

A REVISION OF THE CLASSIFICATION OF
THE GREEN ALGÆ

BY

F. F. BLACKMAN,

University Lecturer in Botany, Cambridge.

AND

A. G. TANSLEY,

Assistant Professor of Botany, University College, London.

(continued from page 192.)

22. *Sphærozozma*. Corda, 1835.

Cells with a deep equatorial furrow; connected by minute tubercles or cone-shaped processes; elliptical or triangular in end view. Semi-cells oval in side-view. Chromatophore of two diverging plates in each semi-cell.

23. *Streptonema*. Wallich, 1860.

Cells considerably broader than long, with a very deep equatorial furrow; connected by three hyaline cylindrical bands; in end-view 3-armed, each arm with a rounded swollen end. Chromatophore of three diverging plates in each semicell, each plate occupying an arm and branching into two in the swollen end.

24. *Aptogonum*. Ralfs, 1848.

Cells nearly square in side-view, with a very slight equatorial constriction, and a slight terminal concavity; in end-view triangular to quadrangular, or oval. Chromatophore of four to six or eight plates diverging from two, three or four pyrenoids in each semi-cell.

25. *Desmidium*. Agardh, 1824.

Cells oblong in side-view, broader than long, with a slight equatorial constriction; triangular or quadrangular, rarely oval in end view. Chromatophore in each semi-cell, with as many pyrenoids as there are angles, and two parietal plates diverging from each pyrenoid.

26. *Phymatodocis*. Nordstedt, 1869.

Cells approximately square in side-view, intimately connected by their flat ends; with a very narrow equatorial slit; in end-view 4-armed, with a tubercle on one side of each asymmetrical rounded arm. In side-view, each semi-cell the inverted counterpart of the other.

27. *Didymoprium*. Kützing, 1843.

Cells oval, each with a slight equatorial furrow; connected by their flat ends to form spirally wound threads; in end-view elliptical, with two opposed promontaries, Chromatophore of eight plates diverging from four pyrenoids in each semi-cell.

28. *Gymnozyga*. Ehrenberg, 1840.

Cells barrel-shaped, with a slight equatorial furrow, on each side of which is a ridge; in end-view round, with two opposed projections of the wall; membrane with transverse ridges, and between them, longitudinal striae. Chromatophore of six plates diverging from a pyrenoid in each semi-cell.

29. *Hyalotheca*, Ehrenberg, 1840.

Cells oblong in side-view, intimately connected by their flat ends to form spirally-wound cylindrical threads; equatorial constriction very shallow, with gently sloping sides; in end-view circular. Chromatophore of six to ten plates diverging from a pyrenoid in each semi-cell.

Series II. *Zygnemoidae*.

Plant-body filamentous, attached or free, consisting of equivalent cylindrical cells (only the attachment-cell differs). Chromatophores symmetrical with reference to the long axis of the cell, of three well-marked types, characterising the three families.

Multiplication by fragmentation of the filament.

Reproduction sometimes by the formation of aplanospores (one in each cell), usually by zygotes, which are formed either isogamously in the conjugation canal, or anisogamously in one of the conjugating cells. Parthenogenesis of the gametes sometimes occurs.

Fam. I. *SPIROGYRACEÆ*.

Chromatophores one to nine in each cell, each a parietal spirally-wound band with a single row of pyrenoids.

Genera.

1. *Spirogyra*. Link, 1820.

Chromatophores usually making a considerable angle with the long axis of the cell, rarely parallel with it. Gametes derived directly from ordinary vegetative cells. Conjugation anisogamous.

2. *Sirogonium*. Kützing, 1843.

Chromatophores almost parallel with the long axis of the cell. Gamete-mother-cells formed from vegetative cells by the cutting off a small cell in the case of the functionally female, and of a large, sometimes also of a small, cell in the case of the functionally male. Conjugation anisogamous.

Fam. II. ZYGNEMACEÆ.

Chromatophores two, one placed on each side of the central nucleus, each consisting of a rounded body containing a pyrenoid. Akinetes sometimes formed.

Genera.

1. *Zygnema*. Agardh, 1824.

Chromatophores with radiating processes. Conjugation isogamous or anisogamous.

2. *Pyxispora*. West and G. S. West, 1897.

