VIII.—*On a New Species of Parasitic Green Alga belonging to the Genus Chlorochytrium of Cohn.* By EDWARD PERCEVAL WRIGHT, M.A., M.D., F.L.S.; Professor of Botany in the University of Dublin; Secretary to the Royal Irish Academy. [With Plates IV. and V.]

[Read, February 12, 1877.]

THE separation of the Thallophytes into two parallel groups, distinguished the one from the other by the presence or the absence of Chlorophyll, seems to be well founded, and the convenience of retaining the names Algæ and Fungi for each group respectively cannot be overlooked.

To arrive at a perfectly just conclusion as to the exact systematic position of any one plant, every phase of its life's history should be known; and it is equally certain that no Classification of Plants can be entirely satisfactory which is based on the peculiarities presented by any one set of phenomena, whether structural or functional.

Nevertheless, the presence or the absence of the green-coloured portions of vegetable protoplasm carries with it so many marked differences in both the structural and functional peculiarities of the organisms in question, that, for the present, and until further research throws a clearer and brighter light on our way, the botanist may well be content to accept provisionally these two—thus broadly defined—groups of Thallus-forming plants.

That a vegetable organism should possess a cell or cells, the protoplasm of which can differentiate green chromules, may, at first sight, seem a matter of little import, and yet the direct consequences thereof are of importance to mankind, for on the presence of these bodies does the plant's power of fixing carbon depend; and when one thinks for a moment

of the marvellous dependence of mankind upon the solid parts of plants, which are built up from carbon, whether as existing in the coal-field or the forest, or in those varied organic products stored up, in the first instance, for the plant's own use, but which are, for the most part, eventually utilized by man, one cannot but feel an interest in the tiny morsels of Chlorophyll, which capture the carbon atoms from the atmosphere—atoms never again to be entirely restored to it, but destined to add to the solid structure of the earth.

A special interest, too, attaches to the group which is destitute of these green chromules (the Fungi). This very want of theirs it is which constitutes them true parasites; the carbon they take up must, before they can take it up, have been in a free state, and not in combination with oxygen; and it is this necessity of theirs for taking carbon from other organic bodies, combined with their prodigious capability of cell increase, that constitutes them among some of the direst plagues of the human race, making havoc of our crops of wheat, of wine, and of silk. Such facts as these are quite familiar to every botanist, and are here only mentioned as leading up to a more difficult and less understood subject—that of the losing by the cell, or rather by its protoplasm, its power of producing Chlorophyll. The idea of a vegetable cell seems to be incomplete without taking into our conception the existence of Chlorophyll. But the protoplasmic mass has certain functions of its own, which can be fulfilled quite independently of the presence of Chlorophyll. Most vegetable cells pass through an early phase of their existence without it, and this condition, which in most cells is but a transient one, might it not, under certain altered conditions of cell-life, have passed over into a more permanent one? Vegetable protoplasm can and does retain carbon already taken from the carbon dioxide of the atmosphere, as well as it can and does differentiate green chromules, which can decompose the atmospheric carbon dioxide; and may it not be possible, therefore, that we have thus two stems springing from the primeval vegetable cell—itself only a simple mass of coloured protoplasm—a small one represented by the Fungi, in which the cells have lost a Chlorophyll-producing protoplasm—and a large one represented by the Algæ, in which the cells have retained

the power of producing Chlorophyll? In the former, parasitism would be the universal rule, and a non-parasitic life an impossibility. In the latter, parasitism might occur (does occur), but as a retrograde step; and as a consequence thereof the Chlorophyll-producing power of the protoplasm (as in the Balanophoridæ) fades away. If all this were so, might not one expect to find some of the members of the smaller (fungal) stem acquiring, as we assume was from the first the case with the starting form of the larger stem, a Chlorophyll-producing protoplasm; and while by its presence the cells would be ready to detach from the carbon dioxide around them whatever carbon atoms they needed, still, by virtue of long inheritance of parasitism, they would retain more or less of their wonted habit of life?

