NOTES.

ALGOLOGICAL NOTES.—

I. OBSERVATIONS ON SPECIES OF APHANOCHAETE, Braun.—Last autumn, whilst examining a mass of Algae, collected in a ditch on Sheen Common, near Richmond, I found a large quantity of an epiphytic species, growing on *Cladophora*¹ (*fracta*, Kütz). A closer examination showed it to belong to the genus *Aphanochaete*, A. Br. Each individual consists of a short filament, of usually only 2-4 cells, although longer filaments of 6-10 cells are not rarely met with (see Fig. 22, 1). Branching of the filaments is exceedingly rare, but the short 2-3 celled individuals may be so closely collected together, that a sort of cushion is formed, which quite obscures the *Cladophora* at that point. The cells of the filaments are more or less spherical in outline, containing a single large pyrenoid (Fig. 22, 6 and 7), and usually filled with large numbers of starch-grains. These latter so obscured the chloroplast, that I was unable to determine its exact structure. There seemed, however, to be only one present, more or less parietal in position, and differentiated so as to appear as a number of grains lining the wall of the cell. Each cell bears a variable number (2-5) of hairs, which sometimes attain great length, quite thirty times that of the cell from which they arise. These hairs are shut off by a transverse wall from the cell below, and their basal portion is more or less swollen to form a kind of bulb. Above this the diameter and therewith the lumen of the hair gradually decreases in magnitude, the apex being often so fine, that it requires careful focussing to see it properly. Certain highly refracting portions in the course of the hair look very much like transverse walls, and make it appear multicellular (Fig. 22, 7).

¹ Intermingled with the *Cladophora* was a species of *Spirogyra*, and although at some points the former was crowded with the epiphyte, I never saw a single individual on the *Spirogyra*. As far as I am aware no species of *Aphanochaete* has as yet been observed on *Spirogyra*, although frequently on the allied genera, *Mougeotia* and *Sirogonium*.

Although I have observed this Alga at intervals for a period of over six months, I am as yet unable to give any details as to the method of reproduction. Cells were frequently observed, in which the contents had divided into two masses along a plane parallel to that of the ordinary vegetative division of the cells; each portion contained a pyrenoid. In other cases cells were found, in which the contents were still undivided, but contained two pyrenoids. These are probably stages in the formation of zoospores. (Cf. Braun, Rejuvenescence; Huber in Bull. Soc. Bot. France, XLI.)

These points agree to some extent with the description and figures Hansgirg¹ has given of his *Herposteiron polychaete*, and I believe that the Alga I have just described is possibly identical with this species. Especially Hansgirg's Fig. 5 has a very similar appearance to my Fig. 1. Hansgirg however says (loc. cit.): 'Die Fäden von *Herposteiron polychaete* Hansg. sind mehr oder weniger reichlich verzweigt, die Verzweigungen auf der Unterlage . . . kriechend, seltener treten auch einzelne aufrechte . . . Aestchen auf.' Such upright branches he shows in Fig. 1, and I must say, that I have only very rarely observed them in the Alga in question, and they were even then not nearly so well developed as Hansgirg's figures show. It was probably the occurrence of these upright filaments that led Hansgirg to regard this species as being only a stage in the development of some *Stigeoclonium* or *Chaetophora*, and indeed his Figs. 1-3 look rather like young *Stigeoclonium* plants. Although I have had my Alga under cultivation in various conditions for over six months, I have seen nothing to warrant the assumption that it is a stage of evolution of some higher form. Finally, the hairs which Hansgirg figures on his plant have such very definite transverse walls, that they could scarcely be due to a false articulation, as in the case of the species I have examined. They very much resemble the hairs of *Stigeoclonium*.

Hansgirg², in 1888, gave a new scheme for the classification of the species of the two genera *Herposteiron* and *Aphanochaete*. The latter

¹ Flora, 1888, p. 214, and Plate XII, Figs. 1-5. Klebahn (Zur Kritik einiger Algengattungen, Pringsheim's Jahrb. f. wissenschaftl. Bot., vol. 25, 1893, p. 295) has no right to state that Hansgirg's diagnosis of *H. polychaete* lacks an illustration, as the figures were published in a later number of the same volume.

