THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[SECOND SERIES.]

No. 3. MARCH 1848.

XVI.—*Further Observations on the* Diatomaceæ; *with descriptions of new genera and species.* By G. H. K. Thwaites, Lecturer on Botany and Vegetable Physiology at the Bristol Medical School.

[With two Plates.]

Agreeably with the promise made in my last communication, I proceed to offer a few observations upon the facts there brought forward with reference to conjugation in the *Diatomaceæ*, and especially as to the bearing which these facts have upon the subject of impregnation in the higher tribes of plants.

It may be desirable perhaps, by way of preliminary, to give a short general account of the phænomena, as far as they have been observed, which present themselves in the course of development of a species of the *Diatomaceæ*.

The frustules of a Diatomaceous plant, which are usually, as is well known, of very definite and often very beautiful figure, are continually undergoing fissiparous division—that is, the contained endochrome of each one of these frustules divides into two portions, each of which developes around itself a cell-wall possessing a form and character precisely similar to those of the original one. The process of fissiparous division continuing, necessarily in course of time causes a very considerable increase in the number of frustules. There appears however to be a limit to this mode of propagation of the frustules, except by the intervention of another phænomenon—namely conjugation, or a mixture of endochromes; after which process fissiparous division proceeds as before.

It seems probable that *physiologically* we ought to consider the numerous frustules which have originated from the primordial frustule (the sporangium or product of conjugation) not as so many individuals of a species, but rather as parts of one individual, which instead of, as takes place in the higher plants, cohering to form one structure, assuming forms more or less modified, and exhibiting a greater or less specialization of func-

tion, maintain an independent existence (analogous to that of the buds of the higher plant), retain all the functions necessary for this independent life and for the propagation of the species, and undergo no modification from their original form. The life of an individual Diatomaceous plant we may therefore consider to extend from the production of the sporangium to the period of the conjugation of the numerous frustules which have originated from it.

Now, for the sake of comparison, let us analyse the higher plant: we find it to consist but of a repetition of similar parts and structure; and by carrying the analysis still further we ascertain the whole to be a modification of cellular structure, and that this cellular structure is the product of a continued fissiparous division commencing from the contents of the primordial cell—the earliest condition of the embryo. In fact, that the entire active vital part of the whole plant is but a diffusion, as it were, of the contents (the endochrome) of the primordial cell. This endochrome possesses an individuality—a character—which though not appreciable by our senses, would be found, were it in our power to analyse it, to be as defined as when, in its further development, it has assumed all the marked peculiarities of the species. The complicated development of the higher plant may be said to be the expression of the quality of the endochrome of its primordial cell, just as the simple development of the frustule of the Diatomaceous plant expresses the quality of its endochrome. If the foregoing is a correct view of the matter, it follows that the sporangium of the Diatomaceous plant is the analogue of the primordial* cell of the flowering plant.

We may now proceed more particularly to the subject of conjugation. In many of the *Diatomaceæ* it is seen that at a certain period of the development of the species a union of the endochromes of two distinct frustules seems necessary for the continued existence of the species as well as for its reproduction. The physiologist will endeavour to arrive at some probable explanation of the reason why this mixture of endochromes is necessary, and he will feel it difficult to come to any other conclusion than this: namely, that in each of the conjugating endochromes an essential element must to some extent, probably very trifling, be wanting, whilst another essential element is in excess, and that a mixture of such an endochrome with another similarly conditioned, except that the quantities of such respective elements are reversed, must take place in order to restore the equilibrium and enable the species to continue its existence. The circumstance of the mixed endochrome developing around itself a cell-wall pre-

* This must not be confounded with the "primordial utricle" of Mohl.

cisely similar in every respect, except in size, to that of the ordinary frustule, would seem to indicate very slight, if any, difference in the qualities of their respective endochromes. The *sporangium*—the product of this mixed endochrome—undergoes fissiparous division too in like manner with the ordinary frustules, and is thus converted into a number of *sporangial frustules*. In what way the small ordinary frustules are produced from these has not yet been observed.

