NOTES on some FRESH-WATER CONFERVOID ALGÆ, new to BRITAIN. By ARTHUR HENFREY, F.R.S., Professor of Botany, King's College, London. (Plate IV.)

(Read March 26, 1856.)

PANDORINA MORUM, Ehr.

Pandorina, Ehrenberg (*Char. emend*). Frond a microscopic, ellipsoidal, gelatinous mass, containing imbedded near the periphery, sixteen or more biciliated, permanently active gonidia, arranged in several circles perpendicular to the long axis of the frond. The gonidia, almost globose, with a short, beak-like process, a red spot, and a pair of cilia which project through the substance of the frond to form locomotive organs upon its surface. Reproduction—1, by the conversion of each gonidium into a new frond within the parent mass; and 2, by the conversion of the gonidia into encysted resting spores, which are set free, and (?) subsequently germinate to produce new fronds.

P. Morum, Ehr. (Pl. IV., figs. 1-25.) Fronds hyaline; from about 1-80" downwards. Gonidia either sixteen, and then arranged in four circles of 4, or thirty-two, and then in five circles, three at the poles of 4, and the intermediate three of 8 gonidia, which in the perfect form stand near the periphery and wide apart. In the forms which produce the resting spores, the gonidia are crowded together in the centre. The gonidia are green, but the contents of the resting spores, after they have become encysted, are converted into oily and granular matter of a bright-red colour.

The description of *Pandorina* given by Ehrenberg, is so incorrect, that no one would be able to determine the organism by its aid; but the figures in the '*Infusionsthierchen*,' although rude, are sufficient for identification. *Pandorina Morum* has been observed by Focke* and Alex. Braun† in recent years, who pointed out the errors of Ehrenberg in stating that the gonidia had only one cilium and no eye-spot; but we do not anywhere find a clear and satisfactory account of this creature. It was with much satisfaction that we received early in February of this year (1856), from H. Pollock, Esq., a bottle containing a vast quantity of *Pandorina Morum*, which he had found colouring the water in a pool at Hatton, near Hounslow, Middlesex.

● 'Physiolog.' Heft., ii. 1854, Pl. IV.

† 'Verjungung,' Ray Society's Vol. for 1853, pp. 169, 209.

The forms presented by this organism are exceedingly varied, and nothing can be more beautiful than a number of them revolving slowly on their long axes in a drop of water, as seen under a power of about 100 diameters.* In the first place, the perfect form exhibits two patterns shown in figs. 1 and 3, and there are minute counterparts to these, remaining in that state, as in figs. 7 and 9; while in the water where the species is actively multiplying, all sizes between figs. 13 and 14, just emerged from the parent frond, and the full grown from figs. 1 and 3, &c., occur. The form with 32 gonidia results from the cell-division going on one stage further than in the form with 16; but this difference is fixed during the earliest stages of development, as the form with 16 (fig. 1) never changes into that with 32 (fig. 3), after it has become free from the parent. In the perfect forms the gonidia are arranged near the periphery of the frond in circles, like the equator and parallels of latitude on a globe, so that *Pandorina* resembles Cohn's *Stephanosphæra*† more closely than any of the other *Volvocineæ*, that having a single equatorial ring of gonidia in its globular frond. Among the forms with the isolated gonidia occur others almost equally numerous with the gonidia collected together into berry-like heaps (figs. 15-20); these are smaller than the others, but equally varied in dimensions; their gonidia resemble those of the other form; they appear destined to form the resting spores.

The gonidia are almost globular; they have no proper membrane, but consist of a gelatinous, granular substance which contains a thinner fluid in the centre, as it contracts strongly by exosmosis when strong saline solutions are applied. There is a large, nucleus-like body (the chlorophyll-vesicle of A. Braun) at the posterior end of the gonidium (fig. 5), and at the opposite side is a short beak-like process, with a colourless space behind it; the pair of cilia arise here, and a little to one side and below these is the reddish-brown granule called the 'eye-spot.' We have never been able to observe a pulsating vacuole, as described by Busk and Cohn in *Volvox* and *Gonium*.

The gelatinous frond appears to be perfectly homogenous, without any boundary membrane. Iodine and sulphuric acid do not colour it blue. It is tolerably resistant, and appears solid, as it does not give way or become indented by external pressure, as is the case with the hollow frond of *Volvox*.

The fronds are multiplied by the conversion of the gonidia

* A. Braun says they revolve constantly to the right; but they change the direction constantly.