² Ueber die Gattungen *Herposteiron*, Näg., und *Aphanochaete*, Berth. non A. Br., Flora, 1888, p. 211.

genus was established by Braun¹ in 1851. Later, Berthold² described a species under the same name as Braun's (*Aphanochaete repens*) considering that there was not sufficient reliable evidence for a specific separation. He found that his plant differed from that of Braun in possessing zoospores, which were enclosed in pairs in a delicate membrane at the time of liberation, and provided with four instead of two cilia. The hairs also were not articulated, and were swollen distinctly at the base. Rabenhorst³ had cast considerable doubt on Braun's observations by the figures, which he gives of *Aphanochaete repens*, Br., in which he figures zoospores with four cilia, at first enclosed in pairs in a membrane. As Rabenhorst⁴ mentions only having seen the authentic dried specimens, it was difficult to understand how he came to figure zoospores, differing so markedly from those described by Braun. This matter has been partly cleared up by Klebahn⁵, who publishes a note found amongst Braun's manuscripts after his death; this shows that Braun had once more observed the formation of zoospores, and had come to the conclusion that there were four instead of two cilia. Although he mentions the occurrence of the zoospores in pairs, he did not observe the membrane described by Berthold in his species. Undoubtedly, however, Rabenhorst had seen this note of Braun's, and had taken his figures from those appended to the note. All species of *Aphanochaete* at present known possess zoospores with four cilia.

Although, as we see, there was thus little reason for separating Berthold's species from Braun's, Hansgirg⁶ established for the former a new genus *Aphanochaete*, Berth. non A. Br., at the same time merging the *Aphanochaete* of Braun into the genus *Herposteiron* of Nägeli, the distinctions drawn between this latter genus and *Aphanochaete*, Berth., being that the former had multicellular hairs, which were destitute of a sheath, whereas the latter had unicellular hairs provided with a delicate sheath at the base. In the genus *Herposteiron*, Näg. (= *Aphanochaete*, Br. non Berth.) were placed three species: (1) *repens* (A. Br.) Wittr. (*Aphan. repens*, A. Br. non Berth.), (2) *con-*

¹ Betrachtungen über die Erscheinung der Verjüngung in der Natur, 1849-1850, p. 196, foot-note. English Transl. by Henfrey, 1853, p. 184, foot-note.

² Untersuchungen über die Verzweigung einiger Süßwasseralgen (Nov. Act. Ac. Leop. Carol. XL, 1878), pp. 214 and 215.

³ Flora Europaea Algarum, III, p. 304.

⁴ Loc. cit., p. 391.

⁵ Pringsheim's Jahrbuch, vol. 25, 1893, p. 288.

⁶ Flora, 1888, p. 216.

fervicola, Näg., (3) *polychaete*, Hansg. The genus *Aphanochaete*, Berth. non A. Br., included: (1) *repens*, Berth. non Br., (2) *globosa*, Nordst. (*Herp. globosa*, Nordst.), (3) *vermiculoides*, Wolle, (4) *polychaete*, Nordst.

Although De Toni¹ and Wille², to some extent, adopted this system of Hansgirg's, it was soon to be attacked by Möbius and Huber. The former³ points out on p. 85 that Rabenhorst's Fig. 114 a (loc. cit.) of *Aphanochaete repens*, Braun, although agreeing in other respects with Braun's description, seems to indicate that the hairs are not truly septate, but only contain a number of masses at definite distances from one another. Further on (p. 97) he describes the development and structure of the hairs in a species, which he takes to be *Herposteiron confervicola* (A. Br.) Hansg.⁴ He describes the development of a thin sheath round the base of the hair, and denies the presence of any articulations in the hairs of this species. According to Hansgirg, however, the presence of a sheath would preclude the possibility of the hair being articulated, for the species Möbius examined must then belong to the genus *Aphanochaete*, Berth., and not to *Herposteiron* at all.

Huber⁵ examined the original specimens of *Herposteiron conferviculum*, Näg., *H. repens* (Br.) Wittr., and of *Aphanochaete*, Berth. He found that in all three the hairs were simple and unicellular, and showed that what Braun had taken for transverse walls in his *Aphanochaete repens* were really only 'bouchons d'une matière réfringente qui fait apparaître le poil comme indistinctement articulé' (loc. cit., p. 327). I have been able to show the same for the species from Sheen Common, which I think may probably be identical with *Herposteiron polychaete*, Hansg. If the young hairs, which appear

¹ Sylloge Algarum, 1889, p. 179.

² Natürl. Pflanzenfam. I. 2, pp. 94, 95. Quite recently West (Algal Flora of Yorkshire, 1901) also adopts this system.

³ Morphologie der haarartigen Organe bei den Algen. Biologisches Centralbl., 1892, vol. xii, pp. 85, 97.

