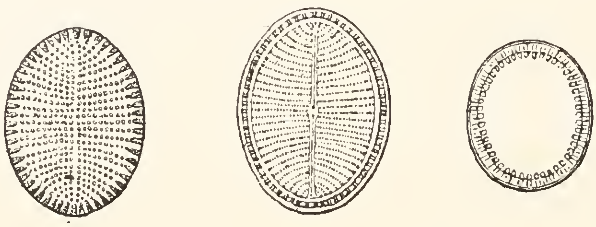
var. Argus Grun. (in Wien. Zool. Bot. Gesel., p. 429, pl. 10, f. 9; H.V.H. Atl., pl. 28, f. 15, 16*), **plate 8, fig. 345.**

Upper valve with very large cells, almost or quite similar; interior cells slightly elongated.

Marine.—These two forms have not yet, but will very probably be found in Belgium. They exist in England (Kitton), Scotland and France.

GENUS 34.—COCCONEIS (EHR. 1835), GRUN., 1868.

Valves broadly oval, elliptic or discoid, rarely lanceolate ; the upper having only a pseudo-raphe, the lower furnished with nodules and a



a. *b.* *c.*

Fig. 65.—*Cocconeis Scutellum.*
a. Upper valve. *b.* Lower valve. *c.* Annulus.

true raphe. Frustules arched or genuflexed, living as a parasite on other algæ. Endochrome as in the *Achnanthes.*

The genus *Cocconeis* includes numerous and varied species. It has been skilfully divided by Prof. Cleve into a certain number of groups which may be considered as subgenera or even as genera if that be preferred. The following are the groups which I adopt to distinguish my species :—

ANALYSIS OF GROUPS.

Valve having a marginal ring.	Upper valve furnished with distinct costæ			1. **Pleuroneis.**
	Upper valve punctate, striate			2. **Cocconeis.**
Valve having neither interior skeleton nor ring.	Upper valve furnished with costæ.	Valve elliptic		3. **Disconeis.**
		Valve lanceolate		4. **Actinoneis.**
	Upper valve without costæ.	Upper valve with a broad axial area		5. **Heteroneis.**
		Upper valve with narrow axial area.	Valve elliptic or broad	6. **Eucocconeis.**
			Valve linear or lanceolate, with fine puncta	7. **Microneis.**

* *Valve having a separate marginal ring.*

Group I. PLEURONEIS CLEVE.—Upper valve furnished with distinct costæ.

P. costata (Greg.) Cleve ; (*C. Costata Greg.*, Q.J.M.S. 1855, iii., p. 39, pl. 3, f. 10 ; H.V.H. Atl., pl. 30, f. 11-12* ; *Pleuroneis Costata Cleve* in litt.), **plate 29, fig. 816.**

Valve elliptic, showing a series of robust costæ 6 in 1 c.d.m., reaching almost to the raphe, between which are formed fine attenuating granules; hyaline area narrow, just somewhat diminuate at the apices. Length, 2 to 2·5 c.d.m.

Marine.—Blankenberghe (H.V.H.) Scotland (Gregory). Arctic Norway (Cleve). Bahusie (Lagerstedt).

Group 2. COCCONEIS CL.—Upper valve punctated, striate.

ANALYSIS OF SPECIES.

Valve with very coarse puncta.	Puncta sub-quadrangular, each striæ being terminated by a small punctated space, triangular . .	**C. Scutellum.**
	All the puncta identical and very distinct . .	**C. distans.**
Valve with fine puncta.	Ring not punctated	**C. pediculus.**
	Ring finely punctated	**C. placentula.**

* *Upper valve with coarse puncta sub-quadrangular.*

C. Scutellum Ehr. (Inf., p. 95, pl. 14, f. 8; H.V.H. Atl., pl. 29, f. 1-3*; Type Nos. 245, 246), **plate 8, fig. 338.**

Valves very broadly lanceolate or elliptic, surrounded by a separable annulus. Upper valve marked with very coarse subquadrangular puncta arranged in radiating lines, about 7 or 8 in 1 c.d.m. Each row of puncta terminated at the margin of the valve by a subtriangular space, covered with very fine puncta; pseudo-raphe straight, narrow. Lower valve with a ring furnished with a sub-marginal row of very coarse puncta and short costæ, separated by a narrow hyaline zone from the internal portion which is covered with radiating striæ (about 7 to 8 in 1 c.d.m.), consisting of puncta much more delicate than those of the upper valve; raphe straight; central nodule round or dilated transversely; terminal nodules very small. Length, 4·5 to 6 c.d.m.

Marine.—Ostend (Westendorp !), England (Kitton, Comber, Stolt, Norm.), Ireland (O'Meara). On all the shores of the North Sea.

var. stauroneiformis. (*C. stauroneiformis W. Sm.*). Lower valve stauroneiform.

forma parva. (H.V.H. Atl., pl. 29, f. 8 and 9*), **plate 8, fig. 339.** Very small, scarcely 2 c.d.m.

C. distans (Greg.) Grun. (Novara, p. 10; Ad. Schm. Nordsee, pl. 3, f. 22, 23*), **plate 29, fig. 817.**

Valve broadly oval, with apices subacute, hyaline area lanceolate, rather narrow. Striæ 4 in 1 c.d.m., formed of 5-7 coarse puncta, very distant, forming

4 or 5 longitudinal lines. Valve bordered with a row of much finer puncta, 8 in 1 c.d.m. Length, about 5 c.d.m. Breadth, up to 4 c.d.m.

Marine.—Scotland, Ireland (O'Meara), Bahusie.

aa. Valves with delicate puncta.

C. Pediculus Ehr. (In Kütz. Bac., pl. 5, f. IX. i.; H.V.H. Atl., pl. 30, f. 28-30*; Types Nos. 248, 249), **plate 8, fig. 340.**

Valve elliptic, plane or very slightly flexed; median hyaline zone of the upper valve enlarged at the centre of the valve, and showing feeble traces of raphe and nodules; lower valve furnished with a ring covered with striæ, punctate, distant, about 15 in 1 c.d.m., separated by a hyaline zone from the rest of the valve, which is covered with radiating striæ, fine, punctate, about 22 in 1 c.d.m. Length, 1·25 to 3·5 c.d.m.

Fresh and brackish water.—Common everywhere.

C. Placentula Ehr. (Amer., I., i., 10, 24; H.V.H. Atl., pl. 30, f. 26 and 27*; in Types Nos. 111, 190, 206, 259, etc.), **plate 8, fig. 341.**

Valve elliptic, plain or very slightly flexed; median hyaline zone of the superior valve enlarged at the centre of the valve, and showing feeble traces of raphe and nodules; inferior valve furnished with an annulus covered with striæ, punctate, distant, about 15 in 1 c.d.m., separated by a hyaline zone from the remainder of the valve, which is covered with radiating striæ, very fine, punctate, about 22 in 1 c.d.m. Length, from 1·25 to 3·5 c.d.m.

Fresh and brackish water.—Common everywhere.

var. lineata. (*C. lineata*; H.V.H. Atl., pl. 30, f. 31 and 32*; Type No. 250), **plate 8, fig. 342.**

Differs from the preceding, from which it is not specifically separable, by its much larger size and by the striæ of the upper valve, the puncta of which form longitudinal lines in zig-zag. Striæ of lower valve about 17 in 1 c.d.m. Length about 7 c.d.m.

Brackish water.—Rare? Antwerp, Blankenberghe.

** *Valve without a separable marginal ring.*

a. Upper valve furnished with costæ.

Group 3.—DISCONEIS CL.—Valve elliptic.

C. pinnata Greg. (Q.J.M.S., 1859, vii., p. 79, pl. 6, f. 1; H.V.H. Atl., pl. 30, f. 6 and 7*); **plate 29, fig. 818.**

Valve broadly elliptic, showing a series of distinct costæ, about 3-4 in 1 c.d.m., which, with a good objective, are resolved into fine puncta, arranged alternately in two rows. Longitudinal hyaline area lanceolate.

Marine —Blankenberghe, rare (H.V.H.); Scotland.

C. Lyra A. Schm. (Nordsee, pl. 3, f. 19* to the right; the figure on the left belongs to another species); **plate 29, fig. 819.**

Valve elliptic with well marked costæ, about 9 in 1 c.d.m. interrupted by sulci which, with the narrow hyaline area surrounding the raphe and the pseudo-stauros, form the figure of a lyre with straight narrow arms, not reaching to the apices of the valve. Length, about 2·5 c.d.m.

Marine.—Norway (Ad. Schm).

Group 4. ACTINONEIS CLEVE.—Valve lanceolate.

Cocconeis Danica Flög. (Diat. Grundproben, p. 91, f. 14*; Lens ii., p. 238, pl. 4, f. 9), **plate 29, fig. 820.**

Valves elliptic, rhomboidal, with apices acute, somewhat attenuated. Upper valve with robust striæ, distant, 6 in 1 c.d.m., all of equal length, showing fine beads arranged in two rows in their intervals. Lower valve with fine costæ, approximate, 14 in 1 c.d.m., the median alternately long and short. Raphe surrounded by a broad hyaline zone, and dilated near the central nodule. Length, about 6 c.d.m. Breadth, 2·5 c.d.m.

Marine.—Norway.

aa. Upper valve without costæ.

Group 5. HETERONEIS CL.—Upper valve with broad axial area and striæ more or less submarginal.

C. Quarnerensis (Grun.) Ad. Schm. (Nordsee, pl. 3, f. 15 and 16*; *Raphoneis Quarnerensis Grun.*, Die Oster. D., p. 381, pl. 7, f. 24), **plate 29, fig. 821.**

Upper valve with robust marginal costæ, 7 in 1 c.d.m., hyaline area very broad, elliptic, finely granular; lower valve with fine costæ, radiant, 7 in 1 c.d.m., reaching close to the raphe. Length, about 3 c.d.m.

Marine.—Norway.

C. Pelta Ad. Schm. (Nordsee, pl. 3, f. 17*), **plate 29, fig. 822.**

Valves small, suborbicular, the upper with rather strong costæ occupying about the moiety of the valve, with a hyaline area broadly lanceolate, finely granular, costæ 12 in 1 c.d.m. Lower valve with finer costæ, 13 in 1 c.d.m., raphe rather marked with central nodule coarse, rounded. Length, 2 c.d.m. Breadth, 1·5 c.d.m.

Marine.—Norway.

Group 6. EUCOCCONEIS CLEVE.—Valves broad or elliptic, the upper valve with a narrow axial area.

Valve with central nodule dilated into an acute stauros . .		**C. dirupta.**
Central nodule round.	Valves very small, elliptic, without sulci . .	**C. molesta**
	Valves very large, broadly elliptic, the upper valve furnished with broad arcuate sulci . . .	**C. pseudo-marginata.**

C. dirupta Greg. (Diat. of Clyde, pl. 1, f. 25; H.V.H. Atl., pl. 29, f. 13-15*; Type No. 247), **plate 8, fig. 343.**

Valves broadly oval or elliptic, more or less flexed. Upper valve with striæ compact, about 15 in 1 c.d.m., radiant, finely punctuate, with puncta forming longitudinal lines in zig-zag. Lower valve striate as in the upper, but with striæ generally interrupted by a hyaline band produced by a lateral stauroneiform dilation of the central nodule. Raphe straight or gently sigmoid. Length, 2 to 3·5 c.d.m.

Marine.—Found once at Antwerp 20 in a gathering made in the Scheldt. England, Scotland, Norway.

C. molesta Kütz ! (Bac., p. 71, pl. 7, f. 1, 2; H.V.H. Atl., pl. 30, f. 18-23*), **plate 29, fig. 823.**

Valves small, elliptic, finely striate; transverse striæ about 40 in 1 c.d.m., reaching to the raphe, formed of puncta, distant and consequently capable of forming longitudinal lines undulate or decussate (according to the direction of the illumination). Raphe robust; central nodule elongated into a narrow acute stauros. Length, 1·5 to 2 c.d.m. Breadth, 1 c.d.m.

Marine.—North Sea.

Observ.—The description of the above form is made from the original specimen in Kützing's collection, in which it is numbered 259. The frustules are parasitic on *Antithamnion cruciatum* It corresponds to the *var. crucifera* of Grunow (H.V.H. Atl, pl. 20, f. 20). It appears to me right to consider it as the type form.

var. Amygdalina (*Cocc. diaphana W. Sm. partim*, S.B.D., i., p. 22, pl. 30, f. 254; H.V.H. Atl., pl. 30, f. 5 and 35*), **plate 29, fig. 823** *bis*.

Much larger in size, 3·5 to 4·5 c.d.m. Central nodule rounded, surrounded by a small hyaline area.

Marine.—North Sea. England (Norman), Ireland (O'Meara), Jersey (W. Sm.).

C. pseudo-marginata Greg. (Diat. of Clyde, p. 20, pl. 1, f. 27; H.V.H. Atl., pl. 29, f. 20-21*), **plate 29, fig. 824.**

Valve broadly elliptic or suborbicular; the upper showing a finely striated pseudo-annulus, and on each side of the hyaline area a broad arcuate sulcus; striæ delicate, 20 to 24 in 1 c.d.m. on the portion exterior to the sulcus, about 12 to 15 in the sulcus and the portion adjacent to the hyaline area; lower valve without sulcus, finely striate, punctuate, about 13-15 striæ in 1 c.d.m. Raphe robust, central and terminal nodules rather coarse, surrounded by a small hyaline area. Length, 3·5 to 5 c.d.m.

Marine.—Scotland, Ireland, France.

Group 7. MICRONEIS CLEVE.—Valve linear or lanceolate.

Microneis delicatula (Kütz.) Cleve is the *Achnanthes* (*Achnanthidium Kütz.*) *delicatula*, which we have described in the last genus.

SUB-FAMILY II.—PSEUDO-RAPHIDIEÆ.

Frustules generally bacillar in valve view, sometimes broadly oval or sub-orbicular, very rarely orbicular. Frustules with or without nodules.

- always with *either*
  - a pseudo-raphe (simple line or blank space) on one or both sides; *or*
  - septa true or false (*vittæ*) in girdle view; *or*
  - valves fusiform, sigmoid, beaked or alate; *or*
  - with numerous plicæ, costæ, striæ or rows of transverse granules on one or both of the valves, rarely regularly radiate; costæ sometimes showing in girdle view.
- without
  - processes, teeth, spines, awns or true raphe on the valves,
    - except spines found rarely among the *Surirelleæ* and *Tabellarieæ* when the character is sufficiently indicated by the above.
- rarely
  - angular in valve view,
  - hyaline,
  - unstriated, *or*
  - much developed in girdle view, unless longitudinally septate.

TABLE OF COHORTS.

- Frustules really or apparently furnished longitudinally with true or false septa, showing distinctly in the girdle view . . . **Tabellariineæ.**
- Frustules without septa.
  - Frustules with valves furnished with a carina (keel) or coarse puncta, often prolonged into short costæ and with endochrome divided transversely, or else frustules fusiform, furnished with three spiral lines (carinate ?), punctate . **Nitzschiineæ.**
  - Valves without carina.
    - Valves elliptic or circular, flat, saddle-shaped, or twisted on themselves, furnished with marginal alæ . . . . **Surirellineæ.**
    - All other forms; length of valves generally much greater than the breadth, always without marginal alæ . . . **Fragilariineæ.**

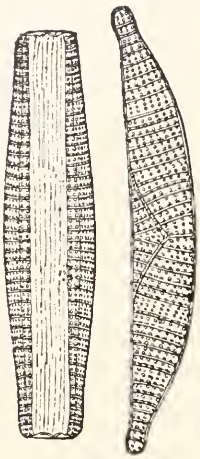
COHORT OF FRAGILARIINEÆ.

ANALYSIS OF TRIBES.

- Frustules with valves more or less arcuate . . . . **Epithemieæ.**
- Valves not arcuate.
  - Frustules forming long filaments, valves always without pseudo-nodules . . . . . **Fragilarieæ.**
  - Frustules not united into a filament.
    - Valves much elongated, bacillar-acicular, showing a false raphe and a fine striation . **Synedreæ.**
    - Valves neither acicular nor bacillar.
      - Valves showing coarse puncta, rounded or square, and without pseudo-nodules . **Raphoneideæ.**
      - Valves with coarse puncta and pseudo-nodules . . **Plagiogrammeæ.**

TRIBE VI.—EPITHEMIEÆ.

- Valves furnished with beads and costæ . . . . . **Epithemia.**
- Valves without costæ.
  - Valves having a central pseudo-nodule . . . **Ceratoneis.**
  - Valve without central pseudo-nodules.
    - Valve without terminal pseudo-nodules . **Pseudo-Eunotia.**
    - Valve furnished with terminal nodules.
      - Valves with equal apices, not bordered with coarse beads . **Eunotia.**
      - Valves bordered with coarse beads or spines, with unequal apices . . . **Actinella.**



a *b*

Fig. 66.—*Epithemia turgida.*
a Girdle view.
b Valve view.

GENUS 35.—EPITHEMIA BREB., 1838.

Valves arcuate, furnished internally with robust costæ, and externally with moniliform striæ, without nodules. Girdle face linear, more or less inflated in the central portion. Frustules parasitic on other plants. Endochrome as in the *Amphora*.

ANALYSIS OF SPECIES.

Two rows of beads between two consecutive costæ.	Costæ and striæ all radiant.	Beads very robust.	Apices more or less rostrate capitate.	Valves very arcuate .	**E. turgida.**
				Valves slightly arcuate .	**E. granulata.**
			Apices very obtuse .		. **E. Hyndmanni.**
		Beads very fine and very approximate .			**E. Sorex.**
	Costæ and striæ parallel, except at apex of valve .				. **E. gibba.**
At least four rows of beads between two consecutive costæ.	Costæ scarcely radiant, beads rather robust . .	Costæ with apices capitate in girdle view . .			. **E. Argus.**
		Costæ with apices not capitate in girdle view . .			. **E. Zebra.**
	Costæ very radiant, beads very fine .	Frustules almost circular; valves semi-circular . .			. **E. Musculus.**
		Frustules elliptic; valves semi-lanceolate . .			. **E. gibberula.**

* *Two rows of beads between two consecutive costæ.*

a. Beads very robust.

E. turgida (Ehr.) Kutz. (Bac., pl. 5, f. 14; H.V.H. Atl., pl. 31, f. 1 and 2*; Type No. 251), **plate 9, fig. 346.**

Valve arcuate, with apices more or less rostrate capitate; dorsal margin rather flexed; ventral margin slightly flexed; costæ radiant, about 4 in 1 c.d.m.; about 8 radiant rows of coarse elongated beads (each of which consists really of two small beads close together) in the same space. Girdle face more or less strongly inflated in the median portion. Length, 7 to 15 c.d.m.

Fresh water.—Very common everywhere.

var. **Westermanni Kütz.** ! (Bac., pl. 5, f. 12, &c.; H.V.H. Atl., pl. 31, f. 8*), **plate 9, fig. 347.**

Smaller and more squat with more convex dorsum, more inflated in girdle view, apices not capitate.

Brackish water.—Antwerp. England (Comber, Norman).

var. **granulata.** (*E. granulata Kütz.*; H.V.H. Atl., pl. 31, f. 5 and 6*), **plate 9, fig. 348.**

Much more elongate, scarcely arcuate, apices more inflated, costæ in girdle view almost parallel. Length, 13 to 15 c.d.m.

Fresh water.—Antwerp, rare? England, Scotland, Ireland (O'Meara).

var. **Vertagus.** (*E. Vertagus Kütz.*; H.V.H. Atl., pl. 31, f. 7*), **plate 9, fig. 349.**

Valve very elongated (attaining to 20 c.d.m.), median portion of the dorsum sometimes bulging.

Fresh water.—Antwerp, Schaerbeeck (Delogne), England, France, Denmark.

E. Hyndmanni W. Sm. (S.B.D., i., p. 12, pl. 1, f. 1; H.V.H. Atl., pl. 31, f. 3 and 4*; Type No. 252), **plate 9, fig. 350.**

Valve with dorsal and ventral margins strongly and regularly arcuate, apices very obtuse; 3 or 4 radiant costæ, and six rows of coarse beads in 1 c.d.m. Girdle face strongly inflated at the central portion. Length, 16 to 20 c.d.m.

Fresh water.—Not yet found in Belgium. England (Norman). Scotland, Ireland (W. Sm.)

It is thought that this may be a sporangial form of *E. turgida.*

aa. Beads very fine and approximate.

E. Sorex Kütz. (Bac., pl. 5, f. 12; H.V.H. Atl., pl. 32, f. 6-10*; Type No. 259), **plate 9, fig. 351.**

Valve strongly arcuate, with margins regularly flexed, apices rostrate and generally capitate; costæ radiant, 6 or 7 in 1 c.d.m., striæ radiant, finely moniliform, 12 to 14 in 1 c.d.m. Girdle face strongly inflated at the central portion. Length, 2·5 to 4 c.d.m. Sporangial frustule, about 7 c.d.m.

Fresh water.—Very common everywhere.

E. gibba Kütz. (Bac., pl. 4, f. 22 ; H.V.H. Atl., pl. 32, f. 1 and 2* ; Type No. 256), **plate 9, fig. 352** *a, b.*

Valve linear, seen with difficulty, with pseudo-raphe bordered on each margin with a row of coarse beads (extremities of costæ?). Frustule always placed on its girdle face, with its dorsal margin showing in the middle of the median inflation a small inflexion, with a central nodule distinctly visible. Ventral margin straight, but arcuate at the apex. Costæ, about 6 or 7 in 1 c.d.m., parallel, except at the apices of the valve where they are radiant ; striæ finely moniliform, about 14 in 1 c.d.m. Length, 8 to 25 c.d.m.

Fresh water.—Very common everywhere.

var. parallela Grun. (H.V.H. Atl., pl. 32, f. 3*), **plate 9, fig. 353.**

Dorsal and ventral margins parallel, without any inflation.

var. ventricosa. (*E. ventricosa Kütz.* (Bac., pl. 30, fig. 9 ; H.V.H Atl., pl. 32, f. 4 and 5* ; Type No. 257), **plate 9, fig. 354.**

Valve short, and strongly inflated at the median portion.

Mixed with the type, and common.

* * *At least four striæ between two consecutive costæ.*

A. Costæ scarcely radiant, beads very robust.

E. Argus Kütz. (Bac., pl. 29 ,f. 55 ; H.V.H. Atl., pl. 31, f. 15, 16, and 17* ; Type No. 255), **plate 9, fig. 355.**

Valve with dorsal margin slightly arcuate, ventral margin almost straight, apices very obtuse ; costæ very robust, only just radiant, 1 or 2 in 1 c.d.m ; striæ gently radiant, finely moniliform, 12 to 14 in 1 c.d.m., more than four striæ between two consecutive costæ. Girdle face linear, with margins straight or undulated as a monstrosity (see pl. 9, f. 355 at extreme right), showing throughout the length of the connecting zone a series of coarse nodules, arising from the thickening of the apex of the costæ. Length, 4 to 7 c.d.m.

Fresh water in calcareous regions.—Frahan (Delogne). England (Comber, Norman). Scotland (Dickie). France, Holland.

var. amphicephala Grun. (*E. Alpestris W. Sm.;* H.V.H. Atl., pl. 31, f. 19*), **plate 9, fig. 356.**

Valve gently arcuate, with apices strongly rostrate capitate.

Fresh water.—England (W. Sm., Comber, Norman).