Regarded from this point of view—the representing of two Phyla—the presence or absence of Chlorophyll would have a higher significance. The Achlorophyllaceous stem, with all its ramifications, never gets beyond the production of a thallus-bearing form; the Chlorophyllaceous stem, with immensely greater strength, breaks into several large branches, with multitudinous twigs. And regarded from the same point of view, the parasitism of Chlorophyll-bearing forms, should such be plainly not degradation forms, would have a fresh interest. Chlorophyll-bearing parasitic forms occurring among Phanerogams are, it would seem to me, plainly retrograde forms; that is, getting their carbon supply otherwise than through the agency of green chromules within their own cells, the organs chiefly containing such cells become by degrees more and more atrophied, and this to such an extent that some of the species might be described as plants reduced to the simple condition of a single flower, stemless, hence leafless, their retrogression is indeed not without distinct indications of from whence they fell; for, as in the Rafflesiads, they show, as Sir Joseph Hooker long ago demonstrated, decided and strong marks of their affinities. But Chlorophyll-bearing parasitic forms among the Cryptogams are of very rare occurrence, indeed so rare, that in a late text-book of authority we find: "Algæ are never true parasites." "All Fungi are destitute of Chlorophyll, and are therefore parasites;" but a green parasitic Alga we have suggested might be a

colourless parasitic Fungus, with but recently acquired powers of developing green granules. Whether this be so or not, Dr. Ferdinand Cohn's discovery of a bright emerald green Alga, living as a parasite in the intercellular spaces of the parenchymatous tissue of *Lemna trisulca*, gathered at Breslau, in the spring of 1872, was one of great interest, introducing us to what, at that date, was the only known chlorophyllaceous endophyte. This plant was placed by Cohn in a new genus Chlorochytrium, and called *Chlorochytrium Lemnæ*. Its zoospores attach themselves to the thallus of the duckweed often in hundreds. They force their way through between the epidermal cells, assuming, as the foremost portion gets into the hypodermal tissues, a more or less figure of eight-shaped form; the foremost portion getting into an intercellular space dilates; the portion that has not entered remains unexpanded, and forms a colourless, nipple-like projection; the portion within the thallus expands to many times its original diameter, sometimes dilating and filling up an intercellular space—at others distorting the sub-adjacent cellular tissue, and frequently itself becoming variously distorted. The cell-wall becomes thicker, even laminated; the Chlorophyll contents get dark and dense, and the cell becomes of a dark nearly opaque green; sometimes starch granules are seen. The cell contents become segmented, breaking up into a number of pear-shaped zoospores, which escape through the nipple-like projection; their actual exit was not seen, nor was the number or position of the cilia observed. Of the zoospores, many never succeeded in penetrating the epidermis of the duckweed upon which they alighted, and such would remain as minute colourless pins'-heads on the surface of the Lemna. Some would linger within the mother cell, and might possibly be resting spores. Such is a very brief abstract of Cohn's description of this remarkable plant,* which has been found by my friend William Archer in duckweed gathered in Westmeath.

* "Ueber parasitische Algen von Dr. Ferdinand Cohn" in Cohn's Beiträge zur Biologie der Pflanzen. Bd. i., s. 87 : Tafel 11., 1870 : 1875. See also "A Résumé of recent observations on Green Algæ," by William Archer, F. R. S., in the Quarterly Journal of Microscopical Science, vol. xiii., New Series, p. 367, 1873.

The object of this Paper is to describe another species, as I believe, of this genus (Chlorochytrium). In 1876 my attention was particularly called to the subject of Chytridia living in the tissues of Florideæ, by reading the description of some new species of the genus by Professor Magnus;* and the Committee of Science of the Academy having placed a small sum from their Government Grant in aid of Scientific Research at my disposal, to enable me to prepare a report on the subject, I began in October, 1876, to follow up Professor Magnus's observations on *Chytridium* (*Olpidium*) *tumifaciens* (Magnus), which I found very common in the hair-like trichomes of *Ceramium acanthonotum* (Carm.) To my surprise I found (under a low objective) a number of bright green dots scattered throughout the mucous tubes of *Schizonema Dillwynii*, Ag., which grew in numbers on the lower parts of the fronds of the Ceramium. Under a higher power it was evident that I had discovered a unicellular algal form, living imbedded in the substance of the Schizonema fronds, and that it was of a brilliant emerald (Chlorophyll) green.