Why should not this conjugation of the endochrome in the lower plants be considered essentially the same process as what takes place during impregnation in the higher tribes? The most eminent physiologists seem to be arriving at the opinion that the fertilization of the ovule, as it is termed, consists in the union of a part of the contents of a pollen-grain with certain matter contained in the ovule, and that the embryo originates from this mixed matter. The correctness of this opinion is rendered still more probable by the consideration of what takes place under the circumstances of hybridization of species. The phænomena which present themselves in these cases are of the highest physiological interest, and it seems impossible after a careful consideration of them to doubt that the hybrid plant owes its existence to—consists in its earliest condition of—an endochrome made up of a portion of the endochrome of each of the parent plants; for the development of the hybrid embryo into the mature plant indicates a quality of the contents of this embryonic cell of a character combining that of the endochrome of each of the two parents. A few facts will best illustrate the meaning of the foregoing observations. The ovules of *Fuchsia coccinea* fertilized with the pollen of *Fuchsia fulgens* produce plants of every intermediate form between these two species—some of the seedling plants closely resembling one, and others the other species, but the majority partaking equally of the characters of the two parents: scarcely however will any two be found so much alike as to be undistinguishable from each other. With respect to each of the hybrid seedlings separately considered, there is a uniformity throughout in the mixed character of its various parts; so that it is easy from the examination of the foliage to arrive at a tolerably correct idea of what will be the character of the blossom. Some persons perhaps will be disposed to believe that an endochrome may be modified in its character—that the peculiarities of the hybrid plant may be produced—by the situation in which it is at first developed; but, if this were the fact, it is clear that the hybrid seedlings ought all to resemble each other as much as do individuals of one species, which is far from the truth, as has been just now stated. Moreover, a fact came under the observation of the writer which completely sets aside the

idea of such an explanation of the phænomena, for in one example of the hybrid *Fuchsia* seedlings the singular circumstance occurred of one seed producing two plants extremely different in appearance and character; one of them partaking rather of the character of *Fuchsia fulgens* and the other of *Fuchsia coccinea*. It cannot be doubted that these very dissimilar structures were the produce of one seed, since they were closely coherent, below the two pairs of cotyledon leaves, into a single cylindrical stem, so that they had subsequently the appearance of being branches of one trunk. The plant was unfortunately, before flowering, killed by an unexpected severe frost, but not before its peculiarity had been observed by many persons besides the writer. In the case just cited the idea of a modification of structure caused by mere circumstance of situation in the early stage of growth is quite untenable; for were such the case, it is clear there could not have been the great dissimilarity which presented itself in these twin-plants—the produce of a single seed.

The following explanation of the phænomena of hybridization appears to the author to be most probably the correct one; namely, that the hybrid embryo consists, like an ordinary embryo, of a mixture of two endochromes—one derived from the pollen-grain and the other from the ovule; and that the peculiar character of each hybrid individual is due to the preponderance of one or other of these endochromes. This view of the matter seems to remove much of the mystery which at present surrounds this subject.

Returning again to the consideration of the lower plants. It is true that in the *Diatomaceæ*, as far as has been yet observed, there is no appearance of a difference of sex—there is nothing to indicate a diversity in the character of two conjugating frustules. In an allied family, however, the *Conjugateæ*, there is, as Mr. Jenner pointed out to me some months ago, an apparent adumbration of the sexes. The filaments of the genus *Zygnema* consist each of a single row of cells which correspond to the frustules of the *Diatomaceæ*, like them undergoing fissiparous division and becoming conjugated. Conjugation of the cells of *Zygnema* however takes place by the endochrome of one cell finding its way into another cell and there mixing with its endochrome; so that the sporangium is formed in one of the cells instead of outside both cells, as in the *Diatomaceæ*. In several species of *Zygnema* some of the filaments consist of cells, all of which, with the rarest exception, after conjugation contain the sporangia, whilst all the cells of other filaments of the same plant are seen to have entirely parted with their endochrome. This has much of the aspect of sexuality, and the sight of the conjugated filaments suggests at once this idea to the mind.