E. Zebra (Ehr.) Kütz. (Bac., pl. 5, f. 12, and pl. 30, f. 5 ; H.V.H. Atl., pl. 31, f. 9, 11, 12, 13, and 14* ; Type No. 253), **plate 9, fig. 357.**

Differs especially from the preceding species by the girdle face not showing costæ inflated at the apices. Costæ less robust, scarcely radiant, 3 or

3·5 in 1 c.d.m.; striæ with more robust beads, about 12 in 1 c.d.m. Length, 2 to 6 c.d.m.

Fresh water.—Common everywhere.

var. proboscidea Grun. (H.V.H. Atl., pl. 31, f. 10*; Type No. 254), **plate 9, fig. 358.**

Rather small, more flexed than the type form, with apices strongly rostrate capitate.

Fresh and brackish water.—Blankenberghe (H.V.H.), Alle (Del.), St. Trond (Van den Born), England (Norman), Scotland (W. Sm.).

AA. Costæ very radiant, beads fine.

E. Musculus Kütz.! (Bac., pl. 20, f. 6; H.V.H. Atl., pl. 32, f. 14 and 15*; in Types Nos. 50 and 105), **plate 9, fig. 359.**

Valve very short, almost semi-circular, with dorsal margin strongly arcuate and showing in the middle a small central nodule; ventral margin with a very slight, if any, curvature; apices acute, very gently rostrate. Costæ very radiant, variable in number, approximate; striæ finely moniliform, about 15 in 1 c.d.m. Girdle face broadly oval, almost round. Length, 4 to 5 c.d.m.

Marine.—Ostend (Grunow), Heyst (Deby), England (W. Sm., Kitton, Norman), Ireland (O'Meara), Holland, France.

var. constricta W. Sm. (*E. constricta W. Sm.*, S.B.D., i., p. 14, pl. 30, f. 248*; Type No. 261), **plate 9, fig. 360.**

Frustule more or less constricted in the girdle face.

Marine.—Blankenberghe. England (W. Sm., Kitton, Norman), Ireland (O'Meara), France.

E. gibberula Kütz. (Bac., pl. 30, f. 3*; in H.V.H. Type No. 46), **plate 30, fig. 825.**

Valve much narrower than in the preceding species, semi-lanceolate, very slightly produced up to the apices which are sub-acute; costæ very distant, 3 or 4 in 1 c.d.m.; striæ about 16 in 1 c.d.m., very radiant. Girdle face elliptic or elliptic-lanceolate. Length, 4 to 7 c.d.m.

Marine.—Ostend (Grunow). Probably on all our coasts.

var. producta Grun. (H.V.H. Atl., pl. 32, f. 11-13*), **plate 9, fig. 361.**

Apices rostrate. Length, 2 to 3 c.d.m.

Fresh and brackish water.—Antwerp, Brussels (Delogne).

RHOPALODIA OTTO MÜLLER, 1895.

Mr. Otto Müller has dismembered the genus *Epithemia*, and at its expense has created the genus *Rhopalodia*, which he characterises by the presence of a central nodule (which I had previously recorded in 1885 in my Synopsis), of terminal nodules, and of a true raphe elevated on a keel, which he believes to exist; by the valves having a more delicate membrane, and by the frustules being more or less asymmetrical. Mr. Otto Muller includes in his genus *Rhopalodia*, *Epithemia gibba*, and its variety *ventricosa*, the very singular species from Lake Nyassa, in Africa, which Dickie named *Epithemia clavata* in 1880, and lastly some new forms allied to the latter species which have their habitat in the same region.

a *b*

Fig. 67.—*Eunotia gracilis.*
a Girdle view.
b Valve view.

GENUS 36.—EUNOTIA EHR., 1837. Char. Emend.

Valve arcuate, without costæ, transversely striated, without raphe or central nodule, furnished with pseudo nodules at apices. Girdle face rectangular. Frustules free or united in filaments or parasitic on other plants. Endochrome divided into two laminæ on the zone by a deep sulcus.

1. *Frustules united into filaments of greater or less length.* (HIMANTIDIUM AUCT.).

Valves with apices capitate, reflexed on the dorsal margin; individuals united in short filaments.	Frustules large; striæ easily visible.	Valves rather broad.	Valve with apices sub-truncate, strongly rostrate-capitate . .	**E. Arcus.**
			Valve with apices obtuse-rounded, scarcely capitate . . .	**E. major.**
		Valves very narrow . . .		**E. gracilis.**
	Frustules very small; striæ scarcely visible . .			**E. exigua.**
Valves with apices not capitate, straight or directed towards the ventral margin.	Apices straight, produced, rostrate; girdle face not showing imperfect divisions . . .			**E. pectinalis.**
	Apices obtuse, not produced rostrate, directed towards the ventral margin; girdle face generally showing septa arising from imperfect divisions . . .			**E. Faba.**

2. *Frustules not united in filaments (true* EUNOTIA).

Frustules free, not parasitic on other plants.			Valve of medium or small size, with fine striæ, and dorsum not indented	E. Veneris.
			Valve very small and very narrow, with three slight elevations	E. tridentula.
	Valve large and robust, with dorsum level or furnished with strong ridges.		Striæ very distant in the median portion	E. prærupta.
			Striæ very delicate, dorsum with two ridges	E. bidentula.
		Striæ approximate.	Striæ very delicate, dorsum with three ridges	E. triodon.
			Striæ robust, dorsum with more than three ridges	E. robusta.
			Striæ robust, dorsum with two slight ridges	E. diodon.
Frustules parasitic on other plants.			Valve very long, robust, straight or flexuous, with apices inflated	E. flexuosa.
			Valve rather small, narrow, arcuate, with apices sometimes rostrate-capitate, not inflated	E. lunaris.

1. *Frustules united in filaments of greater or less length.*
(HIMANTIDIUM OF AUTHORS).

a. Apices of valves reflexed on the dorsal margin. Individuals forming short filaments.

E. Arcus Ehr. (Abh., 1840, p. 17; Inf., pl. 21, f. 22; H.V.H. Atl., pl. 34, f. 2*; Type No. 267—a form approximating to *var. uncinata*; Type No. 268, *forma curta*), **plate 9, fig. 362.**

Valve arcuate, with apices strongly capitate, ventral margin straight or slightly arcuate; striæ delicate, about 12 in 1 c.d.m., finely divided transversely. Girdle face rectangular-linear-elongate, connecting zone with very fine transverse striæ (22 in 1 c.d.m.), interrupted by longitudinal plicæ. Length, 3 to 9 c.d.m.

Fresh water.—Rare? Belonging to calcareous regions according to Grunow. England (Comber, Kitton, Norman), Scotland (Dickie), Ireland (O'Meara). Found throughout Europe.

var. minor. (H.V.H. Atl., pl. 34, f. 3*), **plate 9, fig. 363.**
Smaller (about 3 c.d.m.) and more slender.

var. uncinata. (H.V.H. Atl., pl. 34, f. 13*), **plate 9, fig. 364.**
Dorsal and ventral curvatures strong.

var. bidens. (H.V.H. Atl., pl. 34, f. 7*), **plate 9, fig. 365.**
Dorsal margin showing two slight gibbous ridges.
Mixed with the type form.

E. major (W. Sm.) Rabenh. (*Himantidium W. Sm.*, S.B.D., ii. pl. 33, f. 286; H.V.H. Atl., pl. 34, f. 14*; Type No. 271), **plate 9, fig. 366.**

Valve very elongate, arcuate, with parallel margins, apices very obtuse-rounded, scarcely capitate; striæ with delicate puncta, almost confluent, about 12 in 1 c.d.m.; connecting membrane showing striæ formed of coarse puncta, distant, about 14 in 1 c.d.m. Length, 9 to 19 c.d.m.

Fresh water.—Rare? Belgium, England (Norman), Scotland (Dickie, Balfour), Ireland (W. Sm., O'Meara).

var. bidens. (H.V.H. Atl., pl. 34, f. 15*), **plate 9, fig. 367.**

Dorsal margins showing two elevations.

E. gracilis (Ehr.) Rab. (Ehr. Verb., p. 129, pl. II. 1, f. 9, and pl. III. 1, f. 41; H.V.H. Atl., pl. 33, f. 1 and 2*; Type No. 262), **plate 9, fig. 368.**

Valve arcuate, elongate, very narrow, with parallel margins, apices gently capitate; striæ delicate, 10 in 1 c.d.m., finely divided transversely. Connective membrane showing about 20 striæ in 1 c.d.m., finely but distinctly punctate. Length, 7 to 16 c.d.m.

Fresh water.—Cornimont (Delogne), Ard. Lieg. (De Wild.), England (H.V.H.), Scotland, Ireland (O'Meara).

E. exigua Breb. (in Kütz. Spec. Alg., p. 8; H.V.H. Atl., pl. 34, f. 11*; Type No. 270), **plate 9, fig. 369.**

Valve arcuate, with apices truncate, more or less capitate, margins almost parallel, striæ very fine, about 24 in 1 c.d.m. Girdle face linear-narrow. Length, 1 to 1·5 c.d.m.

Fresh water.—Paliseul. Noirfontaine (Del.), Ard. Lieg. (De Wild.), France (Breb.), Scotland.

aa. Apices straight or directed towards the ventral margin. Individuals united into long filaments.

E. pectinalis (Kütz.) Rabenh. (*Himantidium Kütz.*, Bac., pl. 16, f. 2; H.V.H. Atl., pl. 33, f. 15 and 16*; Type No. 264), **plate 9, fig. 370, 371.**

Valve very slightly arcuate, elongate, narrow, with parallel margins, apices produced subrostrate, but not capitate; striæ well marked, finely divided transversely, about 8 in 1 c.d.m. at the median portion, much closer at the apices. Connecting membrane with about 15 rather irregular striæ in 1 c.d.m. formed of puncta rather coarse, but faintly visible. Length, 3 to 15 c.d.m.

Fresh water.—Common.

forma curta. (H.V.H. Atl., pl. 33, f. 15*), **plate 9, fig. 370.**
Small, almost straight.

forma elongata. (H.V.H. Atl., pl. 33, f. 16*), **plate 9, fig. 371.**
Long, feebly arcuate.

var. ventricosa Grun. (H.V.H. Atl., pl. 33, f. 19*b**), **plate 9, fig. 372.**
Ventral margin showing an embossment in the median portion.

var. undulata Ralfs. (H.V.H. Atl., pl. 33, f. 17*; Type No. 265), **plate 9, fig. 373.**
Ventral margin showing a median embossment, dorsal margin with three to five embossments.

var Soleirolii Kütz. (H.V.H. Type, No. 266).
Form with septate frustules (double internal valves) in consequence of an imperfect division.

E. Faba. (Ehr.) Grun. (*Himantidium Soleirolii W. Sm. part;* H.V.H. Atl., pl. 34, f. 34*; in Type No. 274), **plate 9, fig. 374.**

Valve reniform, elongated, with somewhat visible striæ, 10 to 12 in 1 c.d.m., finely divided transversely; girdle face almost always showing septa arising from an imperfect division (*var. Soleirolii W. Sm.*). Length, 3 to 5 c.d.m.

Fresh water.—Not yet found in Belgium, very doubtful if indigenous. France, England (Comber), Scotland, Ireland (O'Meara).

II. Frustules not united in filaments.

a. Frustules free, not parasitic on other plants.

E. Veneris Kütz. (Bac., p. 40, pl. 30, f. 7; *E. incisa Greg.;* H.V.H. Atl., pl. 34, f. 35A*), **plate 30, fig. 826.**

Valve of medium size, with ventral margin almost straight, dorsal margin arcuate, apices subacute. Striæ fine, 16 or 17 in 1 c.d.m. Length, about 4 c.d.m.

Fossil.—Mull deposit, Scotland (Gregory).

var. obtusiuscula Grun. (H.V.H. Atl., pl. 34, f. 35B*; in Type No. 271), **plate 30, fig. 827.**
Ventral margin somewhat concave, apices obtuse.
Fossil.—Sweden, England.

E. tridentula Ehr. (Verb., p. 126, pl. II., i, f. 14; H.V.H. Atl., pl. 34, f. 31 *var.**; in Types Nos. 309 and 347), **plate 9, fig. 375.**

Valve small, narrow, with apices capitate; ventral margin level, slightly concave, dorsal margin with three slight elevations; striæ delicate, about 15 in 1 c.d.m. Length, about 2 c.d.m.

Fresh water.—Paliseul (Del.), Ard. Lieg. (De Wild.).—Rare. England (H.V.H.), Scotland.

E. prærupta Ehr. (Amer., p. 126; H.V.H. Atl., pl. 34, fig. 19*) **plate 9, fig. 376.**

Valve robust, elongate, with apices attenuate, subcapitate, truncate; dorsal margin rather strongly arcuate; ventral margin almost straight; striæ very narrow, distant, about 6 in 1 c.d.m. in the middle of the valve, very compact at the apices, finely punctate; terminal nodules very coarse. Girdle face quadrangular, showing about 12 very delicate striæ at the median portion. Length, 4 to 8 c.d.m.

Fresh water.—Not yet found in Belgium, and probably not indigenous. Northern Europe.

forma curta. (H.V.H. Atl., pl. 34, f. 23 and 24*), **plate 9, fig. 377.** Scarcely attaining 3 c.d.m.

var. inflata Grun. (H.V.H. Atl., pl 34, f. 17*), **plate 9, fig. 378.** Valve broader, with more inflated dorsum.

var. bidens Grun. (*E. bidens* (*Ehr.*) *W. Sm.*; H.V.H. Atl., pl. 34, f. 20*; in Types No. 98, 548), **plate 9, fig. 379.**

Valve very large and very broad, with dorsum showing a median inflexion.

Fresh water.—England (Norman), Ireland (O'Meara).

var. bigibba. (*E. bigibba Kütz.*; H.V.H. Atl., pl. 34, f. 26*; in Type No. 62), **plate 9, fig. 380.**

Valve short, squat, with apices abruptly constricted on the dorsal margin; with dorsum bearing two strong ridges; ventral margin very concave.

Fresh water.—Frahan (Delogne).

E. bidentula W. Sm. (S.B.D., ii., p. 83; H.V.H. Atl., pl. 34, f. 28*), **plate 30, fig. 828.**

Valve of medium or small size, with ventral margin almost straight, dorsal margin showing two rounded or somewhat acute elevations, apices strongly attenuate, capitate; terminal nodules very distinct; striæ very delicate, about 15 in 1 c.d.m., finely punctate Length 2·5 to 4 c.d.m.

Fresh water.—England: Fellend near Lancaster (Johnson !), Scotland: Braemar (Balfour !); Arran (Arnott !); Barley Lough (W. Sm. !); Ben Nevis (Greg. !), etc.

In all these gatherings the form is considerably shorter, more squat, with ridges more elevated and more acute than in the figure in the Atlas, which is 5 c.d.m. It is always rare in gatherings, and is found in company with *Nav. serians*, *Vanh. rhomboides*, etc.

E. robusta Ralfs. (in Pritch., p. 763; H.V.H. Atl., pl. 33, f. 11-13*; in Types Nos. 263 and 274), **plate 9, fig. 381.**

Valves robust, semi-lunar, with apices broadly rounded; ventral margin concave; dorsum inflated, convex, with three to five ridges; striæ radiant, robust, about 10 in 1 c.d.m. in the middle of the valve, many between them simply marginal; girdle face quadrangular.

Fresh water.—England, France, Sweden.

var. tetraodon. (H.V.H. Atl., pl. 33, f. 11*; in Types No. 51, 263, 462), **plate 9, fig. 382.**

Dorsum with four ridges. Length, about 5 c.d.m.

Fresh water.—Liresse (Delogne). Ard. Lieg. (De Wild.). Scotland. England (Norman). Ireland (O'Meara).

E. triodon Ehr. (Inf., p. 192, pl. 21, f. 24; H.V.H. Atl., pl. 33, f. 9 and 10*; Type No. 263), **plate 9, fig. 383.**

Differs from the preceding species by the dorsal margin, which has only three ridges, and by the very delicate striæ, about 16 in 1 c.d.m., finely punctate. Length, about 4 c.d.m.

Fresh water.—Ard. Lieg. (De Wild.). Scotland (Baxter Coll., No. 2633), Sweden.

E. diodon Ehr. (Inf., p. 192, pl. 21, f. 23; H.V.H. Atl., pl. 33, f. 5, 6*), **plate 30, fig. 829, 830.**

Valve with ventral margin concave, dorsal margin showing two slight rounded ridges. Apices obtuse, rounded, subcapitate. Length, 5 to 7 c.d.m. Breadth at the median constriction, 1 c.d.m.

Fresh water.—England, Scotland (Baxter Coll., No. 2633), Ireland (O'Meara). Fossil.—Sweden, Finland.

aa. Frustules parasitic on other plants.

E. lunaris (Ehr.) Grun. (*Synedra Ehr.*, Infus., pl. 17, f. 4; H.V.H. Atl., pl. 35, f. 3, 4 and 6A*; Type No. 272), **plate 9, fig. 384.**

Valve more or less arcuate, narrow, with apices sometimes gently rostrate-capitate, not inflated, with well-marked nodules; striæ delicate, distinctly punctate, 15 in 1 c.d.m. Girdle face linear, narrow, with apices truncate, somewhat produced. Length, 5 to 9 c.d.m.

Fresh water.—Rather frequent.

var. subarcuata (Naeg.) Grun. (H.V.H. Atl., pl. 35, f. 2*), **plate 9, fig. 385.**

Valve short, rather broad, strongly arcuate.

var. bilunaris (Ehr.) Grun. (H.V.H. Atl., pl. 35, f. 6B*), **plate 9, fig. 386.**

Valve rather short, flexuous.

E. flexuosa Kütz. (Spec. Alg. p. 6; H.V.H. Atl., pl. 35, f. 9 and 10*), **plate 9, fig. 387.**

Valves straight, sometimes somewhat arcuate or somewhat flexuous, with apices inflated, capitate, nodules well marked; striæ delicate, 11 or 12 in 1 c.d.m., distinctly punctate; girdle face linear, with connecting membrane very delicately striate-punctate. Length, 15 to 30 c.d.m.

Fresh water.—Rare?

var. bicapitata Grun. (*Synedra biceps W. Sm.*; H.V.H. Atl., pl. 35, f. 11*), **plate 9, fig. 388.**

Valve broader, with apices more strongly inflated.

Amphicampa Ehr. (1849). A genus created by Ehrenberg for certain *Eunotia*, which presented no other differentiating characters than having the two margins indented.

At the expense of this genus he further created in 1869 two others. Ehrenberg called *Ophidocampa* forms having equal and alternate indentations on the dorsum and venter, and he called *Heterocampa* forms with a valve inflated at the median portion.

Climacidium Ehr. (1869), is another synonym of *Eunotia*. It comprehends forms quadrangular in girdle view, with valves having the dorsal margin indented and truncate, and apices rounded.

E. monodon, *triodon*, *tetraodon*, etc., are also *Climacidium*, according to Ehrenberg.

Desmogonium Ehr. (1848). This genus comprises forms which, in our opinion, cannot remain united.

Desmogonium gracile Eul. (Eul. Spec., Type No. 150), from South Africa, has frustules furnished with terminal nodules, inflated at the apices, and united by its apices in long filaments by means of short filaments of interposed coleoderm. This species ought to be arranged by the side of *Eunotia flexuosa*.

Desmogonium Guyanense Ehr. (Eul. Spec. Type, No. 151), which is found in Asia, Africa, and America, in filaments like the *Eunotia* of the section *Himantidium*. The valves are inflated at the apices. We have only noticed terminal nodules on one valve of the specimens in our possession.

Upon the whole, we believe that these two forms ought to be included in the genus *Eunotia*, notwithstanding the slight differentiating characters which separate them from it.

D. Rabenhortstianum Grun. (D. Ins. Banka, p. 6, pl. 1, f. 1*; H.L. Sm. Sp., Type No. 129, and Cleve and Möller, No. 187), **plate 30, fig. 831.**

This diatom is found also in long filaments, it has very conspicuous terminal nodules, valves slightly or not inflated at the apices, and margins with large beads like the *Actinella*. It appears to me to be intermediate between *Eunotia* and *Actinella*.

It is found in the Island of Banka and in China, in fresh water.

GENUS 37.—PSEUDO-EUNOTIA GRUN. (1865 and 1882).

Fig. 68. *Pseudo-Eunotia Hemicyclus.*

Characteristics of *Eunotia*, from which it is differentiated by the absence of terminal nodules. Frustules solitary, free.

Ps. Hemicyclus (Ehr.) Grun. (H.V.H. Atl., pl. 35, f. 23*; in Types Nos. 262, 275.

Valve narrow, strongly arcuate, with apices inflated obtuse; transverse striæ obtuse, finely divided transversely, 10-11 in 1 c.d.m.

Fossil.—Scotland (Gregory), Sweden (Ehr.).

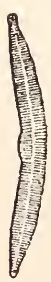


Fig. 69. *Ceratoneis Arcus.*

GENUS 38.—CERATONEIS EHR., 1840.

Valve arcuate, with apices more or less rostrate-capitate, nodules distinct. Ventral margin generally inflated at the central portion, showing a very distinct pseudo-nodule. Pseudo-raphe straight. Frustule free, solitary, with girdle face linear, narrow.

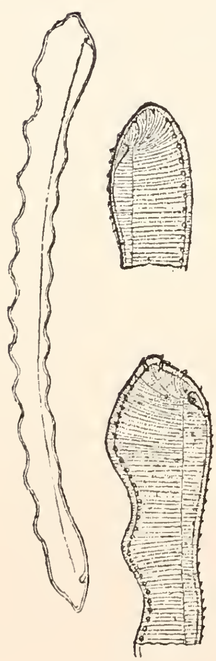
A single species.

C. Arcus Kütz. (Bac., p. 104, pl. 6, f. 10; H.V.H. Atl., pl. 37, f. 7*; Type No. 281), **plate 10, fig. 401.**

Characteristics of genus. Striæ fine, delicately punctate, 16 or 17 in 1 c.d.m. Mean length, 5 to 7 c.d.m. Some specimens attain a much more considerable length.

Fresh water.—Rare: Liresse, Rochehaut (Delogne), Liége (A. Verbeeck), Ard. Lieg. (De Wild.), Westmoreland, England; Arran, Scotland.

GENUS 39.—ACTINELLA LEWIS (1865).



a. b.
Fig. 70.
Act. mirabilis (Eul.) Gr.
a. Entire valve.
b. Upper and lower apices.

Valves arcuate, furnished with terminal nodules; apices unequally developed, the upper very strongly inflated in the form of a club and furnished with a projecting point; the lower with a more feeble inflation, sometimes without any point. Margin of valve level or undulated and furnished with coarse beads and sometimes with small spines. Striæ delicate, punctate. Frustules parasitic, grouped together, according to Lewis, in the form of a star by the inferior apex.

The genus *Actinella* consists of American diatoms, of which only four species have hitherto been described. The *Act. Guyanensis Grun.*, *Brasiliensis Grun.* and *mirabilis* are peculiar to Brazil; *A. punctata Lew.* belongs to North America, but it has, however, also been found in Norway.

Actinella punctata Lewis. (H.V.H. Atl., pl. 35, f. 18 and 21*; Type No. 274), **plate 30, fig. 832.**

Small, clavate, with superior apex strongly emarginate; the inferior apex rounded, obtuse, scarcely inflated. Striæ, about 17 in 1 c.d.m. Length, about 8 to 11 c.d.m.