Some few of the cells seen in profile were circular in form, with a large nucleus; at their apex was a colourless nipple-shaped projection, so that there seemed no reason why this plant should not be placed in Cohn's genus Chlorochytrium. The parasite was met with during October in comparatively small quantities in the mucous tubes or fronds not of one but of several species of Schizonema collected at Howth (Plate IV., figs. 1 and 2).

I cannot better describe the outline of this unicellular form than by comparing it to a Stein wine bottle without the handle; the short neck of the plant projecting from the outer surface of the mucous tube, and the body portion being imbedded therein. During the month of December the plant became so numerous and crowded the Schizonema fronds to such a degree, that it imparted to these a sufficiently green hue to make it easy to select those studded with the parasite with the unaided vision, as was also the case when the more regular tubes of *Colletonema vulgare* were affected (Plate IV., fig. 3).

* Jahresbericht der Commission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel für die Jahre 1872–1873. Erste Abtheilung. Berlin, 1875, s. 76. Tab. Botanik 1.

I regret that I have never been able to witness the actual unassisted escape of the zoospores, and this, though I have watched for them at intervals during all the hours of the day and night for a period extending over three months; yet towards the end of November the zoospores were to be found in thousands. In specimens examined quite fresh from the rock pools, they could be seen dancing round the mucous Schizonema fronds; nearly circular in form, and apparently uniciliate, they would be seen very speedily, after impinging on the mucus, to bury themselves to about one half their diameter in it, becoming in the act constricted into a figure of eight shape. At this stage the zoospore is colourless; the nucleus is very apparent, being a little excentric, but nearer the base than the neck of the cell. Once within, the cell begins to expand laterally, increasing also in depth. Having reached nearly to an adult size, the protoplasm commences to develope green chromules. These generally arise as minute points along the inner surface of the cell-wall (Plate IV., fig. 5), from whence they radiate to the nucleus, giving at this period the appearance as if a number of necklaces were hung in loops from the sides of the cell to the nucleus. Shortly afterwards the green chromules appear evenly distributed through the protoplasmic mass, leaving however the neck portion colourless, and often not being found in the portion of the protoplasm immediately in contact with the cell-wall. This colourless portion would seem to lay down several fresh layers upon the first-formed cell-wall, giving the cell often quite a laminated appearance. After a few days the coloured portion of the protoplasm will be found to very slightly contract; this gradually increases, the outer margin presenting often a regular undulated appearance, as it is drawn away from the cell-wall (Plate IV., fig. 5). In the space of a few hours this mass becomes segmented into a well-marked series of oval or nearly circular spores, in each of whch at this stage a nucleus is apparent. The number of spores varies immensely; as few as ten, and as many as thirty and more, have been counted. While within the mother cell the spores have a green hue, not at all as bright as the cell contents were before cell division had taken place; but on the mother cells being artificially ruptured, if the zoospores have reached a certain

stage, they will be seen to escape destitute of colour: so that I am inclined to think that the colouring matter may, at this stage, be located in the thin protoplasmic pellicle surrounding the spore mass. There is without any doubt in this species two series of these zoospores—one very much smaller in size than the other (Plate IV., fig. 4a, b). The true significance of this fact I am at present unable to determine. Cells containing the smaller zoospores, and cells containing the larger forms, will be found growing side by side; but the number of the former far exceeds that of the latter. The motions of the larger spores, when set free, are slower and less vivacious than are those of the smaller ones. In neither one nor the other could I at their first exit (artificial) detect a cell-wall: in neither, even with a one-eighth inch objective, could I be quite certain of the number or the exact position of the cilia. It would, however, seem as if the delicate protoplasm projected itself to one pole, and then became attenuated into a single cilium: but the cell-wall soon makes its appearance, and this apparently quite independently of whether the zoospore imbeds itself in a host plant or not. Sometimes these zoospores attach themselves in such masses around the Schizonema frond, that there is actually no room for them to force their way into the mass; often under these circumstances they will content themselves by simply adhering to the more or less adult Chlorochytrium cells, and present quite the appearance of the little male plants of an Oedogonium sitting on their large oogonium; but in a little time the small plants grow into unmistakeable adult plants, producing zoospores. As might be expected, plants thus circumstanced exhibit a wonderful variety of cell outline; at times they scarcely show even a trace of the figure of eight form, and remain for the most part irregularly spherical. When the plants are much crowded in the frond of Schizonema they will often assume an irregular hexagonal form; sometimes the diatom frustules will be almost completely pressed into the upper portion of the frond, then the lower portion will in turn become filled with the green parasite, so as to appear as if one solid tissue of nearly uniform-sized green cells; the more completely these filled the frond, the brighter the green colour seemed to be. The species became more and more common as the spring season advanced;