The conjugation of the *Diatomaceæ* seems to throw some light upon a question of much interest with respect to the real nature of certain vegetable structures, respecting which many eminent botanists are at present at issue. The structures alluded to are the so-called *antheridia* and *pistillidia* (archegonia) of Mosses. The paper on this subject by Mr. Valentine* would seem to settle the point that there can be no impregnation of the contents of the moss-capsule by the introduction into its cavity of any external substance, after the formation of the sporules. On the other hand, the learned authors of the 'Bryologia Europæa' state with emphasis that certain species of Mosses, which are dioicous,—that is, some plants of the same species bearing *antheridia* only, and others only *archegonia*,—do not bear fruit unless the male plants (those with antheridia) are in the neighbourhood of the plants possessing archegonia. It is perhaps not impossible to reconcile these at first sight apparently conflicting opinions. It may be that impregnation takes place before the production of the capsule;—that the cell from which the capsule, with its seta, &c. is developed corresponds with the sporangium of the Diatomaceous plant or the embryonic cell of the flowering plant; that this cell contains a mixed endochrome derived partly from the antheridia; and that the entire capsule (with its contents, appendages, &c.), the further development of this primordial cell, corresponds to a perfect seed of the flowering plant, or to the aggregate of the sporangial frustules of a Diatomaceous plant. It is true that in some of the Mosses the structure of the capsule appears very complicated, but it is upon a very simple type, as shown in other species: and, moreover, the sporangial frustules of the Diatomaceous plant possess cell-walls as highly developed as occurs in any other phase of the species. In some of the *Conjugateæ* there is also a division of the reproductive mass before this escapes from the plant, so that the numerous sporules of the Moss furnish no argument against the hypothesis just advanced. As a further argument in favour of the idea of the capsule of the Moss being the product of a mixed endochrome, it is stated by Bruch and Schimper that the capsule itself is not developed unless the two so-called sexes of the species are in proximity.

There now remains to consider a tribe of the *Diatomaceæ*, namely the *Meloseireæ*, which would at first seem to offer an exception to the usual mode of reproduction in this family, but the exception is probably rather apparent than real. In those species of *Meloseira* and its allied genera which have been met with in fruit, there is no *evident* conjugation or mixture of endo-

* Linn. Trans. vol. xvii. p. 465–484.

chromes; but it is, nevertheless, perfectly certain that something analogous to it must take place; for, excepting the mixture of the endochromes of two cells, the phænomena here exhibited are of precisely similar character to what has been noticed in the other *Diatomaceæ*. In the *Meloseireæ**, instead of a conjugation occurring between two frustules, a change is observed to take place in the endochrome of a single frustule—that is, a disturbance of its previous arrangement, a moving towards the centre of the frustule, and a rapid increase in its quantity: subsequently to this it becomes a sporangium, and out of this are developed sporangial frustules as in the other *Diatomaceæ*. A careful consideration of these phænomena, coupled with the fact of conjugation of endochromes being necessary in other species of the same natural family, leads to the opinion that there is great probability of a process taking place in the one cell of the *Meloseireæ* precisely similar in physiological character to the conjugation or mixture of endochromes in other species. In some species of *Zygnema*, to which genus reference has been before made, a conjugation takes place between *contiguous cells* in the *same filament*, and the contents of such pair of conjugated cells necessarily occupied one cell previously to its fissiparous division: it is therefore not difficult to believe, taking into view the secondary character of cell-membrane, that the two kinds of endochrome may be developed at the opposite ends of one frustule as easily as in two contiguous frustules, and that at a certain period a mixture of these may take place, giving rise to the same phænomena which succeed conjugation in other *Diatomaceæ*. The unity of plan which runs through the whole of nature forbids our entertaining the idea of a physiological, though there may be a structural, difference in the phænomena of reproduction in such closely allied productions as the several species of *Diatomaceæ*.