⁴ Hansgirg later (Flora, 1888, p. 505) united *Aphanochaete repens*, Br. = *Herposteiron repens* (Br.) Wittr. with *Herposteiron confervicola* Näg. I do not quite understand what Möbius means by the two authors' names he places after his species (cf. also Klebahn, loc. cit., p. 292). Möbius also examined *Aphanochaete globosa*, Nordst. (p. 104); in which he found a distinct sheath, as has been observed by other investigators.

⁵ Observations sur la valeur morphologique et histologique des poils et des soies dans les *Chaetophorées*. Journal de Botanique, 1892, p. 325.

quite distinctly articulated (cf. Fig. 22, 7), are treated with chlor-zinc-iodide, we find that, whereas the external wall of the hair takes on a distinct violet tinge, the transverse portions round themselves off, becoming slightly yellow. Congo-red stains the walls of the cells a light red colour; the walls of the hairs take on a similar, but much fainter tinge, and no transverse portions in the course of the hair are stained, thus proving that there are no transverse cellulose-walls. The false septa show up well in the stained hair, but do not seem to take on any colour themselves. They are seen to be small, highly refracting bodies of various size and shape, and at high focus appear to have a slight yellow tinge.

The first indication of a developing hair is to be seen when the cell elongates slightly in the direction of the future hair. At the same time the (somewhat bluntly) pointed apex of the cell becomes colourless (Fig. 22, 5), the green contents collecting in the hinder part of the cell. The colourless tip is full of protoplasm, which no doubt plays an important part in the elongation of the hair, which now takes place (Fig. 22, 6). I was not able to observe the division of a nucleus and the transfer of the one half into the young hair, as described by Huber¹ for *Aphanochaete repens*, Braun. After the first rudiment of the hair is formed, elongation goes on more and more rapidly, and the growing colourless apex becomes more slender. When the hair has reached from 2-3 times the length of the cell, the bulbous base commences to form, and the hair is cut off by a thin transverse wall from the cell below it; this wall may be formed sooner or later in different cases, however. Before the formation of this wall the protoplasm extends irregularly into the hair for some little way, but afterwards only a small quantity remains in the young hair. This is chiefly aggregated at its apex, which at this stage has the appearance of being quite solid; there is only a distinct lumen in the bulbous base. When this base is once formed, elongation proceeds very rapidly, and at the end of about twenty-four hours the hair is 6-10 times as long as the cell it has developed from² (Fig. 22, 7). During this later elongation the protoplasm, which was before aggregated in the apex, becomes split up into a number of separate portions, some

¹ Loc. cit., p. 326, Fig. 2 a, and b.

² It will be observed, that this account does not agree in all respects with Huber's; we have, however, undoubtedly examined different species, and the differences are not very important.

of which form transverse plugs in the lumen of the hair, and come to look like walls. Later still, the highly refracting bodies¹ appear in the protoplasm, and in the adult hair it is they that look like transverse partitions.

Similarly, I have examined the hairs on a specimen of *Aphanochaete repens*, Br.², contained in the British Museum. Here the masses were very distinct inside the hairs, and did not at all have the appearance of transverse walls. Specimens from various localities in the Royal Botanic Gardens at Kew have also induced me to accept Huber's explanation, and led me to the assumption that septate hairs do not occur at all in either *Aphanochaete* or *Herposteiron*.

In a young *Stigeoclonium* the hairs develop in exactly the same way as in *Aphanochaete*. The zoospores on coming to rest have an elongated, elliptical shape, bearing a great resemblance to some species of *Characium*. At the one end a hair very soon begins to form, this end becoming colourless, and gradually growing out to form the hair. This rapidly lengthens, and becomes segmented, so as to form a long multicellular structure. Soon after this is well developed, the young plant becomes two-celled by the formation of a transverse wall. No branching takes place until it is several cells in length (cf. Fig. 22, 3);—generally 2–3 lower ones filled with chlorophyll, succeeded by one or two with sparing contents, these leading off to the absolutely colourless cells of the hair-tip. The lowest cell then first puts out a lateral process, which rapidly increases in size, and soon the second cell shows signs of branching, this branch being developed either on the same or on the opposite side (Fig. 22, 4).

After what has been said above, there is thus no longer any reason for believing that multicellular hairs occur at all in either *Herposteiron*, Näg., or *Aphanochaete*, Berth. Further, it seems very probable that Hansgirg's observations³ on the occurrence of a sheath in *Aphano-*

¹ The development of the hair would seem to indicate that these are derived from the protoplasmic plugs referred to in the text; and the yellow colour taken on with chlor-zinc-iodide shows them to be proteid in their nature. I tried the Xanthoprotein-reaction on them with little success; there was a trace of colouration, but generally the acid was too much for the delicate hairs. These bodies are insoluble in alcohol and xylol, so that they do not consist of any fatty substance. They remain dark in polarised light.