but during the month of January there were difficulties in procuring fresh specimens. There are difficulties in the way of the collector of the marine Algæ that never occur to the collector of the freshwater forms. The shortest and darkest winter day is sure to afford to the one some opportunity of filling his collecting bottles, while to the other, should the time of low tide fall between four and seven o'clock, collecting is out of the question; and this was the more inconvenient in my case, because College duties left me for such a purpose only the early morning and late evening hours of each day; still I continued to keep specimens of Schizonema alive, and in good condition, for several days at a time together, having found that, by keeping the bottles containing such specimens tightly corked, so as to prevent, as far as possible, evaporation of the salt water, they continued in excellent condition, and I was thus enabled to watch the growth of this, and many other marine forms.

When the Schizonema fronds grew quickly, the zoospores of Chlorochytrium were well off, for the newer portions of the fronds were then ready to form a resting-place for them; and hence it was not until later in the season, and when the first growth of the Schizonema was over, that any great or undue crowding of the parasitic Alga took place; nor all this time did I find it occurring in any other of the Algæ than the Diatoms; but once their fronds got fully formed the lower portions thereof soon became more or less densely beset with other (epiphytic) Diatoms—species of Epistylis crowded among these; numbers of a pretty stipitate Rhizopod form, probably the *Lecythia elegans* of Strethill Wright, occurred, and more notable than any of these was a fine species of Vaginicola, possibly a variety of *Vag. crystallina*, which was found in abundance. Against one and all of these the zoospores of the Chlorochytrium would ever and anon impinge, and in several instances I observed and noted that the spores attached themselves to the stipes of the Vaginicola and Epistylis. Such specimens continued to grow, assuming a nearly spherical form, and differentiating green chromules, but never increasing to anything like the size of those which had entered into the mucous exudation that makes up the tube of the Schizonema. In many specimens thus located I have traced the growth to

the stage in which it was quite easy to count the number of the within-contained zoospores.

Still further research showed that this species was parasitic on other species of marine Algæ; for a little later I found it occurring in the bright pink fronds of *Polysiphonia urceolata;* and some idea of the contrast presented by the different colours of the host plant and its parasite may be obtained from an inspection of Mr. Tuffen West's drawing, which however was made from a slightly faded specimen (Plate V., fig. 1). Although the difference between the consistency of the mucous frond or tube of a Schizonema or a Colletonema and the cell-wall of a florideous Alga must be great, still this seemed to present no obstacle to the Chlorochytrium. Sometimes it would be found between the siphons, though most generally outside of them, and at the intervals between the siphon rows. The difference in the host plant seemed to bring about but little difference in the parasite, unless that the individual plants seemed to be more symmetrical in outline, and that the neck-shaped portion was somewhat more conspicuous. Seated on the twigs of the Polysiphonia were numbers of the Vaginicola, already referred to; but the zoospores of the Chlorochytrium, not content with simply attaching themselves to the stipes, or to the outer clear lorica of this Infusorium, were now seen to intrude themselves into its cup-shaped body covering, and, as far as I could make out, they entered by piercing through the peristomatous portion; and the neck portion of the parasite always pointed to the central line of the body of the Infusorium. In such a nidus they seemed to thrive, though, even when they seemed to seriously encroach on the space belonging to their host, they did not appear to cause it any serious inconvenience. When, however, it died, the parasites would then rapidly fill up the whole of the hollow cup-shaped lorica, presenting the appearance of a tiny crystal vase, filled with emerald gems (Plate V., fig. 1a). Before leaving this portion of the subject it may not be amiss to note that specimens of this Polysiphonia thus affected, when treated with an alcoholic solution of iodine, for the purpose of determining certain facts in connexion with the Chlorochytrium, presented an appear-

ance of being in fruit, such as would have deceived me had I not known the whence and the whither of the "utricle"-like forms.