It is unnecessary to enlarge upon the importance of the doctrines now enunciated, if they are, as I believe, correct; but the remainder of the paper will be more exclusively occupied with observations on the genera and species to be described.

The general mode of formation of the sporangia in the *Meloseireæ* having already been adverted to, it will now be necessary only to indicate the peculiarities exhibited in those species of this family, which have been met with in the state of fructifica-

* It would seem that in the *Biddulphieæ* there is the same absence of an evident conjugation; for specimens of *Odontella polymorpha*, Kütz. (*Biddulphia? lævis*, Ehr. and Bailey), kindly communicated to me by Professor Harvey of Dublin, who received them from Professor Bailey, exhibit sporangia, each evidently originating from the endochrome of a single cell, and in the early stage of growth appearing as a dilatation of one end of such cell.

tion; and it is interesting to find that differences are observable in the character and position of the sporangia sufficient to justify a removal of some of the species from the genus *Meloseira*, in which they are at present included by Professor Kützing in his valuable work on the *Diatomaceæ*. A careful examination shows too, that, independently of the difference in the sporangia, there is sufficient distinction between the frustules themselves to characterize the proposed new genera.

Although it is very probable that hereafter it will be found desirable to break up still further the genus *Meloseira*, it is proposed at present only to separate from it—1st. Those species characterized by the absence in the frustule of an evident central line indicating the place of subsequent fissiparous division, but each frustule having two somewhat distant sulci or fossulæ passing round it—*Aulacoseira*. 2ndly. Those species, the frustules of which are not at all convex at the extremities, and which therefore form by their close contact an uninterrupted cylindrical filament; each frustule is marked with a central line and its internal cavity is spherical or subspherical—*Orthoseira*.

These two new genera may be defined as follows :—

Aulacoseira.—Cellulis cylindricis bisulcatis extremitatibus plus minusve rotundatis in filamenta concatenatis.

Typ. spec. *Meloseira crenulata*, Kütz. = *M. orichalcea*, Ralfs.

Orthoseira.—Cellulis exacte cylindricis linea centrali notatis in filamenta cylindrica connexis; cavitatibus internis sphæricis vel subsphæricis.

Typ. spec. *Meloseira americana*, Kütz.

The genus *Meloseira*, as it stands after this removal of some of its species, will include all those whose frustules are in any degree convex at their extremities, and have the central line indicating the place of future fissiparous division. It will probably be found expedient to separate *Meloseira arenaria*, Moore, from its present congeners when its sporangia have been discovered.

Sporangia or sporangial frustules have been observed by the writer in the following species of the genus *Meloseira* as now restricted, viz. in *M. varians*, Ag., *M. nummuloides*, Ag., *M. Borreri*, Grev., and in an Antarctic species collected by Dr. Hooker allied to *M. globifera*, Ralfs. In these species the sporangium is spherical with its axis of growth corresponding with that of the filament in which it is situated, and to which it continues for some time closely to adhere. The sporangium of *M. varians*, Ag., has one, sometimes two projections or mammillæ, each of which fits into an empty half-frustule, and frequently so closely as to be inseparable from it. Pl. XI. fig. A 1 represents various forms and stages of development of the sporangium of *M. varians*; and

fig. A 2 a filament consisting of sporangial frustules produced from one sporangium. Fig. C is a filament of *M. Borreri*, consisting partly of ordinary and partly of sporangial frustules. *M. nummuloides* of Kützing I cannot help believing to be the sporangial state of *M. salina* of the same author.

In *Aulacoseira crenulata* the sporangium is spherical, with its axis of elongation at right angles to that of the frustule from which it originated. Around the young sporangium a considerable quantity of mucus is developed, by which the empty half-frustules are for some time held attached. Fig. B 2 represents filaments of *Aulacoseira crenulata* with sporangia; and fig. B 3 sporangial frustules of the same species.

