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XLV.—On the British Desmidiæ. By JOHN RALFS, Esq.,
M.R.C.S., Penzance*.

IN a former paper† I followed the example of most preceding writers on these plants and referred them to the *Diatomaceæ*; but further observation has convinced me that they must be removed from that tribe, which should comprise only the *Algæ* with siliceous covering, which I called *Cymbellæ*. I have in that paper pointed out many of the differences between these tribes; they also differ greatly in another respect. The *Diatomaceæ* (*Cymbellæ*) for the most part quickly acquire an offensive odour after being gathered; the *Desmidiæ*, on the contrary, are remarkable for the length of time they may be preserved in a moist state without material change. Many indeed I have kept unaltered for weeks in a damp piece of linen. As drying often produces a great change in their appearance, it is fortunate that they can be thus preserved until it is convenient to examine them.

They are generally very minute, and, with the exception of a few not hitherto detected in this country, are all found in fresh waters, either mixed amongst other *Algæ* or in old peat-pits, and such shallow pools as do not become dry in summer‡.

These *Algæ* have attracted but little attention from British algologists, and only two species of *Desmidium* and two of *Euastrum* are described in our Flora. I am convinced that these have even a stronger claim to be considered plants than the *Diatomaceæ*. This was also Meyen's opinion; for whilst he allows that the true place of the latter is somewhat uncertain, yet, speaking of the *Desmidiæ*, he remarks, "This family includes those true *Algæ* of whose nature there can be no doubt."

Ehrenberg, who refers them to the animal kingdom, lays the greatest stress upon their "spontaneous division," which indeed is the only reason he produces for denying the vegetable nature of some genera§. It has however been shown by Meyen, Mr. Hassall|| and others, that growth by the elongation and bisection of the cells is very frequent, if not universal, in the more simple *Algæ*.

The *Desmidiæ* have, in general, their cells more or less constricted in the middle, and the endochrome divided into two por-

* Read before the Botanical Society of Edinburgh, Jan. 11th, 1844.

† See Annals of Natural History, vol. xi. p. 448.

‡ They frequently form finger-like tufts at the bottom of the pool, and if gently separated by passing a knife or the finger beneath them, rise to the surface, when they can be taken out and put into a bottle or placed on linen and drained, and afterwards scraped off with a knife.

§ "The increase by voluntary division is the character which separates animals from plants." *Ehr.* See Annals of Nat. History, vol. ii. p. 123.

|| See Annals of Natural History, vol. ix. p. 431.

tions. In *Euastrum* this constriction is so great that the fronds seem to consist of two segments united by a narrow central chord, whence most authors, erroneously as I think, describe the plant as binate.

In the *Diatomaceæ*, where the frustules are often truly binate, as each frustule is complete in itself, though they be separated from each other, their respective contents will still be protected on all sides, and even if one be broken the contents of the other will not be disturbed. In this tribe, on the other hand, as there is no septum between the parts, if these separate or an opening be made in one, the contents of both escape. In *Desmidium* the constriction is often but slight, and although the endochrome is most frequently in two portions, yet in an advanced state it is sometimes collected into a single central spot. Whatever may be the shape of the frond, this connecting portion is always nearly or quite cylindrical; and this is equally the case in the triangular fronds of *Stauroastrum* and the compressed ones of *Euastrum*, as in those species having cylindrical fronds. Of course the more the plant is compressed the narrower will be the connecting portion, whilst in the cylindrical species the constriction is often but slightly marked. In *Closterium* there is generally only a transverse central line which divides the endochrome into two portions; but in all the *Desmidiæ*, when the plant is mature, the cells separate at the centre and allow the granules to escape. In all the species, the growth by the repeated division of the cells is extremely rapid. In *Desmidium* the process is exactly similar to what occurs in the *Conjugatæ*: the joint first elongates, and then becomes double by the formation at the centre of internal transverse septa; but in most of the other *Desmidiæ* the fronds are simple, or consist of only a single cell, which, as I have observed above, is more or less evidently in two segments. *Euastrum* has these united by a narrow chord, and therefore in that genus the manner of their increase by division can be most easily observed. The central chord elongates, and two new segments are formed, which gradually increase until they attain the same size as the halves of the original frond. About this time it separates into two distinct fronds, each of the old segments having united with one of the new ones: during this process the original halves do not undergo any alteration, except in being separated by the two new segments, all the growth taking place in the central chord that united them. As this addition is continually taking place in those fronds which have reached their full size, the two segments of a frond are very often unequal.

All the species are binate during the production of the new portions and until separation takes place.