The Oscillatoriaceous Alga—*Calothrix confervicola*, Ag.—proved to be another host plant. This plant is well known to British Algologists as an annual plant, which is found very commonly on the stems of other Algæ, living between tide marks. Professor Harvey in his description of this species writes: "Now and then, but rarely, roundish bodies, resembling conceptacles, are found attached to the sides of the filaments: their exact nature is not determined:" and further—"I have ventured to figure globular bodies which I never saw but once, though I have repeatedly sought for them. They were originally noticed many years ago by Sir W. J. Hooker, and figured from his drawings in one of the supplementary plates of Dillwyn's Confervæ, and on the faith of that figure the plant has been erected into a genus by Bory (a measure sanctioned by Endlicher), and placed in the neighbourhood of Ectocarpus. Whatever the nature of these bodies may be, I think that this little plant (*Calothrix confervicola*) can scarcely be removed from its congeners without violence, and certainly am unwilling to admit a relationship to Ectocarpus. The spore-like bodies may be of the nature of buds or excrescences, and may possibly be afterwards changed into the tufted ramuli which are frequently found as it were twisting from the sides of the filament."* I have no doubt that the spore-like bodies of Harvey are absolutely the same as the new species of Chlorochytrium here described; and while Harvey's instincts against, on their account, altering the generic position of *C. confervicola* were true, yet I can find some excuse for Bory and Endlicher making a new genus for it, though none for their placing this near Ectocarpus.

It is not until the spring is somewhat advanced that specimens of *Calothrix confervicola* are to be met with; but shortly after the fully developed filaments made their appearance, I found these to be attacked by the zoospores of Chlorochytrium. In this case the colours of the host plant

* Phycologia Britannica, or a History of all the species of Algæ inhabiting the British Islands. Volume IV., 4to Edit. Description of Plate CCLIV.

and its parasite are not as dissimilar as in the previous case; and if one happens to focus down on the filamentous form, so as to bring into focus at the same time the spherical outline of the unicellular plant, this latter is most easily overlooked, or it might be taken for some accidental variation of one of the cells of the filamentous form. But if, on the contrary, the parasite happens to occur in numbers, and is seen in profile, strongly protruding beyond the edge of the filament, and if the protoplasmic contents are contracted (as in Plate IV., fig. 5), then the extreme likeness to Harvey's figure cannot be overlooked.

In some of the filaments of the Calothrix, I from time to time observed specimens of the Chlorochytrium which apparently had reached adult size, and the cell-walls of which had become even slightly laminated, and yet in which the green chromules had not made their appearance. Such specimens often puzzled me, for they had a very close resemblance to simple vacuoles, and this, especially on one occasion when I found them in like condition, in the fronds of *Enteromorpha erecta*. A close examination of the forms however, assured me that they were only abnormal conditions of the Chlorochytrium, and I could come to no other conclusion than that the protoplasm in these cases simply failed to differentiate the Chlorophyll. Its absence could not be accounted for by the bleaching of the tissues, as the Chlorophyll of the cells of the Enteromorpha was of as bright a green as possible. The occurrence of such specimens first induced me to speculate that it was not impossible but that this marine Chlorochytrium might be an unicellular plant that not long since belonged to the Achlorophyllaceous division of Thallophytes, and such a pedigree would account for its present parasitic habits, even although its recently-acquired powers of differentiating Chlorophyll had left it quite independent of any such mode of life—an independence, too, that seemed to be in some measure taken advantage of in the cases where it lived simply attached to the stalk of one Infusorium, or when it developed into maturity on the urn-shaped receptacle of another, or even more strikingly when—the number of specimens on the host being very large—the plant could scarcely in anywise be called an Endophyte.