Fresh water.—A stream at Fisco, near Christiania, Norway (G. Norman, No. 529; in Coll. Walker Arnott, No. 856!).

TRIBE VII.—SYNEDREÆ.

Valves much elongated, with denticulate margins and short marginal costæ			Thalassiothrix.
Valve with margins not denticulate.	Valves slender, with apices inflated into a head in an unequal manner; united together by the most inflated apex, in a stellate form . .		Asterionella.
	Valves acicular or bacillar, or with apices equally inflated.	Valves acicular or bacillar, with fine regular puncta; or valves very attenuate between the centre and the apices; puncta rather coarse and placed irregularly, especially in the median inflation . .	Synedra.

Fig. 71.
Synedra ulna var. spathulifera.

GENUS 40.—SYNEDRA EHR., 1831.

Valves much elongated, more or less lanceolate or linear, sometimes somewhat bent or undulate, furnished with a hyaline median line or with a blank space, sometimes obscure; frequently with a central pseudo-nodule and often with terminal nodules very small and obscure; striæ transversal, never with transverse costæ. Frustule sessile on other plants.

Endochrome formed of two laminæ, denticulate at the edges, or divided into straps and resting on their valves at their median portion.

I. Eusynedra.—Valves regularly striated, scarcely or not inflated at the middle and without sulci.

- Striæ extending throughout nearly all the breadth of the valve; pseudo-nodule linear.
  - Valve furnished with a pseudo-nodule.
    - Pseudo-nodule annular, central . . . . **S. pulchella.**
    - Pseudo-nodule eccentric . . . . **S. Vaucheriæ.**
  - Valves without a pseudo-nodule.
    - Valve furnished with a median hyaline space.
      - Valves narrowly linear-lanceolate.
        - Striæ well marked, about 13 in 1 c.d.m.; apices very slightly rostrate-capitate . **S. Acus.**
        - Striæ fine, from 16 to 18 in 1 c.d.m.; apices slightly rostrate-capitate . . **S. radians.**
      - Valve narrowly linear; apices more or less rostrate, or rostrate-capitate . . **S. Ulna.**
    - Valves without hyaline space.
      - Valves with apices not capitate; marine species.
        - Striæ robust, about 9 in 1 c.d.m.
          - Valve large, linear-lanceolate . **S. Gallionii.**
          - Valve very small, very narrowly linear lanceolate . **S. investiens.**
        - Striæ fine, about 18 in 1 c.d.m.; valve rather broadly lanceolate . . . . **S. barbatula.**
      - Apices capitate; fresh water species.
        - Valve very large and very robust, with apices strongly capitate, head triangular . **S. capitata.**
        - Apices not with triangular head.
          - Valve long and robust **S. Ulna var. div.**
          - Valve small.
            - Raphe narrow; striæ very delicate . **S. famelica.**
            - Raphe rather broad, striæ very robust . **S. amphicephala.**
- Striæ marginal or pseudo-raphe lanceolate.
  - Striæ marginal; no coarse beads on the margins of the valve . . **S. affinis.**
  - Striæ of valve furnished with coarse beads, between which are fine striæ scarcely visible . . . . **S. Nitzschioides.**

II. Ardissonia.—Valves furnished with two or more sulci.

- Valves having only two sulci.
  - Pseudo-raphe distinct; valve narrow.
    - Pseudo-raphe obscure; striæ delicate.
      - Sulci very close to the margins **S. fulgens.**
      - Sulci distant from the margins **S. crystallina.**
    - Raphe very distinct, striæ robust . . **S. superba.**
  - No pseudo-raphe, valve very broad . . . **S. baculus.**
- Valve with more than two sulci, some submarginal, others placed in the middle of the valve . . . . . **S. robusta.**

III. TOXARIUM.—Valves very narrow, but strongly inflated at the median portion and at the apices and covered with irregular puncta, no sulci.

Valve strongly undulated throughout its length . . .	**S. undulata.**
Valve not undulated	**S. Hennedyana.**

I. EUSYNEDRA.—Valves scarcely or not inflated in the middle, regularly striated.

*** Valve without marginal sulci.**

A. STRIÆ EXTENDING THROUGHOUT THE WHOLE VALVE.

a. Valve furnished with an annular pseudo-nodule.

S. pulchella Kütz. (Bac., p. 68, pl. 29, f. 87 ; H.V.H. Atl., pl. 40, f. 28 and 29* ; Type No. 298), **plate 10, fig. 402.**

Valve narrowly lanceolate, with apices gently rostrate-capitate, pseudo-nodule strongly marked, often reaching to the margin. Pseudo-raphe narrow, terminated by small but distinct nodules. Striæ, 13 or 14 in 1 c.d.m., distinctly punctate. Girdle face narrow, linear, attenuate at the apices. Frustules forming flabella. Length, about 6 c.d.m.

Fresh (?) and brackish water.—Antwerp, Blankenberghe, (H.V.H.) Ard. Lieg. (De Wild.). England (Kitton, Comber, Norman, Grove), Scotland, Ireland (O'Meara), France.

forma major. (H.V.H. Atl., pl. 40, f. 27, and plate 41, f. 1*) **plate 10, fig. 403.**

Much larger and attaining to more than 12 c.d.m.

var. Smithii Ralfs. (*S. acicularis W. Sm*, H.V.H. Atl., pl. 41, f. 2* ; Type No. 300) **plate 10, fig. 404.**

As long as the *major* form, but much narrower. Striæ 14 or 15 in 1 c.d.m.

Fresh water.—Antwerp, Ireland. Brackish water.—England (W. Sm., Kitton, Stolt., Norman, Grove), Ireland (O'Meara).

var. lanceolata O'Meara. (*S. minutissima W. Sm.* ; H.V.H. Atl., pl. 41, f. 7* ; Type No. 299) **plate 10, fig. 405.**

Much smaller than the type form, about 3·5 c.d.m., and proportionately broader, almost naviculoid ; 15 striæ in 1 c.d.m.

Fresh water.—Antwerp. England (W. Sm., Norman, Comber), Ireland.

var. vertebra. (*S. vertebra Greg.*) Q.J.M.S., 1855, p. 41, pl. 4, f. 22).

Valve large ; broad at the median portion, then becoming narrower up to the apices.

Lacustrine deposit.—Scotland,

S. Vaucheriæ Kütz. ! (Bac., p. 65, pl. 14, f. 4; H.V.H. Atl., pl. 40, f. 19*; Type No. 297), **plate 10, fig. 406.**

Valve narrow, linear, with apices attenuate rostrate, pseudo-nodule eccentric; striæ robust, 12 or 13 in 1 c.d.m., divided transversely. Length, 3 to 4 c.d.m.

Fresh water.—Rouge Cloître. England (W. Sm., Kitton). Found here and there throughout Europe.

var. parvula. (*S. parvula Kütz.*: H.V.H. Atl., pl. 40, f. 22*), **plate 10, fig. 407.**

Much smaller, and more lanceolate; striæ 14 or 15 in 1 c.d.m. Length, 1·5 to 2 c.d.m.

var. perminuta Grun. (H.V.H. Atl., pl. 40, f. 23*), **plate 10, fig. 408.**

Very small (sometimes less than 1 c.d.m.); 18 or 19 striæ in 1 c.d.m.

var. deformis. (*S. deformis W. Sm.*; H.V.H. Atl., pl. 40, f. 10*), **plate 30, fig. 833.**

Valve more or less deformed, with variable distortions; 10 striæ in 1 c.d.m.

England (W. Sm., Norman), Scotland (Baxter Coll., No. 2908).

aa. Valve without a pseudo-nodule.

b. VALVES HAVING GENERALLY A MEDIAN HYALINE SPACE.

S. Ulna (Nitzsch) Ehr. (Inf., p. 211, No. 295, pl. 17, f. 1; H.V.H. Atl., pl. 38, f. 7*; Type No. 284), **plate 10, fig. 409.**

Valve narrowly linear, with apices more or less longly rostrate; pseudoraphe narrow; striæ robust, 9 in 1 c.d.m., finely divided transversely, usually leaving a quadrangular hyaline space at the median portion of the valve. Length, about 15 to 25 c.d.m.

Fresh water.—Common.

var. splendens. (*S. splendens Kütz.*; H.V.H. Atl., pl. 38, f. 2*; in Types Nos. 312, 15, 107, etc.), **plate 10, fig. 410.**

Much elongated, and attaining as much as 30 c.d.m. in length.

Fresh water.—Common.

var. subæqualis (Grun.) (H.V.H. Atl., pl. 38, f. 13*; Type No. 286), **plate 10, fig. 411.**

Valve linear, narrow; apices obtuse, scarcely or not rostrate-capitate.

Fresh water.—Brussels (Delogne). Rouge Cloître.

var. longissima. (*S. longissima W. Sm.*; H.V.H. Atl., pl. 38, f. 3*; Type No. 287), **plate 10, fig. 412.**

Valve linear, narrow, and excessively elongated (attaining 30 to 55 c.d.m.), with apices strongly capitate.

Brackish water.—Between Ostend and Blankenberghe (H.V.H.), Ard. Lieg. (De Wild.). Ireland (Dickie). England (Norman in Baxter Coll., No. 2839). Scotland (Baxter Coll., No. 2733).

var. spathulifera Grun. (H.V.H. Atl., pl. 38, f. 4* ; in Type No. 25), **plate 10, fig. 413.**

Linear, long ; apices somewhat dilated into a spatulate form.

Fresh water.—Deurne, near Antwerp.

var. amphirhynchus. (*S. amphirhynchus Ehr.* ; H.V.H. Atl., pl. 38, f. 5*), **plate 10, fig. 414.**

With apices rostrate-capitate.

Fresh water.—Ard. Lieg. (De Wild.). Ireland (O'Meara).

var. Danica. (*S. Danica Kütz.* ; H.V.H. Atl., pl. 38, f. 14*a**), **plate 10, fig. 415.**

Long, and very narrowly lanceolate, with apices rostrate capitate.

Fresh water.—Ard. Lieg. (De Wild).

var. lanceolata. (*S. lanceolata Kütz.* ; H.V.H. Atl., pl. 38, f. 10*), **plate 10, fig. 416.**

Narrowly lanceolate, and infinitesimally attenuate up to the apices.

Fresh water.—Ard. Lieg. (De Wild.). Ireland.

var. obtusa. (*S. obtusa W. Sm.* ; H.V.H. Atl., pl. 38, f. 6*), **plate 10, fig. 417.**

Linear, rather broad, with obtuse apices.

Fresh water.—England (W. Sm., Stolt., Comber, Kitton in Baxter Coll., No. 4305).

var. oxyrhynchus. (*S. oxyrhynchus Kütz.* ; H.V.H. Atl., pl. 39, f. 1*a**), **plate 10, fig. 418.**

Small (7 to 8 c.d.m. mean), linear, with apices infinitesimally attenuate into a rather broad rostrum ; striæ somewhat closer, about 10 in 1 c.d.m.

Fresh water.—England (Comber, Norman). Ireland (O'Meara).

var. vitrea. (*S. vitrea Kütz.* ; H.V.H. Atl., pl. 38, f. 11 and 12*), **plate 10, fig. 419.**

Valve linear, narrow, with apices longly and narrowly rostrate ; striæ extending throughout the valve.

Fresh water.—Ard. Lieg. (De Wild.).

S. Acus (Kütz.) Grun. (Wien, 1862, p. 398 ; *S. oxyrhynchus W. Sm. nec Kütz.* ; H.V.H. Atl., pl. 39, f. 4* ; in Type No. 479), **plate 10, fig. 420.**

Valve narrowly lanceolate, with apices slightly rostrate-capitate ; pseudoraphe narrow ; striæ well marked, about 13 in 1 c.d.m., interrupted in the middle of the valve by a hyaline space, elongated, generally quadrangular. Length, about 13 c.d.m.

Fresh water.—Brussels (Delogne) England (W. Sm., Comber). Ireland (O'Meara). Here and there throughout Europe.

var. **delicatissima Grun.** (*S. delicatissima W. Sm.;* H.V.H. Atl., pl. 39, f. 7*; in Types Nos. 221, 269, etc.), **plate 10, fig. 421.**

Shorter and much narrower, with apices somewhat more strongly capitate ; striæ extending throughout the valve. Length, 5 to 10 c.d.m.

Fresh water.—Antwerp, Brussels, etc. England (Kitton, Norman). Ireland (O'Meara).

var. **angustissima Grun.** (H.V.H. Atl., pl. 39, f. 10*), **plate 10, fig. 422.**

Very long, with median portion somewhat inflated, apices excessively narrow, feebly capitate. Length, 20 c.d.m.

Fresh water.

S. radians (Kütz.) Grun. (H.V.H. Atl., pl. 39, f. 11 ; Type No. 289 and in Types Nos. 221 and 312), **plate 10, fig. 423.**

Valve very narrowly linear, lanceolate, with apices somewhat capitate ; striæ fine, 16 to 17·5 in 1 c.d.m. Length, 4 to 10 c.d.m.

Fresh water.—Rouge Cloître (Del.), Ard Lieg. (De Wild.). Antwerp (H.V.H.). England (Kitton, Comber, Norman). Scotland. Ireland (O'Meara).

bb. STRIÆ NOT LEAVING A HYALINE SPACE IN THE MEDIAN PORTION OF THE VALVE.

c. Valves with apices not capitate, sometimes somewhat rostrate. Marine species.

S. Gallionii Ehr. (Inf., p. 212, pl. 17, f. 2 ; H.V.H. Atl., pl. 39, f. 18*; Type No. 291 and Type No. 292 var.), **plate 10, fig. 424.**

Valve linear lanceolate, with apices rounded, sub-obtuse. Pseudo-raphe very distinct, somewhat enlarged at the median portion ; terminal nodules very distinct. Striæ robust, about 9 in 1 c.d.m., distinctly punctate, absent at the apices of the valve, which are covered with very fine granules. Length, 16 to 22 c.d.m.

Marine.—Not yet found in Belgium. England (W. Sm., Stolt), Scotland (Kitton in Baxter Coll. No. 4293), Ireland (O'Meara), and on all the Coasts of Europe.

S. investiens W. Sm. ! (S.B.D., ii., p. 98 ; H.V.H. Atl., pl. 40, f. 3* ; Type No. 293), **plate 10, fig. 425.**

Valve narrowly linear-lanceolate, often slightly gomphonemoid ; striæ very robust, about 9 in 1 c.d.m. Length, 1·5 to 4 c.d.m.

Marine.—Ostend (Westendorp. No. 797). England (Kitton), Ireland (O'Meara), Scot (Grev.).

S. barbatula Kutz. ! (Bac., p. 68, pl. 15, f. 107 ; H.V.H. Atl., pl. 40, f. 6A* ; Type No. 294), **plate 10, fig. 426.**

Valve small, rather broadly lanceolate, with apices slightly rostrate. Raphe narrow. Striæ delicate, about 18 in 1 c.d.m. Length, 2 to 2·5 c.d.m.

Marine.—Not yet observed in Belgium. England. Ireland (O'Meara).

cc. Valves with apices rostrate-capitate. Fresh water species.

S. capitata Ehr. (Inf., pl. 21, f. 29 ; H.V.H. Atl., pl. 38, f. 1* ; Type No. 283), **plate 10, fig. 427.**

Valve linear, with apices strongly capitate, head triangular, with a somewhat attenuated termination. Pseudo-raphe narrow, terminated by obscure nodules. Striæ robust, 8 in 1 c.d.m. Length, 20 to 50 c.d.m.

Fresh water.—Rather common everywhere.

S. famelica Kütz. ! (Bac., p. 64, pl. 14, f. VIII. 1 ; H.V.H. Atl., pl. 39, f. 17*), **plate 10, fig. 428.**

Valve rather broadly lanceolate, with apices strongly rostrate-capitate. Pseudo-raphe narrow. Striæ delicate, 21 in 1 c.d.m. Length, 2·5 to 3 c.d.m.

Fresh water.—Not yet found in Belgium.

S. amphicephala Kütz. ! (Bac., p. 64, pl. 3, f. 12 ; H.V.H. Atl., pl. 39, f. 14* ; *var.* in Types Nos. 30, 128 and 332), **plate 10, fig. 429.**

Valve very narrowly lanceolate, with apices strongly rostrate-capitate. Pseudo-raphe very distinct. Striæ very robust, about 11 in 1 c.d.m. Length, 4 to 6 c.d.m.

Fresh water.—Ard. Lieg. (De Wild.), Scotland, Ireland.

AA. STRIÆ MARGINAL, OR AT LEAST THE PSEUDO-RAPHE ENLARGED AT THE MEDIAN PORTION AND CONSEQUENTLY LANCEOLATE IN FORM.

S. affinis Kutz. ! (Bac., p. 68, pl. 15, f. 6 and 11; H.V.H. Atl., pl. 41, f. 13*; Type No. 302 and in various type slides), **plate 10, fig. 430.**

Valve lanceolate, with apices sometimes slightly rostrate-capitate; striæ marginal, leaving a considerable lanceolated pseudo-raphe, rather fine, 13 or 14 in 1 c.d.m. Length, 9 to 12 c.d.m.

Marine and brackish water.—Blankenberghe. England (Kitton, Comber, Norman, Stolt.). Scotland (Baxter Coll., No. 2830). Ireland (O'Meara). Throughout Europe.

var. tabulata. (*S. tabulata Kütz.*; H.V.H. Atl., pl. 41, f. 9A*; in Types Nos. 102, 174, and 234), **plate 10, fig. 431.**

Valve more longly lanceolate; striæ more shortened, about 9·5 in 1 c.d.m.

Same habitat.

var. parva Kütz. (*S. parva Kütz.*; H.V.H. Atl., pl. 41, f. 23*), **plate 10, fig. 432.**

Very small (about 3 to 7 c.d.m.), with striæ fine, approximate, 19 to 21 in 1 c.d.m.

Same habitat.

These three forms pass into one another by every graduation.

var. fasciculata. (*S. fasciculata Kütz.*; H.V.H. Atl., pl. 41, f. 15*; Type No. 302), **plate 10, fig. 433.**

Valve rather broadly lanceolate, with pseudo-raphe lanceolate, narrower than in the preceding forms.

England (W. Sm., Norman). Scotland (Baxter Coll., No. 2524).

S. nitzschioides Grun. (Oest. D., 1862, p. 89, pl. 8, f. 18*; *Thalassiothrix? nitzschioides Grun.*; H.V.H. Atl., pl. 43, f. 7-10*), **plate 10, fig. 434.**

Valves linear, narrow, or more or less lanceolate, with apices acute or obtuse; pseudo-raphe very broad. Valves showing on their margins coarse beads, 10 to 12 in 1 c.d.m., very distinct, and between these are often found short indistinct striæ. Frustules rectangular in girdle view, united into a filament, arranged sometimes in stellate forms, as in an *Asterionella*. Length, 4·5 to 7 c.d.m.

Marine.—Basin at Blankenberghe—Rare. Scheldt (pelagic, very frequent, H.V.H.). Ireland, (O'Meara).

This diatom is not a true Synedra. Perhaps a new genus should be created for it.

II. ARDISSONIA.—Valve furnished with two or more sulci.

** Valves furnished with two marginal sulci.

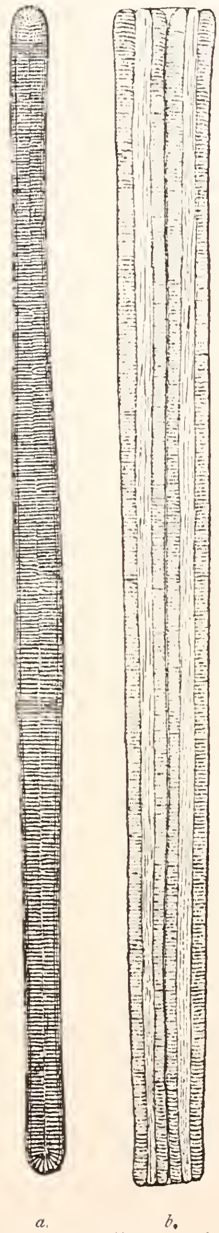


Fig. 72.—*Ardissonia fulgens.*
a. Valve view.
b. Girdle view.

S. crystallina (Lyng.) **Kutz.** (Bac., p. 69, pl. 16, f. 1; H.V.H. Atl., pl. 42, f. 10*; Type No. 305), **plate 10, fig. 435.**

Valve very long, linear, inflated at the apices and median portion with broad, very distinct sulci, distant from the edges of the valve; striæ fine, 12 in 1 c.d.m., formed of strong puncta, absent at the apices of the valve, which are covered with granules arranged in radiant lines. Length, about 50 c.d.m.

Marine.—Not yet found in Belgium. England. Ireland (O'Meara).

S. fulgens (Kütz.) W. Sm. (S.B.D., i., p. 74, pl. 12, f. 103; H.V.H. Atl., pl. 43, f. 1 and 2*; Type No. 308), **plate 10, fig. 436.**

Valve linear, narrow, with marginal sulci, often indistinct, confounded with the margins, usually inflated at the median portion and at the apices, showing at the apices a very distinct crown of radiant delicate striæ; pseudo-raphe narrow; striæ delicate, 13 or 14 in 1 c.d.m., delicately punctate. Length, 17 to 42 c.d.m.

Marine.—Ostend: Oyster beds, very rare. England (Stolt, Norman), Scotland (Kitton in Baxter Coll., No. 4292), Ireland (O'Meara), France.

S. superba Kütz. (Bac., p. 69, pl. 15, f. 13; W. Sm., S.B.D., i., p. 74, pl. 12, f. 102*), **plate 30, fig. 834.**

Valve robust, linear, infinitesimally attenuate from the median portion to the apices, which are rounded sub-truncate. Two sulci, extending the length of the valve, distant from the margins, dividing into two parts the portion of the valve situated between the margin and the pseudo-raphe. Striæ very robust, punctate, about 10 in 1 c.d.m. Length, 25 to 50 c.d.m.

Marine—England (Norman, W. Sm.), Ireland (O'Meara).

S. baculus Greg. (T.M.S., 1857, v., p. 83, pl. 1, f. 54; H.V.H. Atl., pl. 42, f. 9*), **plate 30, fig. 835.**

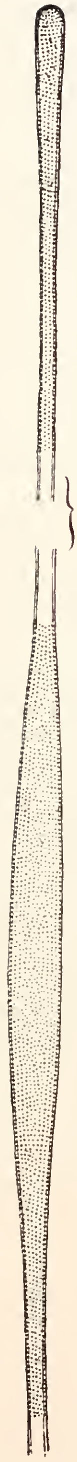
Valve very broadly linear, with apices rounded. Sulci confounded with the margins of the valve. Striæ delicate, 9 or 10 in 1 c.d.m., undulated, finely divided transversely, in such a manner as to form very approximate longitudinal striæ. Length of valve, 40 to 60 c.d.m. Breadth, 1·5 to 3 c.d.m.

Marine.—Coasts of Scotland and Ireland.

S. robusta Ralfs. (in Pritch. Inf., p. 789, pl. 8, f. 3; H.V.H. Atl., pl. 42, f. 6 and 7*; Type No. 304), **plate 30, figs. 836, 837.**

Valve very broadly linear, with apices somewhat produced, rounded, obtuse. Pseudo-raphe very robust and simulating a sulcus; two sulci marginal and two others intermediate; transverse striæ robust, about 5 in 1 c.d.m., showing in their intervals fine longitudinal lines, and sometimes an appearance of rows of beads in the middle of each compartment. Length, 50 to 80 c.d.m. Breadth 3·25 to 4 c.d.m.