Orthoseira Dickieii, n. sp. Pl. XII. fig. E 1–7 ($\frac{220}{1}$). Filamentis brevibus; cellulis lævissimis.

The filaments of this beautiful species consist generally each of from two to four frustules, which are hyaline and perfectly smooth, and each with its central cavity filled with a dark red-brown endochrome. The sporangium of *Orthoseira Dickieii* is no less beautiful than interesting: it is fusiform in shape and marked with numerous annular constrictions, each with a corresponding internal septum or chamber, the origin of which can only be understood by paying attention to the early development of the sporangium. In fig. E 3 is shown a filament of this species, the terminal cells of which have each commenced to develope a sporangium; E 4 represents two such cells or young sporangia; and E 5 a mature sporangium. It will be observed that the formation of the ring-like markings is progressive, and that they go on increasing in number until the sporangium is fully developed. At the commencement of the formation of the sporangium, the endochrome, at the same time that it withdraws from the end of the frustule, produces at its centre an additional ring of cell-membrane; and this process continuing to take place at certain intervals—each new ring of cell-membrane exceeding in diameter those previously formed—produces at length the structure represented in E 5. Or it may be a more correct explanation of the process to say, that an entire new cell-membrane has been developed by the young sporangium at the time each new ring has been formed, and that thus have originated the several chambers into which the ends of the sporangium are divided. Fissiparous division of the sporangium subsequently takes place, as shown in fig. E 6, and sporangial frustules are developed from each half, E 7.

Meloseira americana, Kütz. Bacillarien, 55. tab. 30. fig. 69, is evidently congeneric with this species; differing from it principally in the ends of its frustules being striated.

Orthoseira Dickieii was kindly communicated to me by Dr. Dickie, who discovered this beautiful species in December last near Aberdeen in a moist dripping dark cave close by the sea, and covering the Mosses, Hepaticæ, &c. as a fine blackish green sand, collecting also in the shelvings of the rock.

Cyclotella? *Kützingiana*, n. sp. Pl. XI. fig. D 1–5 ($\frac{22}{1}$). Cellulis latere primario sigmoideo-flexuoso, lateribus secundariis radiatim striatis.

The frustules of this species, fig. D 1, 2, are short, and exhibit an apparent sigmoid curvature, which is due to each of their striated disciform ends having a prominence on one side of its centre and a depression on the other, and the opposite end of the frustule having a depression and prominence corresponding to these. The sporangia, fig. D 3, 4, are developed much in the same way as in *Meloseira*. This species is evidently closely allied to *Cyclotella*? *minutula*, Kütz. Bacill. tab. 2. fig. 3, but differs in the fewer number of curvatures apparent in the frustule. The sporangial frustules, fig. D 5, are very similar to *Cyclotella*? *Rotula*, Kütz. Bacill. tab. 2. fig. 4. A species of *Cyclotella* collected by Geo. Dansey, Esq. near Devonport, and which I suspect may be the *C. operculata* of Kützing, differs from the present species in the radiating striæ being only slightly marked, and in the curved appearance of the frustule being scarcely evident.

Occurs in brackish ditches amongst the leaves of *Myriophyllum*, &c. Wareham, Rev. W. Smith; Shirehampton near Bristol, G. H. K. T.

Before taking leave for the present of the *Meloseireæ*, I cannot avoid referring to the analogy they offer to the genus *Tiresias*, Bory (*Œdogonium*, Link, *Vesiculifera*, Hassall), and its allies. The *Meloseireæ* seem to bear the same relation to these that the other *Diatomaceæ* do to the *Conjugateæ*. The annulated structure of the sporangium of *Orthoseira* also recalls to mind and explains the character of the rings which are met with at the end of the fructifying cell in *Tiresias*.

Schizonema eximium, n. sp. Pl. XII. fig. F 1 ($\frac{1}{1}$), 2, 3, 4 ($\frac{220}{1}$). Cælomatibus simplicibus aut parce ramosis, rugulosis: naviculis sigmoideis lævibus.