It is not improbable that when more is known as to the minute anatomy of our Algæ in a quite fresh state, many so-called abnormal structures may be proved to be only some form or other of this, or some allied parasite; thus it seems probable that it is this very species that is figured by Jessen in his Monograph of the genus Prasiola* as an abnormal cell of *Prasiola leprosa*, Kütz. But this is a subject that must be very much more fully investigated before anything very definite is written about it, and it seems surprising that after the discoveries of Cohn† and Meneghini‡ no botanist has taken up an investigation so full of promise and interest. Professor Cohn may indeed have discovered the very plant I describe in the tissues of *Polyides lumbricalis* at Heligoland, for I venture to suggest that the green cells seen by him may not have been the same form as that identified by Thuret as *Cladophora lanosa*.§

It is possible that the discovery of this marine species of Chlorochytrium may be found to throw some light on the Lichen-gonidia question. Wherever at Howth a plant of a Schizonematous diatom was found living, there I found distinct evidence of the presence of these unicellular green Algæ. During the stormy spring weather, small crevices in the rocks which in summer time would be left high and dry, are found filled with salt water which is replenished at each tide. In these Schizonemæ flourished, and on their fronds the green parasites grew apace. In summer time these tiny rock pools are almost dry, the diatoms become detached, and are certainly blown to considerable distances up the cliffs, and along the coast: might they not thus convey their unicellular green parasites within the reach of the hyphæ of some maritime Lichen and the parasitism thus become reversed? I do not presume, however, to do more than to call attention to the fact that we now know of at least two Chlorophyllaceous Algæ, which can live as Endo-

* Prasiolæ Generis Algarum Monographia scripsit F. G. Jessen. Kiliæ, 1848, Tab. 11, fig. 21.

† Cohn, "Ueber grüne Schlaüche der *Cruoria pellita*, Fries," in Rabenhorst's Beiträge zu näheren Kenntniss und Verbreitung der Algen, Heft II., Leipsig, 1865.

‡ Meneghini, Alghe Italiane e Dalmatiche, Tom. 1, 1843, p. 315.

§ Cohn, "Ueber parasitische Algen.," *loc. cit.*, p. 91.

phytes within host plants, one to be met with in freshwater, and the other in the sea. With reference to the two species of Pleurococcus described by Welcker and Kühn, as found on the hairs of Sloths, and referred to by Mr. Archer,* I have, through the kindness of Mr. H. C. Sorby, F.R.S., been enabled to examine both the *Pleurococcus Bradypi*, W. & K., and *P. Cholopei*, W. & K., and it appeared to me that these Algæ were more epiphytic than endophytic; their algal nature, however, admits of no doubt. Mr. Sorby writes to me that "they contain the two chlorophylls—the three xanthophylls and licheno-xanthine, and are most certainly well able to earn their own living. They seem to occur on the surface, and that only of the cellular portion of the hair, to which they adhere remarkably firmly. . . . I do not know of any hairs but those of the Sloths to which such plants could so adhere." From this it would seem probable that the hairs of the Sloths in these cases served as a nidus for the Protococci spores, just as doubtless also did the bark of the trees upon which the Sloths lived.

Chlorochytrium (Cohn).

Plant endophytic; green, unicellular; cells globose, or somewhat irregularly bi-, tri-, or multi-lobed; densely filled with chlorophyll, first dividing into large segments, and then these giving origin to innumerable pyriform zoospores, which escape through a tubular process.

Chlorochytrium Lemnæ (Cohn).

The zoospores, impinging on the epidermis of the duckweed at the junction of two cells, after germination commences, a tube is produced which, entering between the walls of the dissepiments, proceeds as far as the mesophyllic parenchyma, growing into the intercellular spaces, and forms either a globose, elongated or irregular-shaped cell—the diameter of the adult cell about 0·1 mm.

Living in the thallus of *Lemna trisulca*, found at Breslau, 1872.