Marine.—This magnificent species, the most beautiful of the Synedra, has hitherto been only found in the Mediterranean and Adriatic. We mention it on account of its singular beauty, its remarkable size, and its very peculiar structure.



IV. Toxarium.—Valve very narrow, but much enlarged in the middle and at the apices, and covered with irregular puncta. Marine species.

S. undulata (Bailey) Greg. (Diat. of Clyde, p. 59, pl. 14, f. 107 ; H.V.H. Atl., pl. 42, f. 2* ; Type No. 303), **plate 10, fig. 437.**

Valve very long and very narrow, inflated at the median portion and at the apices, strongly undulated throughout its length. Puncta forming irregular lines, about 12 in 1 c.d.m. on the narrow portion of the valve, arranged irregularly on the enlarged portions. Length, about 40 to 45 c.d.m.

Marine.—Not yet found in Belgium, but found in England, Scotland, France, etc.

S. Hennedyana Greg. (Diat. of Clyde, p. 60, pl. 6, f. 108 ; H.V.H. Atl., pl. 42, f. 3*), **plate 10, fig. 438.**

Valve very narrow, not undulated, strongly inflated in the middle and at the apices, covered with puncta, rather coarse, arranged irregularly. Length, attaining up to 90 c.d.m.

Marine—Ostend (Deby.), very rare. Scotland (Gregory).

Fig. 73.
Toxarium Hennedyana.

Alongside of the *Syncdra* must be placed two small genera of secondary importance and somewhat doubtful position.

Fig. 74.
Campylostylus striatus.

GENUS 41.—CAMPYLOSTYLUS SHADB., 1849 (Manuscript).

Only one species.

C. striatus Shadb. M.S. (*Synedra Normania Grev.* in Q.J.M.S., 1862, ii., n.s., p. 231, pl. 10, f. 1-3).

Valves curved, clavate, somewhat twisted, sometimes inflated like a club at one of the apices, and very gently attenuated into a long prolongation at the other, sometimes more or less longly attenuated at the two apices; transverse striæ excessively delicate, about 13 in 1 c.d.m., finely divided transversely, interrupted by a pseudo-raphe, very narrow, more or less eccentric on one portion of the valve, and terminating in a pseudo-nodule. Length, 15 to 45 c.d.m. Breadth at the inflation, .5 to ·75 c d.m.

Marine.—Has been found in the London Docks, on mahogany logs, first by Shadbolt who made a good pure gathering, then by Norman whose gathering was principally composed of Melosira valves.

Note.—Greville was mistaken in making a Synedra of this curious diatom, the appearance of which is quite peculiar. Greville's figures are very indifferent, and he has noted neither the tortuosity of the valve, nor the pseudo-raphe, nor the terminal nodules, details which might not be noticed with the objectives which Greville had at his command in 1862.

Thalassionema Grun. (in H.V.H.'s Atl.)

In my Atlas, pl. 43, fig. 7-10, Mr. Grunow has proposed to raise *Synedra Nitzschioides* to the rank of a genus. I have preferred to preserve this form

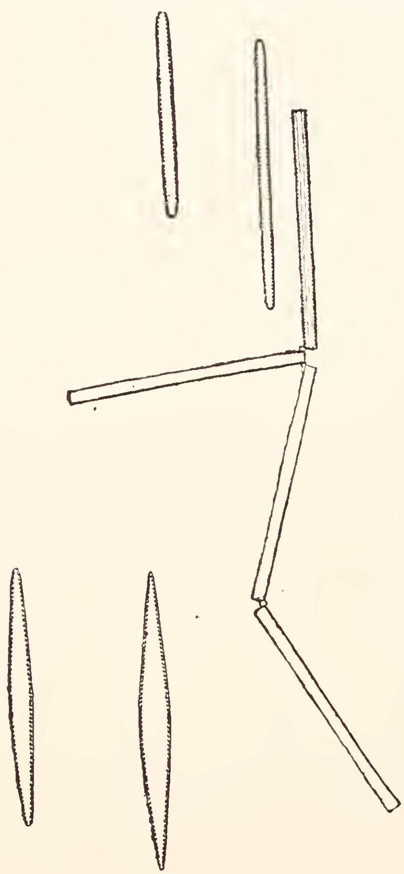


Fig. 75.—*Thalassionema Nitzschiodes.*

(as I have done in the Text of the Synopsis) among the Synedra with which I arranged it in the first instance.

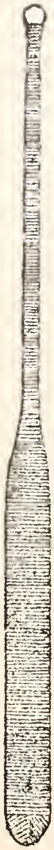


Fig. 76. *Pseudo-synedra Peragalli.*

Pseudo-Synedra Leud-Fortm. (Diat. Malaisie, p. 32).

Without any generic diagnosis being given by the author, Mr. Leuduger-Fortmorel includes in his genus two very different forms.

The *P-S. Peragalli* (fig. 74), "oar-shaped," with fine parallel striæ (12 in 1 c.d.m.) and without pseudo-raphe ; and the other,

The *P-S. Debyi*, in the form of a "constricted dagger," and furnished with a narrow pseudo-raphe, very distinct, and having likewise parallel striæ (10·5 in 1 c.d.m.).

The habitat of the first is Java, and the second Sumatra. We are not acquainted with either form beyond the figures.

GENUS 42.—ASTERIONELLA HASSALL, 1850.

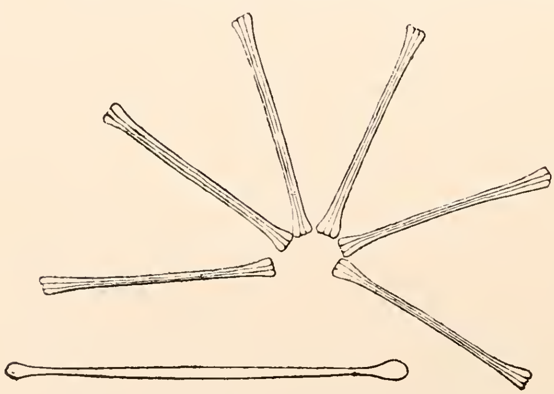


Fig. 77.—*Asterionella formosa var. gracillima*

Valves narrow, linear, with apices unequally capitate ; girdle face linear, with apices unequally inflated. Frustules united in a stellate manner.

A. formosa Hassall. (Microscopical examination of the Water supplied to the Inhab. of London, 1850; T.M.S., 1860, viii., p. 149, pl. 7, f. 8; H.V.H. Atl., pl. 51, f. 19 and 20*), **plate 11, fig. 439.**

Valve narrowly linear, diminishing somewhat in breadth from the base, which is very strongly capitate, to the superior apex, the head of which is much smaller; striæ fine, about 17 in 1 c.d.m., interrupted by a very narrow pseudo-raphe and a rather large hyaline area in the basal inflation. Girdle face strongly inflated at the inferior portion, very slightly so at the superior portion. Length, 7 to 10 c.d.m.

Fresh water.—The type-form has not yet been found in Belgium, but it has been found in England (Kitton, Comber, Roper, Norman, Arnott.), Scotland (Baxter Coll., 2790), Ireland (O'Meara), France, and Denmark.

var. gracillima (Hantzsch) Grun. (H.V.H. Atl., pl. 51, f. 22*; Type No. 345), **plate 11, fig. 440.**

Valves much narrower than in the type-form.

Rather common at Antwerp in the town ditches and neighbouring waters.—England, Denmark, Ireland (O'Meara).

var. inflata. (H.V.H. Atl., pl. 51, f. 23*; in Type No. 345), **plate 11, fig. 441.**

Girdle face abruptly inflated in its inferior third.

Antwerp, mixed with the preceding. Denmark.

var. Bleakeleyi. (*A. Bleakeleyi* W. Sm.!; H.V.H. Atl., pl. 52, f. 1*), **plate 30, fig. 838.**

Frustules short, enlarged, dilated at the base. Length, 4·5 to 5 c.d.m.

Marine.—Harwich (Bleakeley), Norfolk (W. Sm..! Kitton), East Coast (Norman).

var. Ralfsii. (*A. Ralfsii.* W. Sm.).

Frustule still shorter and relatively broader than the preceding. Length, 3·5 to 4·5 c.d.m.

Fresh water.—England (W. Sm., Norman).

GENUS 43.—THALASSIOTHRIX.—CLEVE AND GRUN. (1880).

Valves quadrangular, with apices unequally developed, margins furnished with spines or elevated points, between which are seen short marginal striæ.

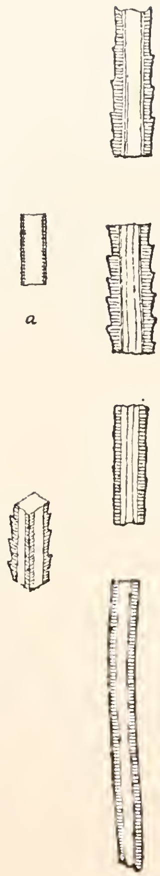


Fig. 78.
Thalassiothrix longissima var. antarctica.

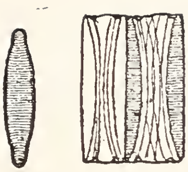
This genus is confined to marine species. Mr. Grunow in the first instance also included in it *Synedra Nitzschioides.* But now the genus should only consist of *Th. Frauenfeldii Grun.* (H.V.H. Atl., pl. 37, f. 11 and 12*), **plate 30, fig. 839**, and *Th. longissima Cl. and Grun.* (fig. 78), the longest known diatom since it attains to 3 to 4 mm. in length. It inhabits the Arctic Seas.

Thal. curvata Castr. (Diat. Challenger, p. 55, pl. 24, f. 6*), **plate 30, fig. 840**, is too incompletely described and figured to form a judgment, on the form, without at least having an authentic specimen at one's disposal. According to the figure it does not appear to differ much from *Synedra (Thalassionema) Nitzschioides*, if it were not for the slight flexure of the frustules.

Tribe VIII.—Fragilarieæ.

Frustules rectangular in girdle view; valves with distinct pseudo-raphe, regularly striated		**Fragilaria.**
Girdle face rectangular. Valves with scattered puncta.	Frustule with connecting zone undulate-arcuate, valves lanceolate	**Cymatosira.**
	Frustules with valves arcuate, connecting zone arcuate and attenuated near the apices, which are inflated .	**Campylosira.**

GENUS 44.—FRAGILARIA LYNGBYE, 1819 (Char. Emend).



a. b.

Fig. 79.—*Fragilaria virescens.* *a.* Valve. *b.* Girdle view.

Valves symmetrical without costæ. Frustules rectangular, united in long filaments or chains. In the section *Staurosira* the endochrome is similar to that of the *Synedra*. In the species contained in the section *Fragilaria*, it is granular.

ANALYSIS OF SPECIES.

Pseudo-raphe narrow and scarcely visible (*Fragilaria*).	Valve linear or linear-elliptic, with apices produced ; striæ 17 in 1 c.d.m. Fresh water species			**F. virescens.**
	Valve elliptic-oval, with apices acuminate-rostrate. Fresh water			**F. undata.**
	Valve elliptic-elongated, scarcely silicious ; striæ very delicate, 24 in 1 c.d.m. Marine			**F. striatula.**
	Valve linear-narrow, with apices inflated ; striæ almost invisible, 31 or 32 in 1 c.d.m. Marine			**F. hyalina.**
	Valve linear, very narrow, inflated at the median portion. Fresh water			**F. Crotonensis.**
Pseudo-raphe distinct (*Staurosira*).	Striæ not marginal.	Striæ formed of distinct beads		**F. capucina.**
		Striæ very robust, with beads more or less confluent or simulating costæ.	Valves small, broadly oval or cruciform. — Valve small, either cruciform, or inflated or constricted at the median portion, striæ fine	**F. construens.**
			Valves small, broadly oval or cruciform. — Valve narrowly lanceolate, with apices inflated, capitate. Fresh water	**F. tenuicollis.**
			Valves small, broadly oval or cruciform. — Valve regularly oval	**F. mutabilis.**
			Valve cruciform, rather large, with robust costæ	**F. Harrisonii.**
	Striæ marginal			**F. brevistriata.**

I. FRAGILARIA.—*Pseudo-raphe very narrow and scarcely visible.*

F. virescens Ralfs. (Ann. and Mag., 1843, XII., p. 110, pl. 2, f. 6 ; H.V.H. Atl., pl. 44, f. 1* ; Type No. 309), plate 11, fig. 442.

Valve linear or linear elliptic, with apices attenuate and often rostrate-obtuse. Pseudo-raphe scarcely visible. Striæ fine, distinctly punctate, about 17 in 1 c.d.m. Frustules quadrangular, elongate, united in long filaments. Length of valves very variable. Mean length, 2 to 6 c.d.m.

Fresh water.—Southern region of Belgium : Namur (P. Gaut.). Pleincvaux (Delogne). Ard. Lieg. (De Wild.). England, Scotland, Ireland, and throughout Europe.

F. undata W. Sm. (S.B.D., ii., p. 24, pl. 60, f. 377*), **plate 30, fig. 841.**

Valves elliptic or longly oval, with apices acuminate and more or less rostrate. Striæ delicate, 17 in 1 c.d.m. Filaments separating easily, and frustules then cohering by their angles. Length, 2 to 5 c.d.m.

Fresh water.—England (W. Sm.), Lock Kinnord Dep. Scotland (Davidson).

var. constricta. Valves constricted at the median portion.

Fresh water.—Scotland (Mull Dep. W. Sm.).

F. striatula Lyngb. (Hydroph. Dan., p. 183, pl. 63A; H.V.H. Atl., pl. 45, f. 12*), **plate 30, fig. 842.**

Valve narrowly lanceolate, with apices somewhat attenuate. Pseudo-raphe very narrow. Striæ very delicate, 24 in 1 c.d.m. Frustules quadrangular, elongated, with connecting zone plicate, in long filaments, very easily deformed, imperfectly silicious.

Marine.—England, Scotland, Ireland, France (probably Belgium), Germany, Norway.

F. hyalina (Kütz.) Grun. (*Diatoma hyalina Kütz.*, Bac., p. 47, pl. 17. f. 20; H.V.H. Atl., pl. 44, f. 14 and 15*; Type No. 310), **plate 11, fig. 443.**

Valve linear, narrow, hyaline, with apices feebly inflated, terminal nodules distinct; striæ very fine, scarcely visible, 31 or 32 in 1 c.d.m. Girdle face quadrangular, elongated, with apices rounded, sometimes inflated, connecting zone showing numerous fine longitudinal striæ. Length, 4·5 to 7·5 c.d.m.

Marine.—Not yet found in Belgium. England, Ireland.

F. Crotonensis (A. M. Edwards) Kitton. ! (Science Gossip, 1869, p. 110, f. 81*), **plate 11, fig. 444.**

Valve linear, very narrow, slightly inflated at the median portion, with apices capitate; striæ 15 in 1 c.d.m. Girdle face strongly inflated at the median portion, and slightly enlarged at the apices. Frustules united in filaments at the middle. Length, 4 to 11 c.d.m.

Fresh water.—Town ditches at Antwerp (only once observed). Ireland (O'Meara).

var. prolongata Grun. (H.V.H. Atl., pl. 40, f. 10*; Type No. 319), **plate 11, fig. 445.**

Valve very narrow, with apices not capitate. Length, about 10 c.d.m.

Fresh water.—Botanical Gardens, Brussels (Del.).

II. STAUROSIRA.—*Pseudo-raphe broad, often more or less lanceolate.*

F. capucina Desmazières (Plantas Crypt. Ed. I. (1825), No. 453; H.V.H. Atl., pl. 45, f. 2*), **plate 11, fig. 446.**

Valves linear, narrow, with apices somewhat produced rostrate. Margin of valve marked with very distinct coarse beads, continued towards the internal portion by delicate striæ, 14 or 15 in 1 c.d.m. Frustules united into long filaments. Length, 3 to 6 c.d.m.

Fresh water.—Common everywhere.

var. mesolepta (*F. mesolepta Rab.*; H.V.H. Atl., pl. 45, f. 3*; Type No. 312), **plate 11, fig. 447.**

Valve strongly constricted at the median portion, with apices rostrate and sometimes capitate; striæ 17 or 18 in 1 c.d.m.

Fresh water.—Rather common.

var. acuta Grun. (H.V.H. Atl., pl. 45, f. 4*), **plate 11, fig. 448.**

Valve narrowly lanceolate with sub-acute apices.

var. acuminata Grun. (H.V.H. Atl., pl. 45, f. 8*), **plate 11, fig. 449.**

Valve narrowly lanceolate. with apices longly and narrowly rostrate; striæ 18 in 1 c.d.m., delicate.

Fresh water.—Paliseul (Delogne).

F. construens (Ehr.) Grun. ! (Oestr. Diat., p. 371; H.V.H. Atl., pl. 45, f. 26, E and D figures on the right and left, and f. 27*); in Type No. 190), **plate 11, fig. 450.**

Valve broadly oval, constricted somewhat below the median portion into rostrate-capitate apices, giving a cruciform appearance. Pseudo-raphe lanceolate. Striæ fine, about 15 in 1 c.d.m. Length, about 1·5 c.d.m.

Fresh water.—Somewhat rare; England (Kitton), Ireland (O'Meara); found throughout Europe.

var. Venter. (H.V.H. Atl., pl. 45, f. 21B, 22, 23, 24B, and 26 (upper and lower * figures); in Type No. 190), **plate 11, fig. 451.**

Valve lanceolate, with obtuse apices, inflated at the median portion.

Fresh water.—Brussels (Delogne). Sheene Dep. Aberdeen (Temp. and Perag., No. 443).

var. binodis Grun. (H.V.H. Atl., pl. 45, f. 24A and 25*), **plate 11, fig. 452.**

Valve lanceolate, with apices rostrate, median portion constricted.

Fresh water.—Antwerp, rather common and parasitic on *Nitzschia Sigmoidea*. Ard. Lieg. (De Wild.). England (Kitton), &c.

F. tenuicollis Heib. (Consp. Diat. Danic., p. 62, pl. 5, f. 13*), **plate 30, fig. 843 and 843** *bis*.

Valves very narrowly lanceolate, linear, with apices rostrate-capitate. Pseudo-raphe narrow; striæ very robust, somewhat radiant, convergent, approximate, about 10 in 1 c.d.m. Girdle face quadrangular, very elongated, somewhat produced at the apices. Length, 2·5 to 5 c.d.m.

Fresh water.—Denmark (Heiberg). Ireland (O'Meara).

var. intermedia (*Fr. intermedia Grun.*; H.V.H. Atl., pl. 45, f. 9*), **plate 30, fig. 844.**

Only differs from the preceding by the presence of a small median unilateral hyaline space. Striæ robust, 9 or 10 in 1 c.d.m.

Fresh water.—England, Ormesby Broad, Norfolk (Kitton in W. Arn. Coll., Nos. 914-915 under the name of *Frag. tenuicollis*.)

F. Harrisonii (W. Sm.) Grun. ! (Oest. Diat., p. 368; H.V.H. Atl., pl. 45, f. 28*; Type No. 316), **plate 11, fig. 453.**

Valve sub-cruciform, with rounded angles, apices obtuse or sub-obtuse. Pseudo-raphe lanceolate. Striæ very robust, 4 or 5 in c.d.m., formed of puncta, confluent and simulating costæ. Length, about 2 to 5 c.d.m.

Fresh water.—Very rare. Mountainous parts of Belgium: Bouillon (Delogne). England (W. Sm., Kitton), New River (Grove).

F. mutabilis (W. Sm.) Grun. ! (Oest. Diat., p. 369, H.V.H. pl. 45, f. 12*; Type No. 315), **plate 11, fig. 454.**

Valves elliptic or, more rarely, linear-elliptic; striæ very robust, with beads confluent, 8 or 9 in 1 c.d.m. Length, 1 to 2·5 c.d.m.

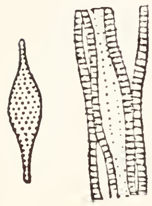
Fresh water.—Brussels (Delogne) Louvaine (P.G.) Ard. Lieg. (De Wild.). England (Kitton), New River (Grove).

F. brevistriata Grun. ! (H.V.H. Atl., pl. 45, f. 32*; Type No. 318), **plate 11, fig. 455.**

Valve lanceolate, with apices produced rostrate; striæ very short and marginal, 13 or 14 in 1 c.d.m. Length, 1·25 to 2 c.d.m.

Fresh water.—Brussels (Delogne). Ard. Lieg. (De Wild.).

GENUS 45.—CYMATOSIRA GRUNOW, 1862.



a. b.
Fig. 80.
Cymatosira Lorenziana.
a. Valve view. b. Girdle view.

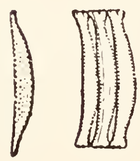
Valve lanceolate, with coarse puncta. Girdle face rectangular, undulated. Frustules in filaments.

C. Belgica Grun. ! (H.V.H. Atl., pl. 45, f. 38-41*), plate 11, fig. 456.

Valve lanceolate, very slightly attenuate up to the apices, which are subacute, with coarse puncta, sparse, but generally leaving a pseudo-raphe of greater or less breadth. Frustules rectangular, in short filaments, with girdle face constricted near the apices. Length, 1·5 to 3 c.d.m.

Marine.—Rare: Blankenberghe.

GENUS 46.—CAMPYLOSIRA GRUNOW, 1882.



a. b.
Fig. 81.
Campylosira cymbelliformis.
a. Valve view. b. Girdle view.

Valve cymbelliform, with rostrate apices, dorsal margin arcuate, ventral margin gently concave, covered with sparse puncta, without visible pseudo-raphe. Girdle face arcuate, constricted near the apices. Frustules united in filaments.

C. cymbelliformis (A. Schmidt) Grun. ! (*Synedra arcus β minor Grun. olim.*; H.V.H. Atl., pl. 45, f. 43*; Type No. 320), plate 11, fig. 457.

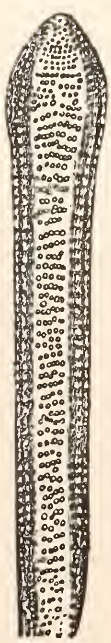
A single species, with characteristics of genus. Mean length, 4 c.d.m.

Marine.—Very common on all our coasts.

TRIBE IX.—RAPHONEIDEÆ.

- Valves with apices similar.
  - Valves elongated, with apices inflated, puncta interrupted by two hyaline lines . . . . . . **Clavicula.**
  - Frustules usually solitary, with girdle face quadrangular or linear. Valves with pseudo-raphe of greater or less breadth **Raphoneis.**
  - Frustules united in twos, attenuated between the middle and apices; suture serrated; valves with coarse puncta without a distinct pseudo-raphe . . . . . **Terebraria.**
- Valves with apices dissimilar, the inferior attenuated like a wedge.
  - Girdle face rectangular, the valve only differing from that of true *Raphoneis* by its inferior apex being cuneate . . **Trachysphænia**
  - Girdle face cuneate.
    - Valves with small terminal pseudo-nodules without pseudo-raphe . . . **Peronia.**
    - No pseudo-nodule, but a pseudo-raphe.
      - Valves gomphonemoid, normal puncta . . . **Sceptroneis.**
      - Valves with coarse round marginal beads . . **Grunoviella.**
      - Valves with coarse puncta very elongated into the form of button-holes . . **Opephora.**

GENUS 47.—CLAVICULA PANT., 1886.



(After a Photograph).

Fig. 82.