The sigmoid frustules of this beautiful freshwater species at once distinguish it from any other described *Schizonema*. The delicate gelatinous sheaths are simple or very sparingly branched and minutely rugulose, especially near their base; they contain from one to four rows of the large, smooth, sigmoid frustules.

Found in small quantity in a rapid stream of fresh water on the filaments of *Vaucheria*, roots of grass, &c., at Crew's Hole near Bristol, in December last.

Schizonema subcohærens, n. sp. Pl. XII. fig. G 1 ($\frac{1}{1}$), 2 ($\frac{20}{1}$), 3–7 ($\frac{220}{1}$). Cælomatibus in massam amorpham subcohærentibus, valde mucosis, ramosis, navicularum sæpe multas singulas series continentibus: naviculis late truncatis, versus apices subito angustatis, striatis.

Evidently closely allied to *Schizonema*? *mucosum*, Kütz. Bacill. 115. tab. 26. fig. 9, but differs from it in having the frustules striated and towards the apices suddenly narrowed. Tufts of the plant from a quarter to half an inch or more high; filaments very mucous and tenacious, and each containing from one to several single rows of frustules, which are continued without interruption into the branches.

For the opportunity of figuring and describing this interesting species I am indebted to the kindness of the Rev. W. Smith, F.L.S., who found it in June last in Wareham "North River," densely spreading in a spongy stratum over the clayey bank and bottom of the stream.

The sporangia of this species, fig. G 6, are produced by the conjugation of a pair of frustules outside the filaments; but sporangial frustules are frequently found in a filament intermixed with ordinary frustules, from which they differ only in size: from this and from what has been observed by the writer in other species, it would appear that the frustules have a tendency to arrange themselves into linear series, and that subsequently a mucous sheath is developed around them.

Schizonema subcohærens would appear to belong to Agardh's genus "*Micromega*": it is difficult however to see the advantage of creating a new genus from characters derived from the mucous sheath only, and which characters really may be present in some species without being clearly evident. The so-called "*spermatia*" of *Micromega*, now that the true sporangia have been discovered, require further examination: a somewhat similar appearance to what is figured by Kützing is sometimes evidently due to minute zoophytes in an immature state.

Schizonema vulgare, n. sp. Pl. XII. fig. H 1 ($\frac{1}{1}$), 2–5 ($\frac{220}{1}$). Naviculis lævibus, lanceolatis, versus apices subito angustatis. *Hab.* in aqua dulci.

Var. *α. rivulorum*. Fig. H 1–4. Cælomatibus distinctis, ramosis: naviculis subacutis.

Var. *β. lacustre.* Fig. H 5. Cælomatibus mucosis, simplicibus (aut parce ramosis?): naviculis latius truncatis quam in varietate præcedenti.

Monema lacustre, Agardh?

Var. *γ. effusum.* Cælomatibus indistinctis, in stratum gelatinosum effusis: naviculis ut in varietate *α.*

Although this is perhaps the commonest species of all the *Schizonemata,* since it occurs during the spring in almost every ditch and running stream, yet it does not appear hitherto to have been described, unless the *Monema lacustre* of Agardh should prove to be one of its forms. The species is most abundant in shallow streams, covering stones, &c. with a dark brown gelatinous coating, but in which a linear arrangement of the frustules may frequently be detected. When the plant occurs in deeper water, the ordinary *Schizonema* filaments make their appearance, which are much-branched when growing in rapid streams, but when occurring in still water, or where there is only a slight current, are simple or nearly so. In the last-named form of the species, which may possibly be the *Monema lacustre,* Ag., there is also a slight difference in the form of the frustules, which are rather shorter compared with their width, and more truncated at their extremities. The frustules of all three varieties are of a lanceolate form, suddenly narrowed near the apices.

Schizonema neglectum, n. sp. Pl. XII. fig. J 1 ($\frac{1}{1}$), 2–4 ($\frac{220}{1}$). Cælomatibus ramosis, mucosis: naviculis lanceolatis, delicatule striatis.