* Welcker "Ueber die Entwickelung und den Bau der Haut und der Haare bei Bradypus, nebst Mittheilungen ueber eine im Innern des Faul-thierhaave's lebende Alge," in Abhl. der Naturf. Gesellschaft zu Halle. Bd. xx., Heft 1, s. 59, *fide* W. Archer, *loc. cit.*, p. 375.

CHLOROCHYTRIUM COHNII (spec. nov.).

The zoospores impinging on the fronds of several species of marine Algæ, quickly assuming a figure of eight form, the lower sphere growing into the frond and rapidly assuming comparatively large dimensions, the upper sphere remaining as a tube-like neck portion to the larger mass. On the cell arriving at an adult stage the whole of the green protoplasmic contents divide into a number of from ten to thirty, nearly circular, zoospores, which escape through the neck-shaped portion.

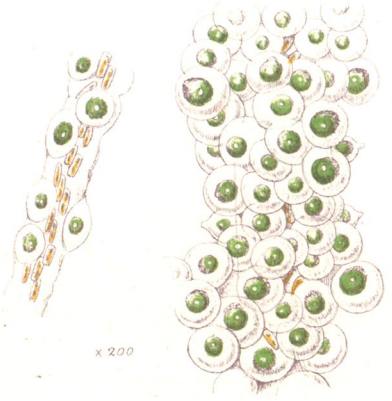
Living in the thallus of various species of Schizonema, Polysiphonia, &c.; also on Infusoria found at Howth, near Dublin, 1876.

I have ventured to dedicate this species to the illustrious Professor of Botany of Breslau.

It will be remarked that I have not altered Professor Cohn's diagnosis of this genus, and yet that in several respects the new species does not exactly conform to the characters he gives. Still, for the present, it cannot, I think, find a better place. The more essential differences are the totally different process of the formation of the zoospores, and the occurrence of large and small zoospores. Further research can alone throw light on these.

[*Note added in Press*].—"On ne saurait déterminer d'une manière tout à fait certaine la cause de l'erreur sur laquelle Endlicher a fait son genre Leibleinia (Gen. Plant., No. 57): nous sommes pourtant très-portés à croire que les conceptacles latéraux dont il parle ne sont que des individus de *Chroococcus turgidus*, Næg., fixés sur les filaments d'un Calothrix. Ce Chroococcus, qui n'est pas seulement une plante d'eau douce, mais qui est commun dans les marais sallants, abonde souvent dans les petites flaques des rochers où croît le *C. crustacea*. Si l'identification laisse quelque doute pour les prétendues spores figurées par Harvey (Phyc. Brit., Pl. CCLIV.), qui avoue d'ailleurs ne les avoir vues qu'une fois, elle est à peu près certaine pour celles qu'a découvertes Hooker, 'qui étaient ' entourées d'un limbe transparent et divisées transversalement par une ligne transparente' (Voy. Dilwyn. British Confervæ, p. 39., Tab. Suppl. A). Il pourrait bien en être de même des Spermatia lateralia sessilia que M. Kützing (Spec. Alg., p. 276) attribue au genre Leibleinia, comme on peut en juger en comparant le *Protococcus turgidus* figuré dans les Tabulæ Phycologicæ, vol. i., pl. 6, et les Spermatia du *Leib. purpurea* (*loc. cit.* Tab. 84, fig. II.)"—Notes Algologiques par Ed. Bornet et G. Thuret, Fasc. 1, Paris, 1876, p. 15.

Nothing in this extract seems to contradict my views as to the probable identity of Harvey's Globular Bodies.