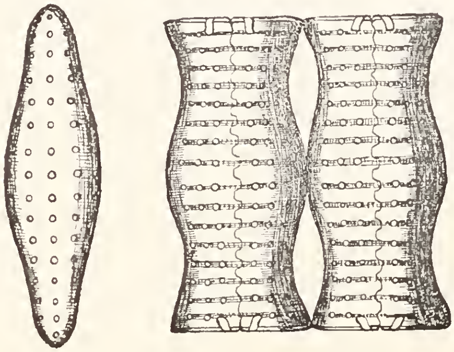
Clavicula polymorpha var. delicatula.

Valve with apices inflated, inflations more or less rhomboidal; coarse puncta leaving a hyaline line on each side of the valves.

This genus consists at present of a very small number of fossil species found in Hungary by Dr. Pantocksek and of some others, also fossil, from Japan, described by Professor Brun.

GENUS 48.—TEREBRARIA GREV., 1864.

Valve elliptic, oblong, with apices attenuate, furnished with 3 or 4 lines of coarse distant puncta. Girdle face quadrangular, attenuated near the apices, punctate.



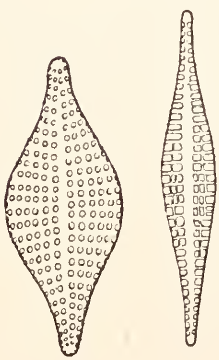
a. *b.*

Fig. 83.

Terebraria Barbadensis Grev. after Greville. *a.* Valve view. *b.* Girdle view.

This genus consists of one species *Terebraria Barbadensis Grev.* found in the deposit of Cambridge Estate (Barbados).

GENUS 49.—RAPHONEIS EHR, 1844.



84. 85.

Fig. 84.
Raphoneis gemmifera. forma curta.
Fig. 85.
Raphoneis scalaris.

Valves lanceolate or elliptic, with striæ transverse, moniliform, generally somewhat radiant, very distinct, with a more or less conspicuous pseudo-raphe. Apices without nodules, often showing fine scattered puncta. Girdle face narrow, linear.

The genus *Raphoneis* includes a large number of species, both living and fossil, but very many of them appear to us to be only modifications of *R. amphiceros.*

ANALYSIS OF SPECIES.

All beads of equal size.	Pseudo-raphe narrow, linear.	Striæ curved, the median shortened; valve very broad, lanceolate . . .	**R. amphiceros.**
		Striæ straight, somewhat radiant; valve linear or narrowly lanceolate . .	**R. Belgica.**
	Pseudo-raphe of greater or less breadth, but attenuate at the median portion		**R. Surirella.**
Valve bordered with a row of beads much smaller than those in the centre of the valve			**R. Liburnica.**

R. amphiceros Ehr. (Bericht. der Berl. Ac., 1844; H.V.H. Atl., pl. 36, f. 22 and 23*; Type No. 276), **plate 10, fig. 394.**

Valve broadly lanceolate, with apices rostrate and sometimes subcapitate; striæ more or less curved, very radiant, 5 or 6 in 1 c.d.m., formed of coarse puncta placed at equal distances and forming almost straight longitudinal lines, the median, and sometimes those near it, shortened. Apices of valve covered with irregular puncta. Mean length, 4 to 7 c.d.m.

Marine.—Common. Blankenberghe, Ostend and Antwerp (Scheldt). Coasts of England, France, and Germany.

var. rhombica Grun. (H.V.H. Atl., pl. 36, f. 20 and 21*), **plate 10, fig. 395.**

Shorter, more inflated, with apices feebly or scarcely rostrate. Mean length, 3 to 5 c.d.m.

R. Belgica Grun. ! (in H.V.H. Atl., pl. 36, f. 25, 29 and 30*; Type No. 277), **plate 10, fig. 396.**

Valve narrowly lanceolate or linear, with apices rostrate-obtuse or subobtuse; striæ 7 to 9 in 1 c.d.m., straight or gently radiant, all of equal length, leaving a narrow pseudo-raphe, composed of puncta forming straight longitudinal lines. Valve with apices covered with puncta, sparse, rather fine. Mean length, 8 to 9 c.d,m.

Marine.—Blankenberghe.

R. Surirella (Ehr. ?) Grun. (H.V.H. Atl., pl. 36, f. 26 and 27*a**; in Type No. 277), **plate 10, fig. 397.**

Valve narrowly elliptic or slightly lanceolate, with apices obtuse, pseudoraphe narrow, linear, dilated only at its apices; striæ 8 in 1 c.d.m., gently radiant, with coarse puncta forming longitudinal lines, more or less curved. Mean length, 4 to 4·5 c.d.m.

Marine.—Common at Blankenberghe. Coast of England (Kitton).

var. Australis. (H.V.H. Atl., pl. 36, f. 27*b**; in Type No. 277), **plate 10, fig. 398.**

Pseudo-raphe very broad, constricted only at the median portion.

Marine.—Blankenberghe.

R. Liburnica Grun.! (Neue etc., 1862, p. 69, pl. 7, f. 6; H.V.H. Atl., pl. 36, f. 33*), **plate 10, fig. 400.**

Valve broadly elliptic, with narrow pseudo-raphe; puncta arranged in radiant lines, about 4 in 1 c.d.m., central puncta very large, diminishing towards the margin, which bears right round its edge a row of much smaller beads, about 6 in 1 c.d.m. Mean length, 3 c.d.m.

Marine.—Blankenberghe, second Basin.—Very rare; only one specimen observed.

GENUS 50.—TRACHYSPHENIA P. Petit, 1877.

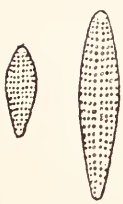


Fig. 86.
Trachysphenia Australis, var. Aucklandica.

Valves cuneate, furnished with coarse puncta, arranged in longitudinal and transverse rows. Pseudo-raphe rather narrow. Frustule and connecting zone rectangular.

Upon the whole, the *Trachysphenia* is nothing more than a *Raphoneis*, one of whose apices is narrower than the other. Only a single species is known, the *Trachysphenia Australis* P. Pet. (fig. 86), which was found in the Isle of Campbell, at Cape Horn, &c. The valves are 3·5 to 5 c.d.m. in length and have six rows of beads in 1 c.d.m.

GENUS 51.—SCEPTRONEIS EHR., 1844.

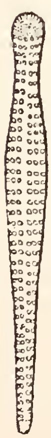


Fig. 87.
Sceptroneis Caduceus.

Valves cuneate, with structure similar to that of the *Raphoneis*; girdle face and connecting zone cuneate.

Sceptroneis Caduceus Ehr. (in Berl. Acad., 1844, p. 264; H.V.H. Atl., pl. 37, f. 5*; Type No. 279), **plate 10, fig. 399.**

Valve bacillar, very elongated, with inferior portion gently cuneate. Median portion very slightly inflated. Superior apex strongly capitate. Pseudo-raphe narrow, somewhat enlarged in the median inflation. Striæ, about 4 or 5 in 1 c.d.m., formed of coarse puncta; apices covered with fine puncta, radiant or sparse. Length, 10 c.d.m.

Marine.—Very rare. I have observed it once in the second Basin at Blankenberghe and another time at Antwerp in the Scheldt. Mr. Deby has observed it at Flessingue at the mouth of the Scheldt. Scotland (Gregory).

GENUS 52.—GRUNOVIELLA H.V.H., 1892, Gen. Nov.

Fig. 83. *Grunoviella gemmata.*

Valve sub-cuneate, furnished with a row of coarse marginal beads; pseudo-raphe lanceolate; girdle face rectangular.

I dedicate this genus to my excellent friend, the eminent diatomographer, Mr. Grunow, who has described the type-form.

G. gemmata (Grun.) H.V.H. (*Sceptroneis? gemmata Grun.* Hedw. V., p. 146; H.V.H. Atl., pl. 37, f. 3*; Type No. 280).

Valve lanceolate, cuneate, very narrow, with apices gently capitate, furnished with a row of very coarse marginal beads, 4 to 4·5 in 1 c.d.m.; pseudo-raphe broadly lanceolate. Length, 6 to 9 c.d.m.

Fossil.—Mors, Jutland (Möller) and Franz Josef Land (Grun.)

Observation.—The girdle face appears to indicate that we are not dealing with true beads, but rather a row of very short costæ.

I include in the same genus *Sceptroneis marina* (*Greg.*) *Grun.* (H.V.H. Atl., pl. 37, f. 2*), **plate 30, fig. 845,** from the Balearic Isles.

GENUS 53.—PERONIA BREB AND ARN., 1868.

Fig. 89.
Peronia erinacea.

Frustule and valve cuneate and similar to a *Gomphonema*, but differing from it by the absence of central nodule and raphe. Frustules sessile solitary or united by twos.

Peronia erinacea Breb. and Arn. (Q.J.M.S., 1868, viii., p. 16; *Gomphonema Fibula Breb. olim;* H.V.H. Atl., pl. 36, f. 19*; in Types Nos. 67, 126, and 274), plate 10, fig. 389.

Valve narrow, cuneate, with superior apex rostrate-capitate; terminal nodules distant from the apices; striæ rather broad, but obscure, about 15 or 16 in 1 c.d.m., interrupted by a well marked pseudo-raphe. Girdle face cuneate, with marginal striæ. Length, 4 to 5 c.d.m.

Fresh water.—Rare. Cornimont (Del.), France (Breb.), England (W. Sm.).

GENUS. 54.—OPEPHORA P. PETIT, 1888.

Fig. 90.
Opephora Schwartzii.

Valve cuneate, furnished with long costæ, distant. Girdle face cuneate. Between the costæ are found small fine beads as in some Navicula.

The type-species is the *O. Schwartzii* (*Gr.*) *P.P.* from Brazil and the Seychelles. Mr. Paul Petit also includes in the genus *Fragilaria pacifica Grun.* (H.V.H. Atl., pl. 44, f. 20-22*), plate 30, fig. 846, but as it has the girdle face rectangular, like *Sceptroneis marina Grun.* and *Fragilaria pinnata Ehr.*, these three forms ought to be included in our genus *Grunoviella*.

Tribe X.—Plagiogrammeæ.

Valves showing in the median portion a transverse hyaline space.			. **Plagiogramma.**
Valves without a transverse hyaline space.	Valves without a central pseudo-nodule .		. **Dimeregramma.**
	Valves furnished with a central nodule.	Pseudo-nodule very coarse, projecting; valves cuneate . . .	. **Omphalopsis.**
		Central nodule rather small; valves not cuneate . . .	. **Glyphodesmis.**

GENUS 55.—GLYPHODESMIS GREV., 1862.

a. *b.*
Fig. 91.
Glyphodesmis Williamsonii.
a. Girdle view. *b.* Valve view.

Valves navicular, furnished with a central pseudo-nodule and terminal smooth spaces. Pseudo-raphe distinct. Puncta more or less quadrangular, usually arranged in longitudinal and transverse rows. Girdle face quadrangular, attenuate between the smooth apices and the connecting zone. Frustules united in filaments.

Authors have enumerated a dozen forms of *Glyphodesmis*, but many of these do not really belong to the genus. The two following, coming from the North Sea, are true types of the genus.

ANALYSIS OF SPECIES.

Beads rather small, extending throughout the valve, frustule attenuate between the central nodule and the smooth spaces . . .	**G. Williamsonii.**
Beads very coarse, marginal; frustules somewhat attenuate between the smooth apices	**G. distans.**

Glyphodesmis Williamsonii (Greg.) Grun. (H.V.H. Atl., pl. 36, f. 14*; *Diadesmis Williamsonii Greg.!* Diat. of Clyde, p. 25, pl. 2, f. 40*), **plate 30, fig. 847.**

Valve linear, narrow, constricted at the median portion, with apices produced-rostrate. Pseudo-raphe very conspicuous, dilated round the central pseudo-nodule and at the apices, where it leaves an oblong smooth space. Striæ formed of coarse sub-quadrangular granules, forming longitudinal and transverse rows, the latter about 8 in 1 c.d.m. Girdle face quadrangular, attenuate between the central nodule and the smooth spaces; similarly attenuate (on the short margin of the frustule) between the smooth spaces and the connecting zone. Length, 6 to 8 c.d.m.

Marine.—Coasts of England (Kitton), Scotland (Loch Fyne, Greg.!) and of Ireland.

Gl. distans (Greg.) Grun. (H.V.H. Atl., pl. 36, f. 15, 16*; *Denticula distans Greg. !* Diat. of Clyde, p. 23, pl. 2, f. 36), **plate 30, fig. 848.**

Valves broadly lanceolate, with apices obtuse rounded, bearing on the margins a row of beads (or short costæ?), very coarse, 5 or 6 in 1 c.d.m.; central nodule coarse, indistinct, terminal smooth spaces round, very large. Girdle face quadrangular, slightly attenuated between the two smooth apices. Length, 3 to 6 c.d.m.

Marine.—Coast of Scotland (Lamlash Bay, Greg. !), Ireland, Sweden.

GENUS 56.—OMPHALOPSIS GREV., 1863.

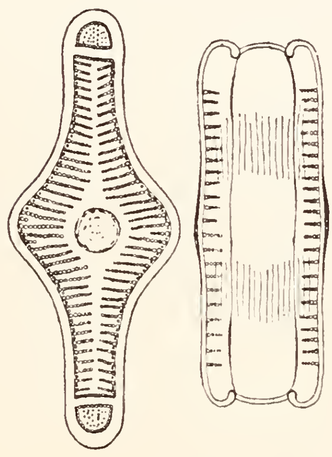


Fig. 92.
Omphalopsis Australis Grev.
a. Valve view. *b.* Girdle view.

Valve cruciform, with apices rounded, obtuse, smooth, separated from the rest of the valve by a transverse diaphragm. Pseudo-raphe narrow, enlarged round the central nodule, which is very coarse. Girdle face rectangular, with rounded angles. Frustules united into a filament.

This genus consists of a single species *O. Australis*, represented in the text. The valve is sometimes elongated, sometimes short, thick-set; the striæ, about 4 in 1 c.d.m., are very distinct and formed of small distinct beads.

Marine.—Seychelles Isles (Coll. Weissf. !). Dredging off Woodlark Island (Roberts).

GENUS 57.—DIMEREGRAMMA RALFS., 1860.

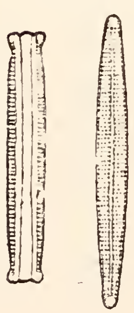


Fig. 93.
Dimeregramma fulvum.
a. Girdle view.
b. Valve view.

Valve with striæ interrupted by a pseudo-raphe, broad and dilated at the median portion, with apices smooth. Without a central transverse smooth space. Frustules united in filaments.

This genus, in fact, only differs from *Glyphodesmis* by the absence of a central pseudo-nodule. The genus *Dimeregramma* includes about a dozen species, three of which belong to our shores.

ANALYSIS OF SPECIES.

Valve more or less broadly lanceolate ; pseudo-raphe lanceolate .		. **D. minor.**
Valve linear or narrowly lanceolate ; pseudo-raphe linear, narrow	Valve not inflated at the median portion ; puncta fine	. **D. fulvum.**
	Valve somewhat inflated in the middle ; puncta robust	. **D. marinum**

D. minor (Greg.) Ralfs. (Greg. Diat. of Clyde, p. 23, pl. 2, f. 35, sub *Denticula* ; H.V.H. Atl., pl. 36, f. 10 and 11*a**), **plate 10, fig. 392.**

Valve lanceolate, with apices obtuse, smooth; pseudo-raphe very gently dilated towards the median portion; striæ 10 in 1 c.d.m. formed of well marked puncta, rather distant, not forming longitudinal lines. Frustules quadrangular, attenuate underneath the apices, which are obtuse-truncate. Length, 3 to 4 c.d.m.

Marine.—Blankenberghe, Ostend. Scotland (Lamlash Bay and Loch Fyne, Greg. ! Cumbrae, sand washings, Baxter Coll., No. 2478. Ireland (O'Meara).

var. nana. (*Denticula nana Greg.*, Diat. of Clyde, p. 23, pl. 2, f. 34 ; H.V.H. Atl., pl. 36, f. 11*b*, 12, and 13*), **plate 11, fig. 393.**

Valve inflated at the median portion, with apices abruptly attenuate ; striæ 14 in 1 c.d.m. ; girdle face as in the type-form, but shorter. Length, 1 to 2 c.d.m.

Marine.—Blankenberghe, Ostend. Mixed with the preceding. England (Stolt.), Scotland.

D. fulvum (Greg. !) Ralfs. (in Pritch. Inf., p. 790 ; *Denticula fulva Greg. ! ;* H.V.H. Atl., pl. 36, f. 7*), **plate 30, fig. 849.**

Valve very narrowly linear, with apices gently capitate, rounded ; striæ about 10 in 1 c.d.m., distinctly granular. Girdle face rectangular, narrow. Length, 4 to 7 c.d.m.

Marine.—Scotland (Lamlash Bay, Greg. !), Ireland, Sweden.

D. marinum (Greg. !) Ralfs. (in Pritch. Inf., p. 790 ; *Denticula marina Greg. ! ;* H.V.H. Atl., pl. 36, f. 9*), **plate 30, fig. 849** *bis.*

Valves lanceolate, linear, gently inflated at the median portion, with apices obtuse, rounded. Raphe rather broad, lanceolate, somewhat dilated at the median portion, terminated by rounded smooth spaces. Striæ, 4 in 1 c.d.m., formed of very coarse puncta. Girdle face rectangular, very narrow, somewhat attenuate near the apices. Length, 8 to 11 c.d.m.

Marine.—English Channel (Temp. and Perag., No. 110). Scotland (Lamlash Bay, Greg. !) Ireland (O'Meara).

GENUS 57 *bis.*—TUBULARIA BRUN, 1894.

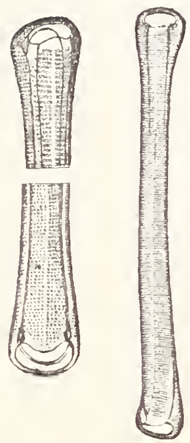


Fig. 94.
Tubularia pistillares.

By the side of *Dimeregramma* should be placed, according to Prof. Brun, a new genus, which he has described under the name of *Tubularia Brun*, in Le Diat., 1894, ii., p. 88.

Frustule tubular, somewhat twisted, flat on the girdle face. Valve transversely striated; raphe obscure; apices opening obliquely and furnished with a large hyaline space.

Only one species up to the present time.

Tubularia pistillaris J. Brun, found in Jackson's Paddock (Barbó). Very rare. Represented in the text.

GENUS 58.—PLAGIOGRAMMA GREV., 1859.

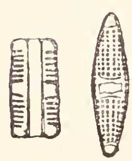


Fig. 95.
Plagiogramma Gregorianum.

Valve having at the median portion a hyaline space, which is generally transverse, often furnished in the middle with a pseudo-ocellus or furnished with two robust costæ, which are prominent in the girdle face: apices hyaline; striæ punctate, puncta distant. Frustules united in filaments.

The *Plagiogramma* are amongst the most beautiful examples of diatoms. About 50 species are known and these inhabit southern regions. The two about to be described are the only species peculiar to the North Sea. Among the *Plagiogramma* are also included two species of *Denticula*, *D. interrupta*, and *D. lævis* of Gregory, found in Lamlash Bay, Scotland, but they are very problematical species, the valves of which have not been described.

ANALYSIS OF SPECIES.

Striæ formed of coarse puncta sub-quadrangular; pseudo-ocellus broad, girdle face scarcely or not attenuate at the apices . . .	**P. Gregorianum.**
Striæ formed of small puncta; pseudo-ocellus narrow, girdle face strongly attenuate at the apices	**P. Van Heurckii.**

P. Gregorianum Grev. (Q.J.M.S., 1859, vii., p. 208, pl. 10, f. 1 and 2; H.V.H. Atl., pl. 36, f. 2*; in Type No. 104), **plate 10, fig. 390.**

Valve oblong lanceolate, with hyaline median portion showing an elongated pseudo-ocellus, bordered with two robust costæ, apices showing a large smooth space. Striæ 9 in 1 c.d.m., formed of coarse puncta, sub-quadrangular, forming longitudinal lines; girdle face quadrangular, obtuse. Length, about 2 to 4 c.d.m.

Marine.—Blankenberghe. England (Stolt.), Scotland (Greg.), Ireland (O'M.), France (Breb.), Bahnsie (Lagerst), Denmark (Heiberg).

P. Van Heurckii Grun! (H.V.H. Atl., pl. 36, f. 4*), **plate 10, fig. 391.**

Valve narrowly lanceolate, with apices generally somewhat rostrate capitate, smooth, with a narrow hyaline transverse band bordered with two costæ, far from robust; striæ 11 or 12 in 1 c.d.m., formed of small puncta, forming longitudinal lines. Girdle face very slightly constricted from the middle to underneath the apices, which are dilated truncate. Median portion only showing one robust costæ, formed by the nearness of the apex of the two costæ visible on the valve. Individuals united in rather long filaments. Length, 1·5 to 4·5 c.d.m.

Marine.—Found on one occasion on a jetty between Heyst and Blankenberghe, and at another time in the mud sediment of the second Basin at Blankenberghe. Surface of the River Dee, England (Stolterfoth)

COHORT OF TABELLARIINEÆ.

ANALYSIS OF TRIBES.

- Frustules genuflexed . . . . **Entopyleæ.**
- Frustules not as above.
  - Valves pyriform (more or less in the shape of a pear) that is cuneate-oval . . . . . . **Licmophoreæ.**
  - Valves not as above.
    - Frustules forming a spiral band . . **Meridioneæ.**
    - Frustules not spiral.
      - False septa very distinct, seldom reduced to knobs . . **Tabellarieæ.**
      - False septa usually absent . **Diatomeæ.**

TRIBE XI.—ENTOPYLEÆ.

- Frustules showing rudimentary septa (diaphragms); valves furnished with costæ . . . . **Entopyla.**
- Frustules without internal septa; valves furnished with costæ . . **Gephyria.**

GENUS 59.—ENTOPYLA EHR., 1841.

Valves furnished with dissimilar costæ, the inferior concave with terminal nodules, the superior convex without nodules. Girdle face curved arcuate, showing several false internal septa. Frustules parasitic, united in short chains, stipitate.

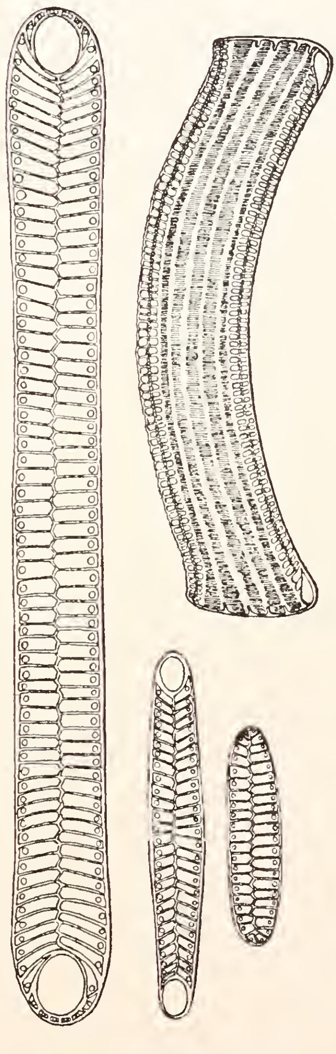


Fig. 96.—*Entopyla Australis.*

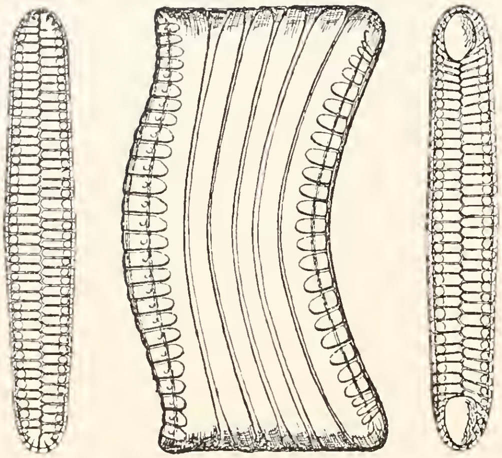


Fig. 97.—*Entopyla incurvata.*

The genus *Entopyla* includes eight species, either fossil or inhabiting tropical regions. *E. Australis Ehr.* is represented in figure 96, reproduced from figures by an esteemed correspondent Mr. C. Janisch (zur Charakteristik des Guanos), and shows on the right the girdle face, and underneath the convex valve, the two other valves showing coarse terminal nodules are concave valves. *E. incurvata* (Arn.) Grun., often met with in collections under the name of *Gephyria iucurvata,* is represented in figure 97.