In describing *Meloseira*, *Isthmia*, &c., I have shown that those

genera also increase by a new growth interposed in the centre of the frustule. May not the growth in some of the higher *Algæ* also be confined to the centre of the joints, instead of being an extension of parts already formed? Should this suggestion prove correct, such a fact would be an additional proof of the vegetable nature of the *Desmidiæ*, and may perhaps also lead to further knowledge of the physiology of the *Conferveæ*.

It will be more difficult to ascertain whether this is the case in the latter; in *Tyndaridea* however, the genus best adapted for observation, I believe that its occurrence can be proved, for in each joint two stellæ are present; and I think that whilst these always remain distinct on their outer side and at the same distance from the septum, they first become more distant from each other by the growth of the intermediate and central portion of the joint, and that two new stellæ are then formed between them, which at first connect the original stellæ, and gradually become more distinct as the joint prepares to divide. If this opinion be correct, the new septum will always be formed where the new portion of the joint is formed. At length the plant ceases to grow, the division of the joints is not repeated, the endochrome alters in appearance, the reproductive organs are formed, and the individual perishes. So in the *Desmidiæ*: the fronds at length no longer divide, the internal matter assumes a different appearance, and what I consider the reproductive granules are perfected.

Meyen adduces the presence of starch as a conclusive proof of the vegetable nature of the *Desmidiæ*. He states that in several genera he has "distinctly seen that the large and small granules contained amylum, and were sometimes even entirely composed of it," and that in the month of May he had observed "many specimens of *Closterium* in which the whole interior substance was granulated, and all the grains gave with iodine a beautiful blue colour, as is the case with starch, *which is not an animal product*." These experiments if correctly made would appear decisive, but Meyen's assertions have not been allowed to pass unquestioned. Mr. Dalrymple, in a very able and interesting paper on the *Closteria**, observes of his own attempts to repeat Meyen's experiments, "In no one instance had the action of iodine produced its ordinary effects upon starch or vegetable matter by colouring it violet or blue, although Meyen asserts it did in his trials." In the 'American Journal of Science and Arts,' vol. xli. No. 2, is an article by Professor Bailey, of the U. S. Military Academy, on the American "*Desmidiaceæ*," in which he gives copious extracts from Mr. Dalrymple's paper accompanied by his own remarks.

He bears testimony to the general correctness of Mr. Dalrymple's

* Annals of Natural History, vol. v. p. 415.

observations, but with regard to those on the action of iodine he says, "I cannot otherwise account for Mr. Dalrymple's statement, that iodine 'in no instance produced in the *Closteria* the violet or blue colour indicating starch,' than by supposing that the specimens he examined were not in the proper state to exhibit it. Meyen expressly states, that it is 'at certain times, particularly in spring,' that the starch may be detected. . . . I am able by conclusive experiments to confirm Meyen's statement as to the presence of starch in these bodies. In specimens gathered in November, I find no difficulty in producing the blue colour with tincture of iodine. Sometimes, however, the specimen becomes so opaque by the action of this reagent, that the purple colour of the granules can only be detected after crushing the specimen by means of the compressor. *The characteristic colour of iodide of starch is then shown most distinctly.* I have repeatedly treated in this way *Closterium Trabecula* as well as others, and have uniformly found that a portion of the interior takes the purplish colour."

Professor Bailey, however, does not "consider the presence of starch in these bodies as conclusive evidence that they are plants;" for he suggests with some ingenuity, "Is it not possible that they are animals which feed, wholly or in part, on amylaceous matter extracted from the aquatic plants among which they live? If so, the detection of starch in their stomachs is not surprising."

Having been indebted to Mr. Dalrymple for much information respecting this tribe, and invariably found his observations most accurate, I was puzzled how to reconcile these contradictory results of the test of iodine; I have therefore repeatedly and carefully noted the effects of iodine on many of the *Desmidiæ*.

In a young state the cells are filled with a green homogeneous fluid, which, as the plant approaches to maturity, becomes denser and minutely granular. Scattered amongst this minutely granular matter larger granules make their appearance; these Ehrenberg calls ova; but I cannot perceive the slightest difference between them and the granules present in the higher Algæ, and Meyen informs us that he "had observed their development into spores."

On applying diluted tincture of iodine to different species of the *Desmidiæ*, these large granules became very dark with a purplish tinge, showing the presence of starch. When the tincture of iodine is used in its undiluted state, the colouring matter becomes so dark as to appear nearly black and conceal the bluish tint; in some specimens too this colour is hardly perceptible, whilst in others it is very apparent.