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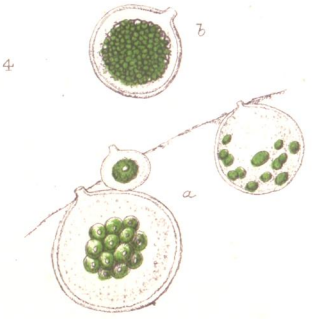

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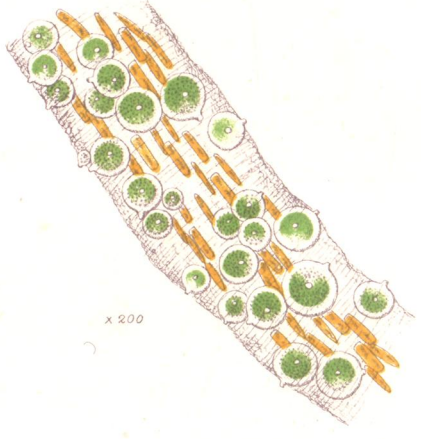

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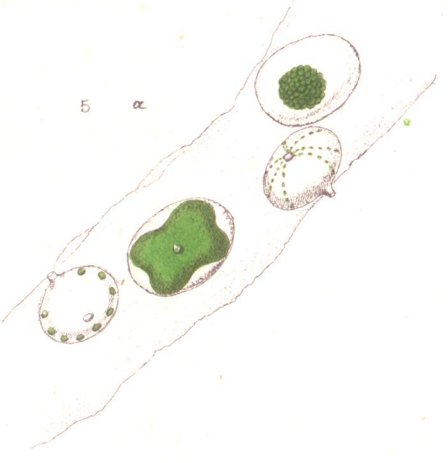
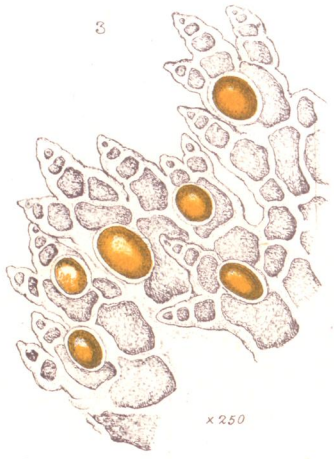
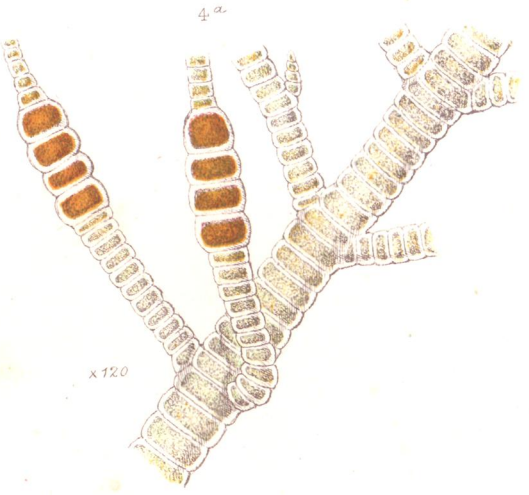
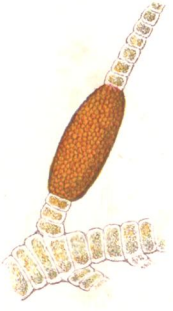
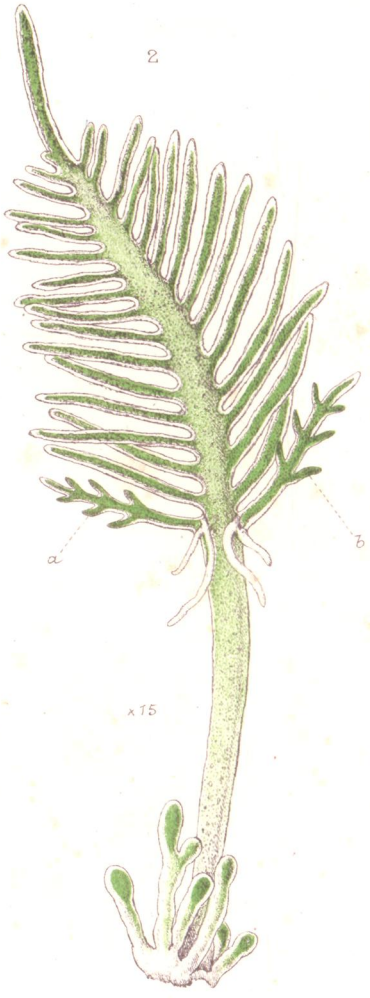
5 a




3
x 250


4a
x 120


4b
x 120


2
a
b
x 15


1
x 200