GENUS 60.—GEPHYRIA W. ARNOTT, 1860.

Differs from *Entopyla* by the absence of false septa. The two genera are closely allied, and might, with some reason, be united into a single genus.

Six species of Gephyria have been described, but they are all found outside the confines of Europe, either living or fossil.

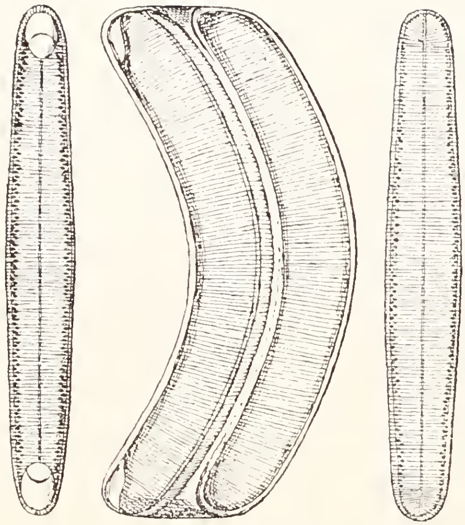


Fig. 98.—*Gephyria media.*

TRIBE XII.—LICMOPHOREÆ.

Frustules cuneate, showing on the valve face a single vitta rounded, and more or less approximate to the enlarged apex . . .	**Licmophora.**
Frustules cuneate, showing on the valve face a large number of transverse septa, simulating the steps of a ladder (scalariform) . . .	**Climacosphenia.**

GENUS 61.—LICMOPHORA (AGARDH), 1827.

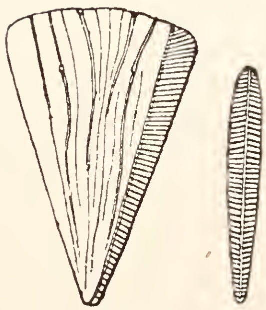


Fig. 99.
Licmophora Californica.

Valves more or less cuneate, with moniliform striæ, pseudo-raphe conspicuous. Frustules cuneate, showing internal septa. Endochrome granular, sparse on the internal surface of the frustules.

The genus Licmophora, as it exists at the present time, results from the fusion of the three former genera *Licmophora*, *Podosphenia* and *Rhipidophora*, founded on inadmissible differences, and which Kützing based on the comparative breadth of the valve and the presence or the absence of a stipes.

About thirty *Licmophora* have been described, the larger number of these forms presenting only the smallest differences, and many given as species ought to be placed in the rank of varieties only.

Licmophora are found in all regions of the globe, the North Sea producing a large number, as the following table demonstrates.

ANALYSIS OF SPECIES.

I.—Frustules scarcely septate.

- Valve very long and narrow, of almost equal breadth at the two apices . **L. flabellata.**
- Valve with superior apex considerably broader than the inferior.
  - Valve very gently attenuated from the summit to the base . **L. Juergensii.**
  - Valve abruptly attenuated near the base.
    - Valve abruptly attenuated towards the lower ½ **L. Dalmatica.**
    - Valve abruptly attenuated towards the inferior ⅓rd.
      - Valve large, broad, 24 striæ in 1 c.d.m. . . . **L. gracilis.**
      - Valve small, narrow, 25 striæ in 1 c.d.m. . . **L. Anglica.**

II.—Frustules profoundly septate.

- Valves very broadly cuneate, striæ very robust . . **L. Ehrenbergii.**
- Valves not broadly cuneate; striæ fine or very fine.
  - Valves abruptly attenuated near the base.
    - Valves rather broad, about 27 striæ in 1 c.d.m. at the middle of the valve . . **L. paradoxa.**
    - Valves very narrow.
      - Striæ rather fine, about 13 in 1 c.d.m. in the middle of the valve . . . **L. Lyngbyei.**
      - Striæ very fine, about 30 in 1 c.d.m. in the middle of the valve . . . **L. tincta.**
  - Valves infinitesimally attenuate.
    - Girdle face broadly cuneate.
      - Septa very arcuate, about 23 striæ in 1 c.d m. in the middle of the valve . . **L. communis.**
      - Septa slightly arcuate, about 30 striæ in 1 c.d.m. in the middle of the valve . . **L. nubecula.**
    - Girdle face very narrowly cuneate, about 16 striæ in 1 c.d.m. in the middle of the valve . **L. tenuis.**

I.—Frustules scarcely septate.

a. Apices almost of the same breadth.

L. flabellata (Carm.) Ag. (Consp., p. 41; H.V.H. Atl., pl. 46, f. 2-3*; Type No. 323), **plate 31, fig. 852.**

Valves excessively long and narrow, cuneate, lanceolate, attenuate towards the inferior apex, which is inflated, subcapitate. Striæ about 30 in 1 c.d.m. Girdle face cuneate, very narrow. Length, up to 30 c.d.m.

Marine.—North Sea. England (W. Sm., Ralfs, Mrs. Griffiths). Scotland (Dickie, Carmichael), Ireland (O'Meara).

aa. Superior apex considerably broader than the inferior.

L. Juergensii Ag. (Consp., p. 42 ; H.V.H. Atl., pl. 46, f. 10, 11*; Type No. 324), **plate 31, fig. 850.**

Valve long, clavate, very slightly attenuated from the base to the summit. Striæ delicate, about 18 in 1 c.d.m. Girdle face broadly cuneate; septa straight, indistinct. Length, 6 to 9 c.d.m.

Marine.—Coasts of the North Sea. Found in England. Ireland (O'Meara).

L. Dalmatica (Kütz.) Grun. ! (*Rhipidophora Kütz.*, Bac., pl. 9, f. 7 ; H.V.H. Atl., pl. 47, f. 7* ; Type No. 326), **plate 11, fig.** 459*a*.

Valve narrowly cuneate, acute at the inferior portion, rounded at the superior. Striæ very fine, about 30 in 1 c.d.m. Girdle face strongly cuneate. Length, 2 to 6 c.d.m.

Marine.—Blankenberghe, with the preceding. England (Comber, Stolt.). Scotland. France (De Bréb).

var. tenella (H.V.H. Atl., pl. 47, f. 8*), **plate 11, fig.** 459*b*.

Smaller and more delicate than the type-form.

L. gracilis (Ehr.) Grun. (in Hedw., 1867, p. 34; H.V.H. Atl., pl. 46, f. 13*), **plate 31, fig. 851.**

Valve clavate, abruptly attenuate towards the inferior third; pseudo-raphe broad; striæ delicate, 20 to 22 in 1 c.d.m. Girdle face narrowly cuneate. Length, 8 to 10 c.d.m.

Marine.—Coasts of the North Sea. England (Stolt.).

L. Anglica (Kütz.) Grun. ! (*Rhipidophora Kütz.*, Bac., pl. 7, f. 27, v., 2 and 4 ; H.V.H. Atl., pl. 46, f. 14*), **plate 11, fig. 458.**

Valves clavate, abruptly attenuate towards their inferior third, and with subparallel margins; striæ 25 in 1 c.d.m. Girdle face much inflated at the superior portion, very cuneate, with superior angles rounded. Length, 2 to 5 c.d.m.

Marine.—Blankenberghe on algæ on the jetties. Coasts of England (Stolt., Norm.).

II.—Frustules profoundly septate.

L. Ehrenbergii (Kütz.) Grun. (in Hedw., 1867, p. 36; H.V.H. Atl., pl. 47, f. 10, 11*), **plate 31, fig. 853.**

Valves broadly cuneate, somewhat obtuse at the base; superior apex rather acute; pseodo-raphe broad; striæ very robust, about 8 to 10 in 1 c.d.m.; frustule narrowly cuneate. Length, 10 to 14 c.d.m.

Marine.—Coasts of the North Sea. England (Kitton). English Channel. Ireland (O'Meara).

var. ovata (*L. ovata W. Sm.*; H.V.H. Atl., pl. 47, f. 13*; Type No. 327), **plate 31, fig. 854.**

Valve much broader, apices more obtuse.

Marine.—Found in England.

L. paradoxa (Lyng.) Ag. (Ag. Icon. Alg., 1829; H.V.H. Atl., pl. 47, f. 10-12*), **plate 31, fig. 855.**

Valve short, obova1, subpyriform, abruptly attenuate towards the inferior third. Pseudo-raphe rather broad; striæ very fine, about 27 in 1 c.d.m. at the middle of the valve. Girdle face very broad at the superior portion, with septa rather strongly arcuate towards the superior third. Length, 3·5 to 6 c.d.m.

Marine.—North Sea. England (Ralfs), Scotland (Greville, Dickie), Ireland (O'Meara).

L. Lyngbyei (Kütz.) Grun.! (*Podosphenia Kutz.*, Bac., pl. 10, f. 1 and 2; H.V.H. Atl., pl. 47, f. 16*; Type No. 321), **plate 11, fig. 460.**

Valve clavate, regularly attenuate up to the inferior third, which is attenuate, and with subparallel margins, the internal septa being distinctly seen through the transparent valve; striæ fine, 14 or 15 in 1 c.d.m. in the superior, and 12 in 1 c.d.m. in the inferior portion. Girdle face rather broad in the superior portion, with angles very rounded. Length, about 5 c.d.m.

Marine.—Ostend (Westendorp, No. 797). North Sea. England (Kitton), Ireland (O'Meara).

L. tincta (Ag.) Grun. (in Hedw., 1867, p. 35; H.V.H. Atl., pl. 48, f. 13-15*; Type No. 328), **plate 31, fig. 856.**

Valves very narrow, abruptly attenuate near the inferior third. Pseudo-raphe indefinite. Striæ very fine, about 30 or 31 in 1 c.d.m. near the middle of the valve. Girdle face very broad, abruptly truncate at the base, rounded at the summit ; septa gently arcuate.

Marine.—North Sea ?

L. communis (Heib. ?) Grun. (in H.V.H. Atl., pl. 48, f. 8, 9*), **plate 31, fig. 857.**

Valves obovate, pyriform, short, with inferior apex subacute ; pseudo-raphe indefinite, striæ fine, 22 to 24 in 1 c.d.m. at the middle of the valve. Girdle face very broad, with septa strongly and abruptly bent towards the superior third.

Marine.—On all the coasts of Europe.

L. nubecula (Kütz.) Grun. (Kaspisch. Meere, p. 123; H.V.H. Atl., pl. 48, f. 18*), **plate 31, fig. 858.**

Valve very gently attenuate ; striæ very fine, about 31 in 1 c.d.m. Girdle face rather narrow, with septa slightly arcuate.

Marine.—North Sea ? Coasts of France (Atlantic Ocean at Granville, De Bréb.).

L. tenuis (Kütz.) Grun. (in Hedw., 1867, p. 35 ; H.V.H. Atl., pl. 48, f. 21* ; *Podosphenia gracilis* W. Sm. !), **plate 31, fig. 859.**

Valve long and narrow, very slightly attenuate, striæ fine, about 16 in 1 c.d.m. Girdle face long, very narrowly cuneate, with septa rather strongly bent near the superior apex of the frustule.

Marine.—North Sea. England (Jersey, W. Sm. !), Norway, etc.

GENUS 62.—CLIMACOSPHENIA EHR., 1843.

Valve oboval, lanceolate or subclavate, linear, very finely striated transversely, showing neither pseudo-raphe nor nodules, leaving the scalariform openings of the underlying septa visible through the valves. Frustules cuneate, showing the apices of the transverse costæ and a connecting membrane, with robust moniliform striæ.

Four species of *Climacosphenia* are known, all of which are marine or fossil ; the best known is *Climacosphenia monilifera Ehr.*, represented in the

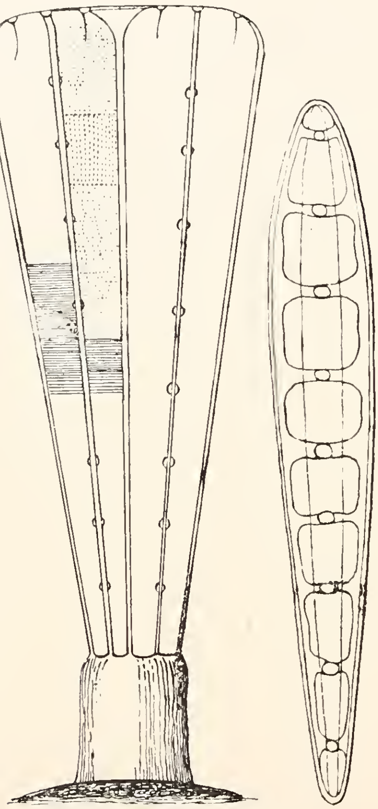


Fig. 100.—*Climacosphenia monilifera.*

text (fig. 100), which inhabits warm regions and is frequently found in collections. It is the true type-form of the genus.

By the side of *Climacosphenia* have been ranked *Climaconeis*, of which there are two species known—*Cl. Lorenzii Grun.* and *Cl. Frauenfeldii Grun.* We are not acquainted with the first, but the second is nothing else than *Stictodesmis Australis Grev.*, which we have already mentioned at end of the description of the Naviculæ (p. 236). The raphe and the nodules of this form do not permit us to consider it as belonging to the Pseudo-raphideæ. *Cl. Frauenfeldii* appears to be only a variety of *Cl. Lorenzii.* The genus *Climaconeis* has been established on the bacillar form and the internal septa of the valve.

TRIBE XIII.—MERIDIONEÆ.

Frustules and valves cuneate, united in a spiral filament . . . **Meridion.**

GENUS 63.—MERIDION AGARDH., 1824.

Differs from the genus *Diatoma* by the cuneate form of the valves and of the frustule in girdle view. Endochrome as in the following genus.

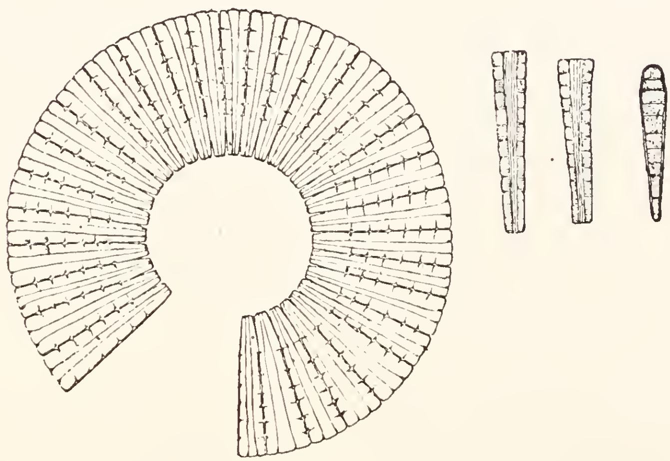


Fig. 101.—*Meridion circulare.*

This genus ought to be suppressed, but in that case it would be logically necessary to suppress all cuneate genera, such as *Gomphonema*, etc.

M. circulare Ag. (Kütz., Bac., pl. 7, f. 16; H.V.H. Atl., pl. 51, f. 10-12*; Type No. 343), **plate 11, fig. 474.**

Valves oval, lanceolate, or clavate, with apices rounded, obtuse, showing transverse costæ rather distant (about 3 in 1 c.d.m.); pseudo-raphe indistinct. Striæ fine, about 16 in 1 c.d.m. Girdle face cuneate, with margins appearing somewhat undulated by the beginnings of the costæ, which terminate insensibly near the connecting zone. Frustules united in a spiral filament. Length, 2·5 c.d.m.

Fresh water.—Not very rare. England (Norman), Scotland, Ireland (O'Meara).

var. constrictum. (H.V.H. Atl., pl. 51, f. 14, 15*; Type No. 344), **plate** 11, **fig. 475.**

Differs from the type form with which it is allied by intermediate forms (see H.V.H. Atl., pl. 51, f. 13), by the superior apex being rostrate capitate.

Fresh water.—Rarer than the type-form. Fays-les-Veneurs (Del.). Ard. Lieg. (De Wild.). England (Norman).

var. Zinkenii. (*M. Zinkenii. Kütz.*; H.V.H. Atl., pl. 51, f. 17*), **plate** 11, **fig. 476.**

Connecting zone showing internal septa.

Tribe XIV.—Diatomeæ.

Valves without a keel (carina)	**Diatoma.**
Valves furnished with a carina, the latter not punctate . .	**Denticula.**

GENUS 64.—DIATOMA DE CANDOLLE, 1805 (Char. Emend.).

Valves lanceolate or linear, furnished with transverse costæ, but without a carina; pseudo-raphe rather indistinct. Frustules with girdle face quadrangular, elongated, united into short filaments or zig-zag chains. Endochrome granular, scattered on the internal surface of the frustules.

ANALYSIS OF SPECIES.

Frustules forming a filament in zig-zag; valves with delicate costæ. (I. Diatoma.)	Valves broadly lanceolate, or linear-elliptic; apices scarcely or not rostrate or capitate . .	**D. vulgare.**
	Valves narrowly linear, with apices more or less capitate	**D. elongatum.**
Frustules united in short filaments; valves with very robust costæ. (II. Odontidium.)	Valves lanceolate, with apices sometimes slightly produced	**D. hiemale.**
	Valves linear, narrow, with apices rostrate or rostrate capitate . . .	**D. anceps.**

I. Diatoma.—*Filaments in zig-zag; costæ rather delicate.*

D. vulgare Bory (Dict. d'hist. natur., 1828, Bot., pl. 20, f. 1; H.V.H. Atl., pl. 50, f. 1-6*; Type No. 335), **plate** 11, **fig. 465.**

Valves broadly lanceolate or linear, with apices scarcely or not rostrate or capitate. Pseudo-raphe indistinct. Costæ delicate, about 5 or 6 in 1 c.d.m.;

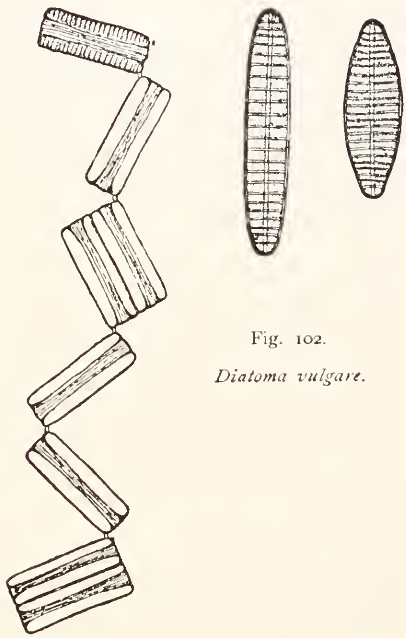


Fig. 102.
Diatoma vulgare.

striæ fine, delicately punctate, 16 in 1 c.d.m. Girdle face quadrangular, with straight margins. Length, 4 to 5 c.d.m.

Fresh water.—Common throughout Europe.

var. linearis. (H.V.H. Atl., pl. 50 f. 7, 8*), **plate 11, fig. 466.**

Valve elongate and broadly linear, with apices sometimes somewhat capitate.

D. elongatum Ag. (Syst., p. 4; H.V.H. Atl., pl. 50, f. 14*c*, 18-22*; Type No. 337), **plate 11, fig. 467.**

Valve linear, very narrow, with apices more or less capitate. Costæ delicate, about 7 in 1 c.d.m. Striæ fine, about 17 in 1 c.d.m. Girdle face very narrow, constricted at the median portion. Length, 4 to 7 c.d.m.

Fresh and brackish water.—Throughout Europe, and especially in our latitudes.

var. tenue. (*D. tenue Ag.;* H.V.H. Atl., pl. 50. f. 14*a* and *b**; in Type No. 337), **plate 11, fig. 468.**

Very narrow, delicate, with apices feebly capitate; length, 3 to 5 c.d.m.

The type-form and the variety, which are allied by various intermediary forms, appear in the brackish water gathering (Type No. 337) made at Nieuport (West. No. 799). Ireland (O'Meara).

var. **hybrida** Grun. (H.V.H. Atl., pl. 50, f. 10-13*), **plate 11, fig. 469.**

Valves more robust, more broadly linear, strongly capitate, with head extending considerably beyond the breadth of the valve. Length, 5 to 8 c.d.m.

Brackish water.—Common: Antwerp.

var. **Ehrenbergii.** (*D. Ehrenbergii Kütz.*). Only differs from the last mentioned variety by its valves being attenuated underneath the capitate apex.

II. ODONTIDIUM AUCT.—*Frustules united in short filaments; costæ very robust.*

D. hiemale (Lyngb.) Heib. (*Odontidium Kütz.*, Bac., p. 44, pl. 28, f. 4; H.V.H. Atl., pl. 51, f. 1 and 2*; Type No. 340), **plate 11, fig. 470.**

Valve lanceolate, with apices sometimes somewhat produced, furnished with 6 to 10 robust transverse costæ; striæ fine, about 20 to 22 in 1 c.d.m. Girdle face quadrangular, elongated. Length, 3 to 5 c.d.m.

Fresh water.—Mountainous regions: Wiry (Del.), Ard. Lieg. (De Wild.). England, Wales (Ralfs.), Scotland (Greville, Arnott), Ireland (O'Meara).

var. **mesodon.** (*O. mesodon Kütz.*; H.V.H. Atl., pl. 51, f. 3 and 4*; in Types Nos. 347 and 461), **plate 11, fig. 471.**

Valves short, very broadly lanceolate, with only 2 to 4 transverse costæ, placed in the middle of the valve. Length, 1·5 to 2·5 c.d.m.

Mixed with the type-form at Wiry (Del.). England, Scotland (Arnott, Gregory), Ireland (W. Sm., O'Meara).

D. anceps (Ehr.) Grun. (*Fragilaria Ehr.*: H.V.H. Atl., pl. 51, f. 5-8*; Type No. 341), **plate 11, fig. 472.**

Valve linear, narrow, with apices rostrate or rostrate capitate, with 6 to 14 robust costæ, having often an oblique direction; striæ about 21 in 1 c.d.m. Girdle face quadrangular, elongated. Length, 2 to 5 c.d.m.

Fresh water.—Mountainous regions; Mogimont (Del.), England, Norway.

var. **anomalum** (*O. anomalum W. Sm.*; H.V.H. Atl., pl. 51, f. 9*; Type No. 342), **plate 11, fig. 473.**

Differs from the type-form by internal septa shown on girdle view.

Fresh water.—Mogimont (Del.). Scotland (Balfour), Ireland (O'Meara).

GENUS 65.—DENTICULA KÜTZING, 1844.