² *Phycotheca Boreali-Americana*, No. 762.—Collins, Holden and Setchell.

³ *Flora*, 1888, p. 214.

chaete repens, Berth., are erroneous¹, and that this latter species belongs to the same genus as the three species of *Herposteiron* mentioned on p. 373. I am entirely of Klebahn's opinion², that these four species should be included in the genus *Aphanochaete*, Braun, which has priority over the *Herposteiron* of Nägeli; and that this latter genus, together with *Aphanochaete*, Berth., which was never established by the author, whose name is appended to it³, be dropped altogether. *Herposteiron globosa*, Nordst., has been included by Klebahn partly in his genus *Chaetosphaeridium*, and partly in *Dicoleon*, Kleb.; *Herposteiron polytricha*, Nordst., is put by him in a new genus *Conochaete*. There seem ample reasons for these separations.

A few more words may be said on the species from Sheen Common. As I have mentioned above, it is certainly not a stage in the development of a *Stigeoclonium*, as *Herposteiron polychaete*, Hansg., may be. It, however, evidently does not agree in several respects with the specimens of *A. repens*, Braun, that I have seen; for these latter specimens have all only one hair to each cell⁴, and these hairs have a broader base than in my species. Other differences are to be found in the average number of cells in each individual, and in the branching of the filaments in *A. repens*, Braun. There is scarcely sufficient evidence to warrant my establishing a new species, and for the present I place it in *Herposteiron polychaete*, Hansg., which must now go under the name *A. polychaete* (Hansg.) Fritsch. I think it very probable that this is really the species I have examined.

I add a scheme of the classification of the species discussed above⁵, according with the views expressed in this note:—

Genus *Aphanochaete*, Braun (1849).

1. *A. repens*, Br., Verjüngung, 1849-50, p. 196, foot-note (= *A. repens*, Berth.⁶).

¹ Cf. Klebahn, Pringsheim's Jahrbuch, vol. xxv, 1893, p. 290; cf. also Huber in Journal de Botanique, 1892, p. 337.

² Klebahn, loc. cit., p. 294; his remarks do not include *Herposteiron polychaete*, Hansg.

³ Klebahn, loc. cit., p. 290.

⁴ According to Huber, Journal de Botanique, 1892, p. 327, *A. repens* sometimes bears two or more hairs on each cell, but as far as I have seen this does not occur nearly as frequently as in the species I have examined.

⁵ No count is taken here of species published after Hansgirg's paper in the Flora of 1888.

⁶ There is no reason now for believing that *A. repens*, Berth., differs in any

2. *A. confervicola* (Näg.) Rabh. = *Herpoteiron confervicola*, Næg., in Kützing, *Species algarum*, 1849, p. 424.

3. *A. polychaete* (Hansg.) Fritsch = *Herpoteiron polychaete*, Hansg., *Prodromus der Algenflora von Böhmen*, p. 258.

Genus *Chaetosphaeridium*, Kleb. (1891).

1. *Ch. globosum* (Nordst.) Kleb. = *Herpoteiron (Aphanochaete) globosa*, Nordst.

2. *Ch. Pringsheimii*, Kleb.

Genus *Dicoleon*, Kleb. (1893).

1. *D. Nordstedtii*, Kleb. = *Aphanochaete globosa* forma *paulo maior*, Nordst.

Genus *Conochaete*, Kleb. (1893).

1. *C. polytricha* (Nordst.) Kleb. } = *Aphanochaete polytricha*,
2. *C. comosa*, Kleb. } Nordst.

It seems probable that *A. vermiculoides*, Wolle, is not one of the Chaetophoraceae at all.