In no instance have I found the presence of starch indicated unless these granules were present, as the fluid colouring matter always becomes brownish. The application of iodine to *Conju-*

galæ in different stages of growth was followed by a precisely similar result. In the young plant no starch was detected, but the colouring matter became changed to an orange-brown. On the other hand, in the conjugated filaments the granules became blue, and the spores especially appeared of the very dark colour often observed in the *Desmidiæ*, and did not exhibit any blue tint until they were crushed*. As the large granules are not present in the early state of the plant, and as it has been shown above that they alone contain starch, the opposite results of the experiments by Meyen and Mr. Dalrymple may be thus explained†.

In the preceding remarks I have classed the *Closteria* with the *Desmidiæ*. Ehrenberg indeed describes them as a distinct family, but his opinion has, I believe, very few advocates. Meyen says, "I see no good reason why *Closterium* should not be placed near *Euastrum*;" and Professor Bailey says, "I have before stated that I consider the genus *Closterium* most closely related to *Euastrum*, and therefore to the *Desmidiaceæ* generally. This relation to *Euastrum* is manifest in their apparent identity in internal structure; the chief difference between them is only in the external forms; and even in them we find there is a perfect transition from the highly-lobed and tabular forms of some species of *Euastrum*, to the entire, elongated and fusiform species of *Closterium*. It is therefore without hesitation that I place *Closterium* (as indeed most writers do) among the *Desmidiaceæ*."

I am aware the following account of the British *Desmidiæ*

▪ I would advise those who wish to repeat the experiments, and have not been accustomed to see the effect produced on starch by the application of iodine, to apply it first to a few grains of flour, and afterwards to some species of *Zygnema* in which the spores are about to form; as they will thus become familiar with the appearance of iodide of starch when formed in the *Algæ*.

After the tincture of iodine is applied let them add a little more water, and then dry the specimen by the application of heat; this will drive off the free iodine, and thus in a great measure remove the brownish stain which obscures the purple tint. They should then add a drop of water, and on applying the highest power of the microscope the peculiar colour of the iodide of starch can in general be easily perceived.

† I have the satisfaction to add, that since I wrote the present paper I communicated the tenor of it, with accompanying specimens of *Closterium digitus*, to Mr. Dalrymple, who acknowledged the presence of iodine in the following terms:—"I have examined the specimens sent up, and in several I can detect the blue colour of the iodide of starch: this is by no means however universal, some being merely stained yellowish brown; but in *those instances* there appears to be an *absence of granular matter*; the fact of blue granules in some is however *decisive* of the presence of starch." He also says, "I am glad to see your explanation of the facts. It is a probable circumstance that iodine may act differently at different stages of growth, and that starch may not always be present in the specimens."

Mr. Jenner also informs me that he has repeated my experiments with success.

will necessarily be imperfect. I have seen no specimens named by original authorities, and I have derived much less assistance from British algologists than I had when treating of the *Diatomaceæ*, as many valued correspondents, whose discoveries and notes greatly aided me in the descriptions of the *Diatomaceæ*, have not studied this tribe.

I should however be ungrateful to omit stating, that my friend the Rev. M. J. Berkeley has, during the preparation of these papers, as on former occasions, supplied many useful hints, and assisted me in determining the species and synonyms; and that Mr. Jenner has not only favoured me with numerous specimens, but sent me several drawings made from his own observations, and necessary for the illustration of different species.

BIBLIOGRAPHICAL NOTICES.

List of the Specimens of Mammalia in the British Museum. Printed by order of the Trustees. London, 1843.

List of the Specimens of Birds in the British Museum. Part I. *Accipitres*, 1844.

It is by no means so generally known as it ought to be, that the Trustees of the British Museum have lately set an example which the Directors of all national museums would do well to imitate. Many persons now visit the zoological galleries of the British Museum, not as a mere holiday show, but as a place of scientific study. To this class of visitors the popular 'Synopsis' sold at the door is far too superficial to be of use; a demand has consequently arisen for a more exact scientific account of the contents of the collection, and this demand is now in the course of being supplied. The officers of the several departments have been directed to draw up accurate catalogues of the contents of the Museum, which are revised by Mr. J. E. Gray, the chief officer of the zoological department, and are sold in a cheap and portable form to the public.

The advantages of this measure are manifold. These catalogues may have the desirable effect of converting the mere sight-seer into the scientific student, while they guide the working naturalist to rare and authentic specimens not elsewhere to be met with. For the arrangement of provincial or private collections they will serve as useful models, showing the latest improvements which have been made in classification. They will greatly facilitate scientific intercourse, and the exchanging of duplicates with the public museums abroad, showing at once the amount of our riches and of our wants, while they will also tend to diffuse through the zoological world a well-digested and universally accepted nomenclature. The value of these catalogues is further increased by their enumerating not merely every *species* but every *specimen*; the latter being indicated by the letters of the alphabet, with a statement of the exact localities and