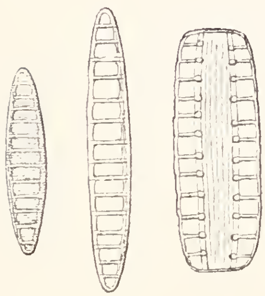


Fig. 103.
Denticula elegans.

Valves more or less lanceolate, fusnished with a carina and transverse costæ, between which punctate striæ can be seen. Frustules solitary or in short chains, with girdle face quadrangular, showing the capitate apices of the costæ.

A dozen species of *Denticula* are known, and these are scattered throughout the world. The presence of a carina enables the *Denticula* to be associated with the *Nitzschia*, and with this genus various authors have arranged them.

ANALYSIS OF SPECIES.

Girdle face very broad, showing costæ with capitate apices; valves with obtuse apices, carina indistinct, striæ 14 to 17 in 1 c.d.m. .	. **D. elegans.**
Girdle face broad. Valve with apices subacute, carina conspicuous; striæ fine, about 17 in 1 c.d.m.	. **D. tenuis.**
Girdle face very narrow. Valves with apices acute, carina invisible; striæ very fine, about 30 in 1 c.d.m	. **D. subtilis.**

D. elegans Kütz. (Bac., p. 44, pl. 17, f. 5; H.V.H. Atl., pl. 49, f. 14, 15*; in Types Nos. 48 and 257; *D. ocellata W. Sm.*), **plate 31, fig. 860.**

Valve linear, lanceolate, with apices obtuse rounded, carina obscure, 4 or 5 costæ in 1 c.d.m.; striæ robust, strongly punctate, about 17 in 1 c.d.m. Girdle face very broad, rectangular, with rounded angles, showing the apices of the costæ, strongly capitate. Length, 2 to 3 c.d.m. Breadth of girdle face, about 1 c.d.m.

Fresh water (on rocks, etc.).—England, Scotland (Balfour), Ireland (O'Meara).

var. thermalis (*D. thermalis Kütz.*; H.V.H. Atl., pl. 49, f. 17, 18*), **plate 31, fig. 861.**

Valve somewhat broader, with apices less obtuse. Striæ, 14 in 1 c.d.m.
Thermal waters.—Sweden (Lagerstedt).

D. tenuis Kütz. (Bac., pl. 18, f. 8; H.V.H. Atl., pl. 49, f. 28 to 31*; Type No. 332), **plate 11, fig. 461.**

Valves longly lanceolate, with apices more or less produced-rostrate, carina conspicuous, costæ 7 or 8 in 1 c.d.m.; striæ fine, 17 in 1 c.d.m. Girdle face broad, showing the carina in the form of a median inflation. Length, 1·5 to 4·5 c.d.m.

Fresh water.—England (Norman, Johnson, W. Sm.). Scotland (Dickie, Arnott). France. Belgium (Ard. Lieg. De Wild.

var. inflata. (*D. inflata W. Sm.*); H.V.H. Atl., pl. 49, f. 32 to 34*; Type No. 333), **plate 11, fig. 462.**

Valve broadly lanceolate, very slightly attenuated up to the apices. About 3 costæ in 1 c.d.m.

Fresh water.—Brussels (Delogne), England (Norman. W. Sm.), France.

var. frigida. (*D. frigida Kütz.*; H.V.H. Atl., pl. 49, f. 35 to 38*; Type No. 334), **plate 11, fig. 463.**

Valve sublinear or moderately lanceolate, with attenuated apices. Costæ 5 or 6 in 1 c.d.m.

Not yet found in Belgium. England.

D. subtilis Grun. (Oest. Diat., p. 546, pl. 12, f. 36; H.V.H. Atl., pl. 49, f. 10 to 13*), **plate 11, fig. 464.**

Valve narrowly lanceolate, with acute apices, carina invisible; striæ very fine, about 30 in 1 c.d.m.; costæ 6 or 7 in 1 c.d.m. Girdle face very narrow. Length, 1·5 to 2 c.d.m.

Brackish water.—Not yet found in Belgium. England (Newhaven, Grunow).

TRIBE XV.—TABELLARIEÆ.

I.—False septa well developed.

Only two false septa.	Septa straight, with three openings			**Diatomella.**
	Septa undulated or hamulous, with only a single median opening			**Grammatophora.**
More than two false septa.	Fossil or fresh water diatoms.	Valves furnished with costæ	Valves orbicular	**Stylobiblium.**
			Valves elliptic, linear, cruciform or inflated	**Tetracyclus.**
		Valves without costæ, linear, inflated at the median portion and at the apices		**Tabellaria.**
	Marine or fossil diatoms.	Valves furnished with costæ or robust beads.	Septa having one to three round openings	**Rhabdonema.**
			Septa having numerous openings delimited by scalariform partitions	**Climacosira.**
		Frustules very delicate, valves without costæ, beads delicate		**Striatella.**

II.—Rudimentary false septa reduced to knobs . **Lamella.**

A.—Only two false septæ.

GENUS 66.—DIATOMELLA GREV., 1855.

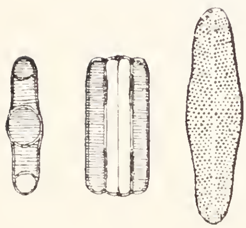


Fig. 104.
Diatomella Balfouriana.

Frustules quadrangular, showing only two false septa (vittæ), straight and pierced with three openings. Valves linear oblong, furnished with a raphe, pseudo-nodules and robust striæ.

A single species.

D. Balfouriana Grev. ! (in Ann. and Mag. Nat. Hist., 1855, p. 259, pl. 9, f. 10-13).

Valves linear oblong, with apices obtuse-rounded, raphe and terminal nodules, the three openings of the false septa (or underlying diaphragms) showing through ; the two terminal openings round, rather large, the median quadrangular, very large.

Striæ robust, about 20 in 1 c.d.m., granular. Girdle face quadrangular, with margins (valves) strongly striate, connecting zone smooth ; showing two conspicuous false septa. Length, 1·5 to 3 c.d.m.

Fresh water.—England (W. Sm.), Scotland (Greville !).

Fig. 105.
Grammatophora macilenta. var. subtilis.

GENUS 67.—GRAMMATOPHORA EHR., 1839.

Valves linear or elliptic, sometimes presenting inflations either at the median portion only or also at the apices, very rarely furnished with costæ, finely punctate ; pseudo-raphe obscure ; furnished with terminal nodules ; no central nodule. Girdle face quadrangular, elongated, with rounded angles, showing two pairs of false septa, generally undulate or curved, and, in addition, two rudimentary septa arising from an internal prolongation of the valve. Frustules united in zig-zag. Endochrome granular, sparse.

ANALYSIS OF SPECIES.

Puncta of valves arranged in rows cutting one another at right angles		. **G. angulosa.**
Puncta in quincunx.	False septa strongly undulated throughout their length, terminating in an acute hook directed towards the connecting zone	. **G. serpentina.**
	False septa only undulated at their origin, not terminating in an acute hook	. **G. marina**

G. marina (Lyngb.) Kütz. (Bac., p. 128, pl. 17, f. 24; H.V.H. Atl., pl. 53, f. 10 and 11*), **plate 11, fig. 479.**

Valves elongated, linear, with rounded apices; striæ 18 to 21 in 1 c.d.m., formed of puncta arranged in quincunx; apices of valves smooth, without any puncta. Girdle face broad, linear, elongated, with rounded angles; false septa at first straight, then broadly curved towards the interior, then becoming again straight, and apparently terminating in a longitudinal thickening. Mean length, 6 to 8 c.d.m. Breadth of valves attaining to 1·5 c.d.m. Breadth of connecting zone, 3 c.d.m.

Marine.—The type-form (*var. major Grun.*) has not yet been found in Belgium. England (Comber, Norman, Stolt.), Ireland (W. Sm.).

var. communis. (*Gr. oceanica var. communis Grun.*; H.V.H. Type No. 355).

Frustule and valve narrower than the type-form. Valve usually somewhat inflated at the median portion. Striæ, 23 or 24 in 1 c.d.m. Breadth of valve, ·45 to ·6 c.d.m. Length of frustule, 2 to 7 c.d.m.; breadth, ·9 to 1·4 c.d.m.

Frequent in Europe, but not yet found in Belgium.

var. vulgaris. (*Gr. oceanica var. vulgaris Grun.*; H.V.H. Type No. 356).

Frustules and valves narrow; valves usually somewhat attenuate between the middle and the apices. Striæ, 23 or 24 in 1 c.d.m. Breadth of valve, ·6 to ·7 c.d.m. Length of frustule, 1·6 to 10 c.d.m.; breadth, 1·3 to 1·6 c.d.m.

Frequent in Europe; Belgium. Nieuport (West.), Ostend (Ch. Petit.).

var. macilenta. (*Gr. macilenta W. Sm.*, S.B.D., ii., pl. 61, f. 382; H.V.H. Atl., pl. 53 *bis*, f. 16*; Type No. 353), **plate 11, fig. 480*a*.**

Girdle face and valves very narrow; valves gently attenuate between the median portion and the apices; striæ 23 to 31 in 1 c.d.m. Breadth of valve, ·4 to ·6 c.d.m. Breadth of girdle face, ·8 to 1·5 c.d.m.; length, 1·5 to 10 c.d.m. (Grun.).

Marine.—Washings of mussels (Deby), England.

var. subtilissima Bailey.

Valves somewhat attenuate between the median portion and the apices. Striæ 34 to 36 in 1 c.d.m. Length of valve, ·6 c.d.m.; breadth of frustule, 1·1 to 1·4 c.d.m. Breadth, 1·1 to 1·4 c.d.m.

This form belongs to South America; we notice it here because it is frequently employed as a test object.

G. angulosa Ehr. (Kutz. Bac., pl. 29, f. 79*), plate 31, fig. 862.

Valves elongate, with rounded apices; striæ 13 to 14·5 in 1 c.d.m., cutting one another at right angles. Girdle face showing septa, having one to four undulations. Breadth of valves, about ·5 c.d.m. Length, 1·5 to 5·5 c.d.m.

Marine.—This species, which Grunow describes as widely dispersed, has not yet been found in Belgium. Coasts of the North Sea, etc.

var. hamulifera Kütz. (H.V.H. Atl., pl. 53, f. 4*; Type No. 351), plate 11, fig. 481*a*.

Apex of undulations forming an acute hook towards the connecting zone.

G. serpentina (Ralfs.) Ehr. (Ber., 1844; H.V.H. Atl., pl. 53, f. 1, 2, 3*; Type No. 350), plate 11, fig. 482*a*.

Valve sub-elliptic; striæ about 17 in 1 c.d.m., formed of puncta arranged in quincunx. Girdle face showing one (in very small forms) to four undulations, the final one terminated by an acute hook. Distinguished easily from the preceding species by the arrangement of the puncta. Breadth of valves, about 1·5 c.d.m.; breadth of girdle face, 3 to 4 c.d.m.; length of same, 2·5 to 15 c.d.m.

Marine.—Scheldt. (P. Gaut. and H.V.H.). Very rare, Blankenberghe (H.V.H.). England (Comber, Stolt., Norman, Ralfs.), Scotland (Hennedy), Ireland (W. Sm.), and on all the coasts of Europe.

var. pusilla. (*Gr. pusilla Grev.*) differs from the type-form by the undulations which are less marked, and only 2 or 3 in number; by the hook which is obtuse, and by the striæ which are finer and 22 or 23 in 1 c.d.m.

Marine.—Scotland (Gregory).

B. More than two false septa.

a. Fossil or fresh water forms.

GENUS 68.—TABELLARIA EHR., 1839.

a. *b.*

Fig. 106.

Tabellaria fenestrata.

a. Valve view.
b. Girdle view.

Valves inflated at the median portion and at the apices, striæ transverse, but without costæ. Girdle face showing false internal septa, generally alternate. Frustules united in a zig-zag filament.

Endochrome granular, with sparse granules.

ANALYSIS OF SPECIES.

Median inflation much broader than the terminal; septa numerous	. **T. flocculosa.**
Median and terminal inflations equal; two to four septa .	. **T. fenestrata.**

T. fenestrata (Lyng.) Kütz. (Bac., p. 127, pl. 17, f. 22, etc.; H.V.H. Atl., pl. 52, f. 6-8*; Type No. 346), **plate 11, fig. 477.**

Valve linear, very elongate, strongly inflated at the median portion and at the apices. Pseudo-raphe narrow, dilated at the inflations. Striæ, 10 in 1 c.d.m., finely punctate. Girdle face narrow, showing a small number (generally two pairs) of false internal septa. Length, about 7 to 10 c.d.m.

Fresh water.—Rare. Antwerp, Louvain (P. Gautier). Ard. Lieg. (De Wild.), England (Kitton, Comber, Brightwell, &c.), Wales, Ireland, and throughout Europe.

T. flocculosa (Roth.) Kütz. (Bac., p. 127, pl. 17, f. 21; H.V.H. Atl., pl. 52, f. 10-12*; Type No. 347), **plate 11, fig. 478.**

Valve linear, with median inflation much greater than the terminal. Pseudo-raphe very dilated in the median inflation. Striæ 13 in 1 c.d.m., finely punctate. Girdle face showing usually a considerable number (from 4 to 8 as a mean) of false internal septa. Length, about 2 to 4 c.d.m.

Fresh water.—More common than the preceding. Antwerp (H.V.H.). Louvain (P. Gaut.). Paliseul (Del.). Ard. Lieg. (De Wild.). England (Kitton, Norman, &c.). Scotland (Dickie, Arnott, Balfour, &c.). Ireland (W. Sm., O'Meara), and throughout Europe.

GENUS 69.—TETRACYCLUS (RALFS, 1843) GRUN., 1862.

Valve with costæ transverse, not numerous. Girdle face showing the margins of the valves and the internal septa, with apices somewhat inflated (clavate). Frustules united in filaments. Endochrome granular, sparse.

ANALYSIS OF SPECIES.

A. Frustules united by twos and threes; valves elliptic without inflations .	**T. rupestris.**
B. Frustules united in long filaments; valves inflated at the median portion.	**T. lacustris.**

A. Gomphogramma (A. Br.).

T. rupestris (A. Braun) Grun. (Oest. Diat., p. 412, pl. 7, f. 37: H.V.H. Atl., pl. 52, f. 13 and 14*; Type No. 348; *Gomphogramma rupestris A. Br.*), **plate 11, fig. 489** *a*.

Fig. 107.

Tetracyclus rupestris.

Valve elliptic-lanceolate, showing 2 to 5 costæ, transverse, robust; striæ fine, about 18 in 1 c.d.m. Girdle face generally showing two pairs of internal septa. Frustules solitary or united by twos or threes or more. Length, ·75 to 2·5 c.d.m.

Fresh water in mountainous regions. Very rare. Alle (Del.) on damp rocks. England?

This diatom closely resembles *Odontidium mesodon*, but it is easily differentiated from it, in the girdle face, by the presence of false septa.

B. Eutetracyclus (Ralfs).

T. lacustris Ralfs (in Ann. and Mag. Nat. Hist., xii., pl. 4, f. 2; H.V.H., in Type No. 349).

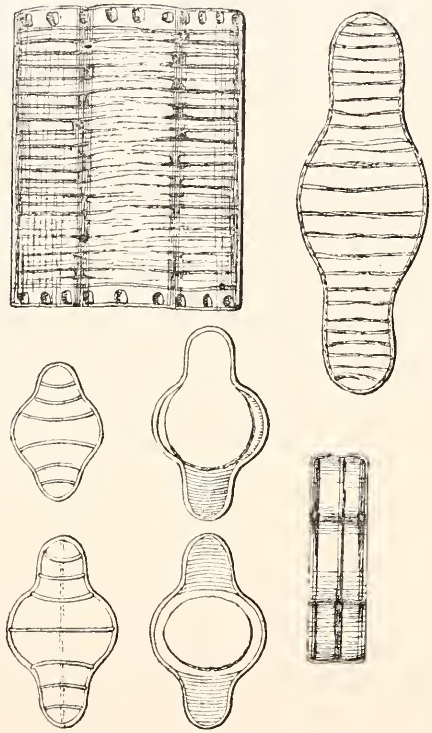


Fig. 108.—*Tetracyclus lacustris.*

Valve more or less cruciform or elliptic, lanceolate, with median portion strongly ventricose, venter rounded, showing 4 to 12 costæ, transverse, curved near the median portion; striæ moniliform, excessively faint, and scarcely visible, about 25 to 30 at the middle of the valve, pseudo-raphe narrow. Frustules in long filaments, showing numerous septa.

Fresh water.—England, Wales (Ralfs.), Scotland (Gregory), Ireland (Wm. Sm.)

var. marginata (Ehr.), W. Sm. (*Tetracyclus emarginatus, W. Sm.; Biblarium emarginatum Ehr.*)

Valve more regularly cruciform, with inflation excavated.

Fresh water.—England. Scotland (Grev., Greg.), Ireland (W. Sm.).

Salacia Pant, 1889.

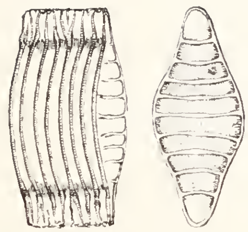


Fig. 109.
Salacia Boryana.

Dr. Pantocsek in his Bacill. Ung., 1889, p. 68, gives the following diagnosis of the sub-genera *Salacia* :—

"Frustula a latere vis a rectangula, cum angulis obtusis, valde elevata, convexa, tabulata, in fascias compressas conjuncta, cum dissepimentis abreviatis transversis, longioribus perpendicularibus, inflatis et lineis perpendicularibus striolatis. Valva elliptice-lanceolata, cum dissepimentis transversis, ad polos cum spacio hyalino nudo ; spacium interseptale striolatum."

He admits one species, *S. Boryana*, which is figured in the text after one of my photographs.

On the grounds that the name of Salacia had previously been given by Linneus to a genus of the Phanerogamia, Professor De Toni has altered the name from *Salacia* to *Castracania*. As there cannot be any confusion between the two I do not see the necessity of the change. But I only notice the genus *Salacia* as a memorandum, as I consider that *S. Boryana* should be included in the genus *Tetracyclus*. The species presents the closest affinity with *T. rhombus*.

GENUS 70.—STYLOBIBLIUM EHR., 1845.

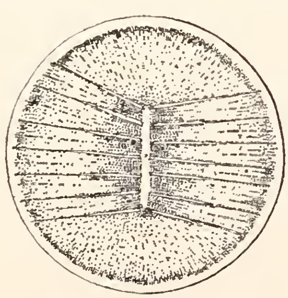


Fig. 110
Stylobiblium divisum.

Valves orbicular, furnished with costæ, without pseudo-nodules. Frustules cylindrical, free, furnished with numerous internal septa.

This genus only includes four species, all fossil ; one from Japan, the other three from Oregon.

The figure opposite represents *S. divisum Ehr.* from Oregon, taken from one of our photographs.

GENUS 71.—RHABDONEMA KÜTZ., 1844.

Valve lanceolate or linear, with pseudo-raphe distinct, apices usually smooth, furnished with costæ or robust beads. Girdle face showing numerous false septa. Frustules united in filaments, shortly stipitate. Endochrome granular, sparse.

The genus includes about 15 species, living or fossil, but only three belong to our shores.

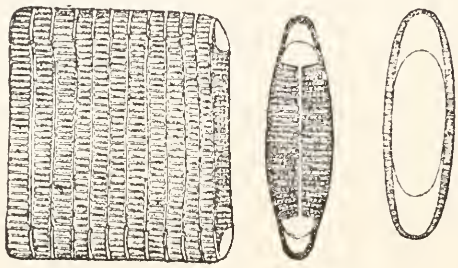


Fig. 111.—*Rhabdonema arcuatum*.

ANALYSIS OF SPECIES

Girdle face showing fine beads alternating with transverse costæ; valves with smooth apices.	False septa having only a single perforation; valves furnished with costæ, alternate with moniliform striæ . . .	**R. arcuatum.**
	False septa having three perforations; valves furnished with costæ, resolvable into beads .	**R. Adriaticum.**
Girdle face not showing transverse costæ; valves entirely striate .		**R. minutum.**

R. Adriaticum Kütz. (Bac., p. 126, pl. 18, f. 7; H.V.H. Atl., pl. 54, f. 11-13*; Type No. 360), **plate 12, fig. 486*a*.**

Valves narrow, linear elliptic, with apices smooth, showing false costæ, 8 to 9 in 1 c.d.m., which can be resolved into approximate beads. False septa with three openings, furnished with transverse costæ and a pseudo-raphe. Girdle face shewing numerous false septa, the intervals between which are filled with transverse costæ (7 or 8 in 1 c.d.m.), and between each of which are found one or two rows of very fine puncta. Length, 6 to 9 c.d.m. Breadth, up to 20 c.d.m. each frustule.

Marine.—Not yet found in Belgium. England (Norman, W. Sm.). Scotland (Arnott), Ireland (W. Sm., O'Meara). France, Bahnsie, Sweden, &c.

R. arcuatum (Agardh) Kütz. (Bac., pl. 18, f. 6; H.V.H. Atl., pl. 54, f. 14-16*; Type No. 361), **plate 12, fig. 487*a*.**

Valves lanceolate, with apices smooth, pseudo-raphe well marked, furnished with costæ, 8 in 1 c.d.m., alternating with rows of rather robust beads. False septa furnished with only a single very large opening. Girdle face showing numerous false septa, the intervals between which are filled with transverse costæ (7 to 7·5 in 1 c.d.m.), between each of which are found two rows of very fine beads, alternating. Length, 4 to 6 c.d.m.

Marine.—Antwerp, in the Scheldt (Belleroche). England (Kitton, Comber, Norman, Stolt.). Scotland (Arnott). Ireland (O'Meara). Norway.

R. minutum Kütz. (Bac., pl. 21, f. ii., 4; H.V.H. Atl., pl. 54, f. 17-21*; Type No. 362), **plate 12, fig.** 488*a*.

Valves broadly lanceolate, with apices attenuate, showing a pseudo-raphe distinct and covered throughout its length with striæ, 9 in 1 c.d.m., composed of coarse beads. Septa furnished with a single very large opening. Girdle face presenting a small number of false septa, appearing to alternate, and with margins furnished with coarse beads, 9 in 1 c.d.m. Length, 1 to 5 c.d.m. Breadth, 1·5 to 3·5 c.d.m.

Marine.—Blankenberghe (H.V.H.). England (Kitton, Comber, Norman, Stolt., W. Sm., Ralfs). Scotland (Hennedy). Ireland (O'Meara). All the coasts of the North Sea.

GENUS 72.—CLIMACOSIRA GRUN., 1862.

The genus *Climacosira* only differs from *Rhabdonema* by the septa showing numerous openings more or less irregularly scalariform.

It includes but one species—*Cl. mirifica Gr.* (*Rhabdonema mirificum W. Sm.*)—found up to the present time living in Brazil, Honduras and Asia, and fossil in the Island of Nankoori. Figure 112 represents one of the characteristic septa.

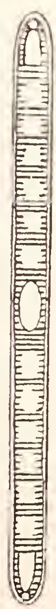


Fig. 112.
Climacosira mirifica.

GENUS 73.—STRIATELLA AGARDH, 1832.

Valves lanceolate or linear elliptic, furnished with a pseudo-raphe usually distinct, without costæ ; striæ excessively delicate. Girdle face showing a large number of false septa. Frustules very slightly silicious, longly stipitate.

Endochrome granular, radiant around a central point.