† 'Annals Nat. Hist.,' 2nd Ser., x., p. 321, &c.

into new families. If they are viewed at night, many of the fronds may be found at rest at the bottom of the vessel (in the daytime they assemble at the side next the light), motionless, and with the gonidia rounded and deprived of their nucleus. By covering up the bottle from the light, the development of the new fronds, which naturally takes place very early in the morning, may be retarded so as to be followed during the morning until noon. Some of the fronds may be found with the gonidia converted into berry-like heaps (fig. 10), others with the gonidia already distinct (fig. 11), while many parent fronds present the young fronds more or less regularly arranged in the softened and expanded parent mass (fig. 12), which ultimately dissolves and sets them free (fig. 13, 14). They then increase in size in proportion to the favourable conditions in which they are placed. I have never seen anything like what are described by Cohn in *Stephanosphæra* as 'microgonidia.'*

When kept for some weeks, an increasing quantity of fronds became accumulated at the bottom of the water, and these chiefly of the character shown in fig. 17, but devoid of cilia; and while many of them decayed, in others the gonidia became encysted so as to form globular cellules. Left for a fortnight, the water was found without a trace of green colour, with merely a brownish sediment at the bottom, upon examining which, it was found to contain a large number of berry-like forms (fig. 17), with the gonidia not only encysted, but with their contents converted into a red, oily, granular substance (figs. 21-25), as in the resting-spores of many Confervoids. The gelatinous frond was here almost dissolved away, and a slight pressure was sufficient to detach and separate the cellules, which are doubtless resting-spores, and destined to become subsequently developed into new fronds. This remains to be decided.

The organism thus described is a well-marked and distinct species, very different from *Volvox* and *Gonium*, but approaching near to *Stephanosphæra*. The form which produces the resting-spores, after losing its cilia, is Kützing's *Botryocystis Morum*, I have met with a form like this not unfrequently, but never before with the perfect *Pandorina*. Mr. Pollock tells me that he has collected from the same pond for some years past, but never found *Pandorina* before, and yet it colours the water green this season. *Volvox* seems, in like manner, to come and go at intervals of years, its revivification from the resting-spores depending much on external conditions.

* 'Ann. Nat. Hist.,' l. c. In a letter received from Professor A. Braun since the above was written, he speaks of the forms with small gonidia (figs. 7-9) as the 'microgonidial' form. A. H., June, 1856.

APIOCYSTIS BRAUNIANA, Nägeli.

Apiocystis, Nägeli. Frond a microscopic, hyaline, gelatinous, sac-like body, attached by an attenuated base; containing numerous green globular gonidia, multiplying, during the growth of the frond, by quaternate division, and finally breaking out by a lateral orifice as active, two-ciliated zoospores, each of which becomes encysted and grows up into a new frond.

A. Brauniana, Näg. (Pl. IV., figs. 26 and 27.) Frond pyriform, 1-600" to 1-25" high, the cavity filled up by gelatinous matter, in which are embedded the gonidia, at first few, increasing in number with age as far as 1600, each about 1-2000" in diameter. Nägeli, 'Einz. Algen,' p. 67, Pl. ii A; Kützing, 'Spec. Alg.,' p. 208. Fresh-water ditches, &c.

A few young specimens of this little plant were observed in January of this year (1856) in a jar of water containing aquatic plants, brought from Wimbledon Common six months previously. The whole collection was destroyed by frost soon after, so that the development was not followed. Nägeli (*l. c.*) gives the following account of it:—

"The young 'swarm-cells' (zoospores) attach themselves by their ciliated point (especially to *Cladophora fracta*), and become invested with a club-shaped enveloping membrane. The first division of the green body then takes place in the direction of the axis of the vesicular envelope, and is repeated, in *A. Brauniana*, alternately in each direction of space. During this the vesicle in which the cells (gonidia) lie, continually expands, and generally becomes very evidently pedunculated. Young vesicles contain a regular number of cells, namely, 2, 4, 8, 16, 32, &c.; but the number afterwards becomes indefinite; in largish vesicles, 1-50" long and 1-120" in diameter, I have counted about 300; in the largest, about 1-25" long and 1-50" thick, some 1600 cells.

"The cells (gonidia) are at first uniformly distributed over the whole cavity of the vesicle. Subsequently they generally become collected on the internal surface of the wall of the vesicle, where they lie in one or more strata. But the cell-division always takes place in all directions of space, the cells situated internally advancing outwards towards the periphery. In old vesicles the cells are sometimes arranged in rings of 8 upon the wall.

"When the family of cells is mature for 'swarming,' which may occur at very different sizes and with very different numbers of gonidia, the cells begin to move at first slowly from their places, and then gradually to circulate more rapidly in and out about each other. The vesicle bursts and the gonidia emerge by the orifice which is formed. Sometimes the swarming is preceded by the state in which the cells are arranged in parietal rings.