Before concluding, I should like to mention the frequent occurrence of cells with curious red granular contents, which are evidently in some way connected with the Alga I have been examining. I found them in great numbers in the winter months, but since then they have disappeared, and not a single one remains. The contents of an ordinary vegetative cell begin to lose their bright green colour, and this is generally followed by the escape of the contents, which however remain lying immediately outside the empty cell (Fig. 22, 1 and 2, E) and are surrounded by a distinct membrane. The contents become more and more granular (Fig. 22, 1 and 2, c), and the green matter becomes replaced by red granules. These granules increase in size, apparently at the expense of the smaller ones, until only 3-7 large ones remain in the almost empty membrane (Fig. 22, 1, R); these exhibit a slight movement, probably due to convection currents. Ultimately the membrane becomes disorganized, and the granules sink to the bottom; a considerable mass of them collected on the bottom of the vessel in which I kept the *Aphanochaete*, forming a dark

essential particular from the same-named species of Braun (cf. Klebahn, loc. cit., pp. 293, 294). Probably also *A. repens*, Br., and *A. confervicola* (Næg.) Rabh., belong together.

red layer. Unluckily they were by mistake thrown away before I could observe them properly or follow up their future fate. I am

FIG. 22. 1, 2, 5, 6 and 7, *Aphanochaete polychaete* (Hansg.) Fritsch. 1. A number of individuals, epiphytic on *Cladophora fracta*; on the upper side a many-celled individual is to be seen. $\times 500$. 2. A three-celled plant, one cell of which has liberated its contents, *C*. $\times 500$. 5. The first stage in the development of a hair. $\times 600$. 6. A further stage, the bulbous base beginning to form. $\times 600$. 7. Young hair, containing a number of highly refracting masses, which look like transverse walls (but are, however, much thicker than the walls in the hair of a *Stigeoclonium*, for example); in the cell on the right the rudiments of another hair are to be seen. $\times 600$. 3, 4. *Stigeoclonium*, sp. 3. A young unbranched plant, at *R* the contents have been emitted from one of the cells. $\times 450$. 4. A young plant beginning to branch. $\times 450$. (*E*=empty cell, which has set free its contents; *C*=the liberated contents, surrounded by a distinct membrane; *R*=the almost empty membrane, only containing a few big granules.) In most cases only a small portion of the hairs has been figured.

very much puzzled to explain the object of these cells. At first sight they would appear to be due to the attacks of some parasite (possibly *Chytridium*), but after a considerable amount of observation, I do not think this very probable. As far as I have been able to make out, they have also no connexion with any process of reproduction. In fact I might not have mentioned them at all here, if I had not come across exactly the same cells whilst examining some young plants of *Stigeoclonium* (Fig. 22, 3, K). They in every way resembled the cells I had found in the *Aphanochaete*, but were not present in such quantities. The fact that they occur in two different genera is interesting.

I have as yet been able to find little mention of them in the literature of the Chaetophoraceae. Somewhat similar cells have been observed in connexion with the liberation of zoospores in other genera of Chaetophoraceae. Thus, Wille¹ mentions that outside the mother-cell, from which the zoospores are derived in *Trentepohlia umbrina*, Born., a vesicle is to be found, which is considerably larger than the zoospores themselves. He goes on to say: 'Diese Blase enthielt beinahe stets einige runde Körner von der Beschaffenheit des Zellinhalts, welche Körner Molecularbewegung zeigten. . . . Nachdem sie eine Weile gelegen hatte, löste sie sich in dem umgebenden Wasser auf.' Hildebrandt² describes a similar structure in the case of the zoospores of a species of *Chroolepus*; here, however, a small mucilaginous sphere is emitted from the sporangium, and round this a number of red granules are aggregated. At present I can say no more on this subject, but hope to return to it at a future date.

II. THE GERMINATION OF THE ZOOSPORES IN OEDOGONIUM.—Several authors (Wille³, Cleve⁴, and Poulsen⁵) have already described the germination of the zoospores in *Oedogonium*. Unluckily in all these cases the species which was used was not

¹ Ueber die Schwärmzellen u. deren Copulation bei *Trentepohlia*, Mart., Pringsheim's Jahrb., vol. xviii, 1887, pp. 427, 428. Pl. XVI, Fig. 1, v.

² Ueber eine *Chroolepus* mit Zoosporenbildung. Botanische Zeitung, 1861, pp. 82, 83; Pl. III, Fig. 9.

³ Algologische Mittheilungen.—V. Ueber das Keimen der Schwärmsporen bei *Oedogonium*. Pringsheim's Jahrb. f. wissenschaftl. Bot., vol. xviii, 1887, p. 454.

⁴ Iakttagelser öfver den hvilande *Oedogonium*-sporens utveckling. Öfvers. af K. Vet.-Akad. Förh., 1863, p. 247.

⁵ Om svärmsporens spiring hos en art af slægten *Oedogonium*. Botanisk Tidskrift, 3rd ser., vol. ii, 1877-79, p. 1.

Fritsch, Felix Eugene. 1902. "Algological notes - I & II." *Annals of botany* 16, 403–412. <https://doi.org/10.1093/oxfordjournals.aob.a088879>.

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