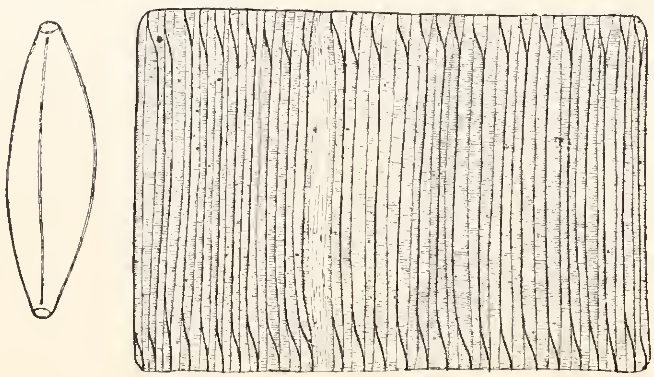


Fig. 113.—*Striatella unipunctata.*

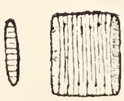


Fig. 114.
Striatella delicatula. var. rectangulata.

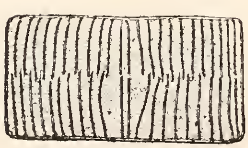


Fig. 115.
Striatella interrupta.

The genus *Striatella*, as at present constituted, results from the fusion of three former genera :—

1. **Striatella Ag.** (fig. 113), septa continued throughout the girdle face of the frustule.

2. **Hyalosira Kütz.** (fig. 114), septa appearing alternately, interrupted at their apex.

3. **Tessella Ehr.** (fig. 115), septa interrupted in the middle of their length.

About a dozen species have been described, but only the following are found in the North Sea :—

ANALYSIS OF SPECIES.

Septa continued throughout the length of the girdle face, size considerable		**S. unipunctata.**
Septa appearing alternate, interrupted.	Size small, septa scarcely visible . . .	**S. delicatula.**
	Size medium, septa clearly visible . . .	**S. interrupta.**

S. delicatula (Kütz.) Grun. (*Hyalosira delicatula Kütz.*, Bac., pl. 18, f. 3 (1), etc. ; H.V.H. Atl., pl. 54, f. 5 and 6* ; Type No. 357), **plate 12, fig. 483*a*.**

Valve elliptic lanceolate ; striæ very fine, 36 in 1 c.d.m. Girdle face quadrangular, showing 4 to 5 pairs of septa, alternate, robust at the margin of the frustule, but becoming gradually slender. Length, about 1 c.d.m. ; breadth, up to 1·5 c.d.m.

Marine.—Ostend (Westendorp in No. 797). Heligoland (Kütz.), and probably on all the coasts of the North Sea, where it is overlooked in consequence of its small size and delicate nature.

S. interrupta (Ehr.) Heiberg. (Danske Diat., pl. 5, f. 15 ; H.V.H. Atl., pl. 54, f. 8* ; Type No. 358 ; *Tessella interrupta Ehr.*), **plate 12, fig. 484*a*.**

Valve linear elliptic, with pseudo-raphe very distinct ; girdle face quadrangular, with rounded angles, showing numerous false septa, alternate, clearly visible up to the middle of the length of the frustule, with intervals covered with delicate granules (22 in 1 c.d.m.) arranged in quincunx, and producing with oblique illumination the image of very approximate fine striæ. Length, about 3 c.d.m. Breadth, about 6 c.d.m.

Marine.—Not yet found in Belgium. Flessingue (H.V.H.), England, Ireland, Germany, Heligoland, Bahnsie.

S. unipunctata Agardh. (Kütz. Bac., pl, 18, f. 5 ; H.V.H. Atl., pl. 54, f. 9 and 10* ; Type No. 359), **plate 12, fig. 485*a*.**

Valve broadly lanceolate, with pseudo-raphe very distinct, covered with very fine puncta, arranged in curved lines ; girdle face showing very numerous septa, extending throughout the length of the frustule, with intervals filled with fine puncta (more marked on the margin of the false septa), arranged in lines cutting one another at right angles, about 23 in 1 c.d.m. With oblique illumination these rows of beads assume the appearance of lines as in fig. 485 (right hand fig.). Figure 485 (left hand fig.) represents the appearance of lines which the rows of beads on the valve can assume. Length, about 6 to 8 c.d.m. Breadth, more than 10 c.d.m.

Marine.—Not yet found in Belgium. Coasts of the North Sea : England (Kitton, Comber, Stolt), Ireland (W. Sm., O'Meara), France, Heligoland, Denmark, Bahnsie.

B. Rudimentary false septa reduced to knobs.

GENUS 74.—LAMELLA BRUN, 1894.

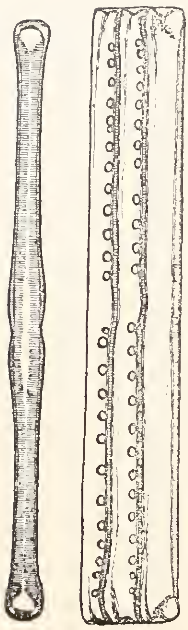


Fig. 116.

Lamella oculata.

Valves bacillar, dilated at the median portion and at the apices; the latter with hyaline inflations. Girdle face showing bosses (false rudimentary septa?) clearly displayed and very smooth.

This genus has been proposed by Prof. Brun for a fossil form found in Totata, Oamaru, New Zealand, *L. oculata Brun*, which will be found represented in the text.

COHORT OF SURIRELLINEÆ.

TRIBE XVI.—SURIRELLEÆ.

Valves undulated transversely, undulations visible in the girdle face, striate, and showing several bands transversely shaded . . .			**Cymatopleura.**
Valves not transversely undulate.	Valve elliptic, sometimes constricted in the middle, furnished with a pseudo-raphe crossed at the median portion and longly bifurcated at the longitudinal apices .		**Hydrosilicon.**
	Raphe not bifurcate.	Valves cuneate, furnished with costæ and beads; valves flat, without alæ .	**Podocystis.**
		Valves flat or spirally torsive, furnished with costæ and moniliform striæ, frustules alate . . .	**Surirella.**
		Valves saddle-shaped, with pseudo-raphe arranged in the two valves in the form of a cross	**Campylodiscus.**

GENUS 75.—PODOCYSTIS KUTZ., 1844.

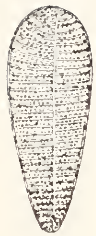


Fig. 117.
Podocystis Adriatica.

Valves cuneate, furnished with transverse costæ and distinct pseudo-raphe. Frustules cuneate, stipitate, without obvious alæ.

Podocystis Adriatica Kütz. (Bac., p. 62; H.V.H. Atl., pl. 55, f. 8*; Type No. 366), **fig. 117 above.**

Valve cuneate, sometimes attenuate near the base, furnished with transverse costæ and rather fine puncta, arranged in transverse and oblique rows.

Marine.—Southern shores of England (W. Sm., Roper), Ireland (O'Meara).

This diatom belongs especially to the Mediterranean and Adriatic.

Euphyllodium spathulatum Shadb. is also a *Podocystis*, but it cannot be considered as identical with *P. Adriatica*, as De Toni and other authors make it. The valves are furnished with a net work of transverse and longitudinal costæ, anastomosed, thickened; at the bottom of the cavities formed by this network is found a transverse costa, excessively delicate, and bearing on each margin a very minute beard. I therefore assign to this form the name of

Podocystis spathulatum (Shadb.) H.V.H. The valve is similar in form to the preceding species. It inhabits the Islands of Ceylon, Nankoori, etc. It is, perhaps, identical with *P. Australica Witt*, which I only know from the description given by De Toni. In the latter case the name of Shadbolt should be retained, as the species of Witt dates from 1873, while that of Shadbolt was described in 1854.

GENUS 76.—HYDROSILICON BRUN, 1891.

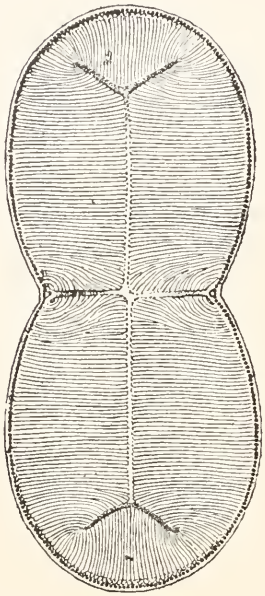


Fig. 118.—*Hydrosilicon mitra.*

Valve lamellar (sometimes panduriform), being transversely and longitudinally a pseudo-raphe, with simple or double bifurcations near the extreme curvatures of the valve. Border thickened, striped, covered with a row of coarse beads. Striation having as centre of radiation, the axes of the crossing of the raphes (Brun).

The genus includes two species, *H. rimosa (O'M.) Brun. (Amphiprora rimosa O'Meara)* and *H. mitra Brun.*, which is represented in figure 118 in the text.

To the description given by Professor Brun., it should be added, that when seen in girdle view the *H. mitra* shows convex valves, strongly constricted at the median portion, and that the space comprised between the terminal bifurcations of the raphe is abruptly flattened.

H. mitra inhabits the Indian Ocean, Australia, etc.

GENUS 77.—CYMATOPLEURA W. SMITH, 1851.

Valves transversely undulate, finely striate, with pseudo-raphe distinct but inconspicuous. Girdle face showing the undulations of the valve.

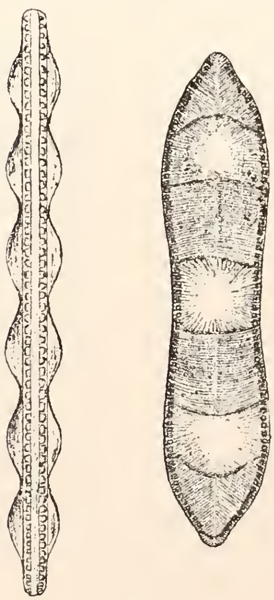


Fig. 119.
Cymatopleura Solea.

ANALYSIS OF SPECIES.

Valves broadly elliptic or elliptic lanceolate	**C. elliptica.**
Valves linear, with apices generally rostrate	**C. Solea.**

C. elliptica (Bréb.) W. Sm. (S.B.D., i., pl. 10, f. 80 *a b*; H.V.H. Atl., pl. 55, f. 1*), **plate 12, fig. 480** *b*.

Valve broadly elliptic or elliptic lanceolate, with margins furnished with short costæ simulating coarse beads; striæ delicate, 18 in 1 c.d.m. Girdle face showing a small number of undulations. Length, 8 to 14 c.d.m.

Fresh water.—Rather common throughout Europe.

var. constricta Grun. (H.V.H. Atl., pl. 55, f. 2*), **plate 12, fig. 481** *b*.

Valves longly elliptic, slightly constricted at the median portion.

var. Hibernica. (*C. Hibernica W. Sm.*; H.V.H. Atl., pl. 55, f. 3-4*), **plate 31, fig. 863.**

Valve broadly oval, with apices somewhat acuminate-rostrate.

Fresh water.—Not yet found in Belgium. Ireland (W. Sm.), Scotland (Dickie), France (De Brébison).

C. Solea Bréb.) W. Sm. (S.B.D., i., pl. 10, f. 78; H.V.H. Atl., pl. 55, f. 5-7*), **plate 12, fig. 482** *b*.

Valves more or less longly linear, with apices generally rostrate, median portion constricted, margins furnished with somewhat longer costæ than in the preceding species, and showing coarse moniliform striæ, about 6 in 1 c.d.m.

In very oblique illumination the striation shown in fig. 482 (left-hand figure) may be seen. Girdle face very narrow, and showing a large number of undulations, sometimes opposite, sometimes alternate. Length, 5 to 13 c.d.m.

Fresh water.—Rather common throughout Europe.

var. regula (Ehr.) Ralfs.

Valve with parallel margins, not constricted in the median portion.

GENUS 78.—SURIRELLA TURPIN, 1827.

Valves cuneate, reniform, elliptic or linear, sometimes twisted, having a pseudo-raphe linear or lanceolate; furnished with costæ, short or reaching to the pseudo-raphe, and a submarginal keel of greater or less size; pseudo-raphe parallel in the two valves. Girdle face showing alæ produced on the projecting keel.

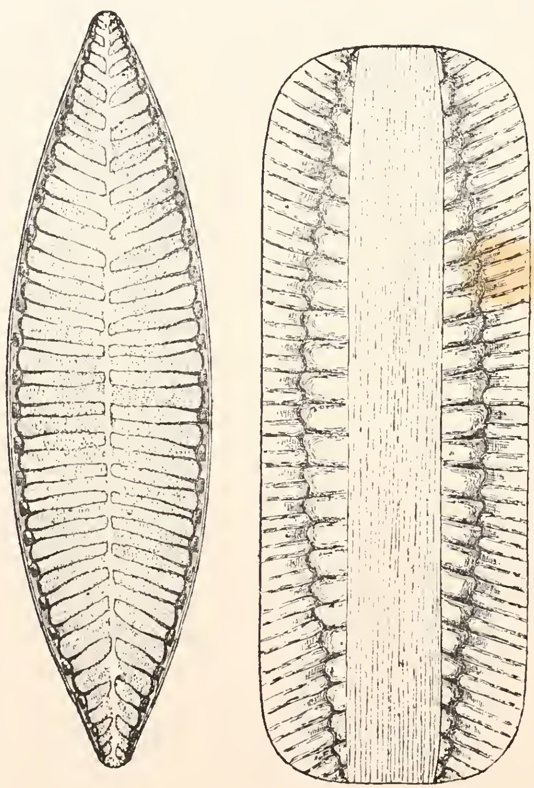


Fig. 120.—*Surirella biseriata.*

Endochrome formed of two layers, each of which rest flat about the middle, on the interior side of the valves.

ANALYSIS OF SPECIES.

- Valves plane.
  - Valves showing robust costæ throughout their length and reaching to the median line.
    - The two apices equally conical.
      - Valve small, linear or elliptic . . . **S. linearis.**
      - Valve very large, lanceolate . . . **S. biseriata.**
      - Valve of medium size, lanceolate, constricted at middle . . **S. Smithii.**
    - Valve oval, one apex acute, the other obtuse
      - Striæ not reaching to the pseudo-raphe; size very considerable . **S. elegans.**
      - Striæ reaching to the pseudo raphe.
        - Costa leaving no space free except a very narrow pseudo-raphe.
          - Size very small, striæ robust **S. subsala**
          - Size very large, striæ fine . **S. Gemma.**
        - Costæ leaving near the pseudo-raphe a rather broad striated space.
          - Valve longly oval; alæ very robust, more or less approximate to the connecting zone. **S. robusta.**
          - Valve broadly oval; alæ conspicuous, quite marginal . **S. striatula.**
  - Costæ marginal or becoming more feeble near the centre of the valve.
    - Costæ very robust on the margin of the valves, becoming more feeble near the median portion. Marine species, very robust . . . . . **S. fastuosa.**
    - As the preceding, but costæ leaving a lanceolate blank space. Fresh and brackish water . . **S. turgida.**
    - Costæ marginal or becoming very delicate near the central portion of the valve. Fresh or brackish water species. Rather delicate . . . **S. ovalis.**
- Valves twisted round the pseudo-raphe. Frustule in form of figure 8 . **S spiralis.**

I. Valves plain.

A. Valves showing robust costæ throughout their length, and reaching to the median line.

a. THE TWO APICES OF THE VALVE EQUALLY CONICAL.

S. biseriata Bréb. (Alg. Falaise, pl. 7; H.V.H., pl. 72, f. 1 to 3*; Type Nos. 420, 421), **plate 12, fig. 575.**

Valve broadly lanceolate, with apices sometimes somewhat sub-rostrate, sub-obtuse, with costæ robust, the median straight, the terminal radiant. Pseudo-raphe with hyaline area of more or less breadth, and more or less lanceolate. Striæ very delicate. Girdle face linear, oblong, with rounded angles, showing the keel alate, robust. Length, 10 to 17 c.d.m.

Fresh water.—Rather common throughout Europe.

var. amphioxys. (*S. amphioxys W. Sm.*). Very small; with valves linear, apices cuneate, more or less acuminate rostrate.

Fresh water.—France (De Bréb.), England (Carrington, Okeden), Aboyne, Scotland (Baxter Coll., 2920), Ireland (Arnott in Baxter Coll., 2817).

S. linearis W. Sm. (S.B.D., i., p. 31, pl. 8, f. 58*a**), **plate 31, fig. 864.**

Differs from *S. biseriata*, of which it is probably only a variety, by its smaller and narrower valves and apices equally rounded, sub-obtuse.

Fresh water.—Belgium (not yet found), England (Kitton, Comber, Norman), Scotland (Dickie), Ireland (O'Meara).

S. Smithii Ralfs (in Pritch. Inf., p. 794; *S. constricta W. Sm.!*; S.B.D., i., p. 31, pl. 8, f. 59*), **plate 31, fig. 865.**

Valves lanceolate, with apices cuneate, slightly obtuse, often constricted at the median portion; costæ delicate, about 4·5 in 1 c.d.m. Pseudo-raphe narrow, linear in the constricted valves; lanceolate in the valves not constricted. Girdle face linear, with apices truncate, angles rounded, alæ very conspicuous. Length, 7 to 14 c.d.m.

Brackish water.—England (W. Sm.! Comber, Stolt.), Ireland (O'Meara).

a a. VALVE OVAL, ONE OF THE APICES MORE OR LESS ACUTE, THE OTHER OBTUSE.

S. elegans Ehr. (Verb., p. 136, pl. III., 1, f. 22; H.V.H. Atl., pl. 71, f. 3*; Type No. 419), **plate 12, fig. 576.**

Valve more or less broadly oval, very large, with median line narrow, surrounded by a hyaline area, lanceolate, broad, with rather strong costæ, about 1·5 in 1 c.d.m.; striæ fine, excessively delicate, 22 in 1 c.d.m. Girdle face cuneate, with apices obtuse, rounded; alæ rather robust, very approximate to the margin. Length, 18 to 22 c.d.m.

Fresh water.—Brussels (Del.), Ard. Lieg. (De Wild.), Devizes, England (Baxter Coll., 2683), Hull (Norman), Ireland (O'Meara), Loch Kinnord, Scotland (Temp. and Per., No. 4), Elgin, Scotland (Arnott in Baxter Coll., 2820).

S. subsalsa W. Sm.! (S.B.D., i., p. 34, pl. 31, f. 259*), **plate 31, fig. 866.**

Resembles considerably a miniature or reduced form of *S. Splendida.* Valves very small, more or less broadly oboval, with costæ rather robust, 3 in

1 c.d.m. Pseudo-raphe very narrow; striæ rather strong, 10 or 11 in 1 c.d.m. Girdle face linear, somewhat cuneate, with alæ very conspicuous. Length, 1·5 to 4 c.d m.

Brackish water.—England (W. Sm. ! Kitton, Norman, Greg.).

S. robusta Ehr. (Mb., 1840, p. 215; Mikr., pl. 15, f. 43; *Surirella nobilis W. Sm.;* H.V.H. Atl., pl. 71, f. 1 and 2*; Type 418), **plate 12, fig. 577.**

Differs from the preceding by its more considerable size, the absence of a hyaline area round the median line, the more robust costæ, the better marked striæ, and by the alæ being approximate to the connecting zone.

Fresh water.—Ard. Lieg. (De Wild.). It is found here and there in Europe.

var. splendida. (*Nav.? splendida Ehr.*, Inf. pl. 14, f. 1; *S. splendida Kütz.*, H.V.H. Atl., pl. 72, f. 4*; Type No. 422), **plate 12, fig. 578.**

Distinguished from the type-form by its smaller dimensions and longer costæ, still more approximate to the median line.

Fresh water.—Rather frequent everywhere.

S. Caproni Bréb.! is only an anomalous form of the preceding variety. It is characterised by a ridge at the inferior apex of the raphe, and resulting from a prolongation of the costæ.

This form is found occasionally mixed with the type-form.

var. tenera. (*S. tenera Greg.;* in H.V.H. Type No. 62, rare), **plate 12, fig. 579.**

Differs from the preceding by its narrower form and less marked alæ.

Fresh water.—Frahan (Del.), Scotland (Greg.).

S. striatula Turpin (Mém. du Mus. d'Histoire Nat., XVI.; H.V.H. Atl., pl. 72, f. 5*; Type No. 423), **plate 13, fig. 580.**

Valve broadly oval, with costæ robust, distant, about 1 in 1 c.d.m., reaching to the median line; striæ rather visible, about 14 in 1 c.d.m. Girdle face very cuneate, showing not very robust alæ, quite marginal. Length, 10 to 16 c.d.m.

Marine and brackish water.—Blankenberghe, Antwerp (Scheldt), England (Kitton, Comber, Stolt., Norm.), Ireland (O'Meara), and on all our coasts.

var. biplicata Grun. (H.V.H. Atl., pl. 72, f. 6*), **plate 13, fig. 581.**

Showing a longitudinal plica near the median portion.

Antwerp (Scheldt. P. Gaut.). Very rare.

S. Gemma Ehr. (Abh., 1840, p. 76, pl. 4, f. 5; H.V.H. Atl., pl. 74, f. 1-3*; Type No. 433), **plate 13, fig. 582.**

Valve more or less longly oval, with costæ indistinct, about 2 to 3 in 1 c.d m., reaching to the median line, which is narrow; striæ fine, transverse, 20 or 21 in 1 c.d.m., resolvable into beads in appropriate illumination. Girdle face strongly cuneate, alæ marginal, scarcely visible. Length, about 7 to 12 c.d.m.

Marine.—Blankenberghe, Antwerp (Scheldt, H.V.H.) Common on all our coasts.

A A. Costæ marginal or becoming gradually fainter.

a. COSTÆ VERY ROBUST ON THE MARGIN OF THE VALVES.

S. fastuosa Ehr. (Abh., 1841, p. 19; H.V.H. Atl., pl. 73, f. 18*; Type No. 432), **plate 13, fig. 583.**

Valves broadly oval; costæ very robust at the margin, but gently diminishing in breadth as far as the third of the valve where they leave a space lanceolate, bordered with elongated dots, and sometimes they continue in this space, but in doing so they become more delicate. Pseudo-raphe narrow. Striæ delicate, about 19 in 1 c.d.m. Girdle face cuneate, with rounded margins, showing robust alæ, approximate to the connecting zone. Length, 5 to 12 c.d.m.

Marine.—Washings of mussels (Deby), Blankenberghe, Scheldt. (H.V.H.), England (W. Sm., Comber, Norman, Stolt,), Ireland (O'Meara), Scotland (Arnott in Baxter Coll. 2546, 2764). Very numerous forms there as well as on all our shores.

var. lata. (*S. lata W. Sm.;* H.V.H. Atl., pl. 73, f.17*), **plate 13, fig. 584.**

Differs from the type-form by its larger size, and by the median constriction of the valves.

With the preceding.—Scheldt (H.V.H.), England (Comber, Ralfs.), Scotland (Williamson), France (Bréb.),

The innumerable forms of *S. lata* have been raised by some authors to the rank of species. Gregory has further recorded intermediate forms, which connect *S. fastuosa* with *S. lata*.

S. turgida W. Sm. (S.B.D.,i., p. 31,pl. 9, f. 60*), **plate 31, fig. 867.**

Valve elliptic, oval, with apices sub-obtuse or slightly acute; median portion much inflated; costæ robust, shortened, about 1·25 in 1 c.d.m.; pseudo-raphe much enlarged, lanceolate. Length, 7 to 12 c.d.m.

Fresh and brackish water.—England (Norman, Carrington), Ireland (Dickie).