"The cells secrete an abundant gelatinous coating, which becomes softened within the vesicle, and confluent into a structureless jelly. The vesicle sometimes appears merely as the boundary line of the jelly; in general, however, it may be distinguished as a distinct wall composed of denser gelatinous substance (Pl. IV., fig. 25), the internal outline of which is always distinct and sharp, while the outer is frequently indistinct and partly dissolved."

The vesicle sometimes presents delicate ciliary processes on the outside. The zoospores have two cilia, according to Al. Braun.* They have no 'eye-spot.'

CLATHROCYSTIS ÆRUGINOSA.

Clathrocystis, Nov. Gen. Frond a microscopic gelatinous body, at first solid, then saccate, ultimately clathrate, (fragments of the broken fronds occurring in irregularly-lobed forms,) composed of a colourless matrix, in which are imbedded innumerable minute gonidia, which multiply by division within the frond as it increases in size. (No zoospores or resting-spores observed.)

C. æruginosa. (Pl. IV., figs. 28—36.) Fronds floating in vast strata upon fresh-water pools, forming a bright green scum, presenting to the naked eye a finely granular appearance; when dried appearing like a crust of verdigris. Gonidia or green cells, with a distinct membrane, about 1-8000" in diameter, leaving a hyaline border at the surface of the fronds; full-grown fronds, 1-50" to 15" in diameter. *Microhaloa æruginosa*, Kützing. ('Linnæa,' viii, p. 371, Pl. 8, fig. 23.) *Microcystis ichtyoblabe*, Kütz., 'Phyc. Gen.' ex parte. *Meneghini*, 'Monogr. Nostoch.' p. 104. *Microcystis æruginosa*, 'Tab. Phyc.' i., Tab. 8. *Polycystis æruginosa*, Kütz., 'Sp. Alg.,' p. 210. "*Flos Aquæ*," 'Treviranus,' Linnæa, xvii., p. 51, Pl. 3. On fresh-water lakes.

This remarkable form does not appear to have been observed hitherto in Britain. We found it in the autumn of 1855, forming a scum extending over a large portion of the surface of the lake in the Royal Botanic Gardens at Kew. A portion of it, brought home and preserved in a room in a bottle of water, continued to grow healthily until the middle of winter.

It is very well described in the paper of Treviranus above referred to; but none of Kützing's descriptions mention its remarkable mode of growth or its peculiar form when perfect. Apparently that author has only seen it in a dry state; it does not agree with the definitions of the genera *Microcystis* or *Microhaloa*; and as the name *Polycystis* has been occupied in the Fungi, we have ventured to add to the already confusing synonymy, by giving it a distinctive and characteristic name.

The smallest fronds met with are usually roundish or ellipsoidal, of the character shown in Pl. IV., figs. 28 and 34. When quite young they appear to be solid, but as they grow by the multiplication of the internal gonidia, and the secretion of gelatinous matter, the expansion takes place chiefly near the

* 'Verjungung,' &c., Ray Soc. Vol. 1853, p. 209.

periphery, so that the frond becomes a hollow body (just as the stems of Grasses or *Umbelliferae* become fistular). The walls of the sac then give way, (figs. 29 and 30,) and as the expansion proceeds, orifices are formed in different parts, until the whole becomes a coarsely-latticed sac or clumsy net, of irregularly-lobed form (fig. 31). Then this becomes broken up into irregular fragments (figs. 32—34) of all shapes and sizes, (giving the stratum a granular appearance to the naked eye,) each of which recommences the expanding growth, and becomes a latticed frond. The internal cells are very minute, but have a distinct margin with internal granules (figs. 35 and 36). They multiply by dividing into two or four. The gelatinous frond always presents a transparent border or peripheral stratum, destitute of green cells; but no boundary membrane exists, the surface exhibiting a softened or half-dissolved aspect. On the approach of winter the fronds ceased to increase, and by degrees most of the gelatinous masses faded to a light brownish tint, swelled up and settled to the bottom of the water in light flocculent clouds. They appear to become half dissolved, and to allow the green cells to become free, as many of the latter were found free, adhering to the sides of the vessel; perhaps these reproduce the fronds in the next season. No zoospores were ever detected.

The verdigris-like appearance of this *Alga* when dead is most remarkable and characteristic. While growing, in its wet state, it is rather of a yellowish opaque green colour.

As to the systematic position of the above species, *Pandorina* belongs, of course, to the *Volvocineae*; *Clathrocystis* is doubtless referable to the same group as *Palmella cruenta*, and therefore to the family of true *Palmellaceae*, which will require to be kept apart from *Protococcus*, and similar forms, on account of the absence of zoospores. *Apiocystis* must remain for the present in the heterogeneous assemblage which includes *Protococcus*, *Glæocapsa*, &c., which require much more study before they can be satisfactorily classified.