The filaments of this species, which are branched, especially towards the base, easily escape detection owing to particles of sand and other substances adhering to their tenacious surface and being with difficulty removed from it. It is therefore next to impossible to get good examples of this species, and hence the reason why it has hitherto escaped the observation of botanists. The frustules are lanceolate and very delicately striated, and are very like those of *Schizonema floccosum,* Kütz., which has been found by Dr. Dickie near Aberdeen; but in that species they are not striated, and are moreover included in a gelatinous sheath of much greater thickness than that of *Schizonema neglectum.*

Occurring amongst other *Diatomaceæ* from fresh or slightly brackish water near Bristol.

Dickieia Danseii, n. sp. Pl. XII. fig. K 1 ($\frac{30}{1}$), 2–4 ($\frac{220}{1}$). Frons gelatinosa, indefinita, mammillosa: naviculis ovalibus, striatis.

The frustules of this species are siliceous and of an oval form,

with a linear space on either side of the central mark striated. This beautiful new species is extremely interesting as illustrating the real structure of the genus *Dickieia*. Each frustule developes around itself a definite amount of gelatine, so that at each repetition of fissiparous division additions are made to the amount of gelatine of the frond by the new frustules which are then produced. In the present species these additions are in the form of mammillæ, and a good deal resemble the mucous prolongations of some of the *Palmelleæ*, a frustule being situated towards the extremity of each. A mammillose and somewhat areolate appearance is thus given to the indefinite frond, whereas in *Dickieia ulvoides* the newly developed additions to the gelatine cohere to form a compact even membrane.

I have great pleasure in naming this species in compliment to its discoverer George Dansey, Esq. of Devonport, who finds it in small quantity upon rocks on the tidal shore of the river Tamar.

EXPLANATION OF PLATES XI. AND XII.

PLATE XI.

A. *Meloseira varians*, Ag. 1. Filaments with sporangia. 2. Filament consisting entirely of sporangial frustules. (Magnified 220 linear.)

B. *Aulacoseira crenulata*. 1. Filament. 2. Filaments with sporangia. 3. Sporangial frustules. (Magnified 220 linear.)

C. *Meloseira Borreri*, Grev. Filament consisting partly of ordinary and partly of sporangial frustules. (Magnified 220 linear.)

D. *Cyclotella? Kützingiana*. 1, 2. Frustules. 3. Frustules becoming converted into sporangia. 4. Sporangia. 5. Sporangial frustules. (220 linear.)

PLATE XII.

E. *Orthoseira Dickieii*. 1, 1. Filaments. 2. Filament deprived of endochrome. 3. Filament the terminal cells of which are becoming converted into sporangia. 4. Immature sporangia. 5. Sporangium. 6. Sporangium become fissiparously divided. 7. Sporangial frustules becoming developed from one of the halves of a sporangium. (Magnified 220 linear.)

F. *Schizonema eximium*. 1. Filaments (nat. size). 2. Portion of filament (magnified 220 linear). 3. Frustule. 4. Frustule deprived of its endochrome.

G. *Schizonema subcohærens*. 1. Portion of plant (nat. size). 2. Part of same (magnified 20 linear). 3. Part of filament (magnified 220 linear). 4. Frustule. 5. Frustule without endochrome. 6. Sporangia. 7. Sporangial frustule.

H. *Schizonema vulgare*. 1. Filaments of var. *a*. (nat. size). 2. Filament (magnified 220 linear). 3. Frustule. 4. Frustule without endochrome. 5. The same (of var. *β*.).

J. *Schizonema neglectum*. 1. Filaments (nat. size). 2. Filament (magnified 220 linear). 3. Frustule. 4. Frustule deprived of its endochrome.

K. *Dickieia Danseii*. 1. Portion of frond (magnified 35 linear). 2. Part of same (magnified 220 linear). 3. Frustule. 4. Frustule without endochrome.