Vegetative cells indistinguishable from *Zygnema*. Conjugation isogamous. Zygote elliptical, with an equatorial ridge bearing a groove, and with its long axis perpendicular to long axis of conjugating filaments.

3. *Pleurodiscus*. Lagerheim, 1895.

Chromatophores disc-shaped, parietal or somewhat excentric. Cell-sap often purple.

4. *Zygogonium*. Kützing, 1843.

Chromatophores irregular, sometimes uniting into a single axile body. Cell-sap sometimes purple. Conjugation isogamous.

Fam. III. MOUGEOTIACEÆ.

Chromatophore single, consisting of a longitudinal axile plate with a single row of pyrenoids; sometimes almost divided into two in the middle of the cell. Cells much longer than broad.

Genera.

1. *Mougeotia*. Agardh, 1824.

Transverse walls lens-shaped. Part of protoplasm of the conjugating cells not used in the formation of the gametes. Zygote formed in the conjugation-canal, but sometimes extending right across one or both of the two conjugating cells.

2. *Mougeotiopsis*. Palla, 1894.

Like *Mougeotia*, but pyrenoids absent.

3. *Debarya*. Wittrock, 1872.

Like *Mougeotia*, but all the protoplasm of the conjugating cells used to form the gametes. Zygote formed in the conjugation canal, its brown middle membrane bearing three parallel ridges connected by striae.

4. *Temnogametum*. West and G. S. West, 1897.

Like *Mougeotia*, but gamete-mother-cells short, specially cut off from vegetative cells.

5. *Gouatonema*. Wittrock, 1878.

Vegetative cells as in *Mougeotia*, but reproduction by increase of vegetative cells to double their original length, division of the chromatophore in the middle, swelling of the cell wall at that point, and finally collection of most of the cell contents in the swelling, which is then cut off as an "aplanospore."

[The cytological details of the process of "aplanospore"-formation in this genus have not been followed, but the sequence of events strongly suggests that the so-called aplanospore is really a zygote, produced by isogamous conjugation of gametes whose mother-cells have never been separated by a wall.]

Class IV.--HETEROKONTAE.

Organisms unicellular, multicellular, or coenocytic. *Cell of "flagellate" or of algal organisation, containing rarely one, usually many discoid, parietal, yellow-green chromatophores, devoid of pyrenoids and starch.* The usual anabolite is an oil. The motile individual cells or the zoospores are provided with two flagella either unequal in length or opposed in direction, arising from a spot a little to the side of the anterior end. The motile cells generally exhibit amoeboid or "metabolic" movement.

Series I. **Chloromonadales.**

Organisms, either unicellular and motile or united to form a mucilaginous colony. *Cells of "flagellate" organisation, devoid of typical cell-walls and dividing longitudinally.* Resting cells occur: gamogenesis does not take place.

[Though the members of this series must be considered to be Flagellata and not Algæ (see p. 22), it is not possible to omit them from this scheme of classification, since they represent the primitive organisms possessing Heterokontan characters from which the next two series have been evolved.]

Fam. I. **CHLORAMOEBACEAE.**

Flagellate cells, free-swimming, naked, with a belt of discoid chromatophores. Flagella very unequal in length, the short one curved sideways. Vegetative division takes place probably in the motile state. Resting cells with thick walls occur.

Genus.

Chloramoeba. Bohlin, 1897.

Cells round to ellipsoid, very amoeboid, with one contractile vacuole and two to six chromatophores, usually nourished holophytically, but also capable of living saprophytically in the dark in solutions of sugars, etc., and then devoid of assimilatory pigment.

Fam. II. **VACUOLARIACEAE.**

Flagellate cells naked free swimming and predominantly motile, but division takes place only in the non-motile condition, within a mucilaginous investment. Chromatophores numerous. Flagella two,

approximately equal in length, but one *directed forwards* and the other *backwards*. Resting cells occur.

Genus.

Vacuolaria. Cienkowski, 1870.

Cells large with numerous parietal chromatophores. The flagella arise in a pit at the anterior end close to which are two contractile vacuoles. A large non-contractile sap-vacuole is often present.

Fam. III. CHLOROSACCACEÆ.

Cells *predominantly non-motile* and united to form a *mucilaginous colony* in which abundant cell-division takes place. In the motile phase (zoospore) the cells have *two lateral chromatophores* and *two unequal flagella* arising close to the apex.

[This family forms a transition from the typically flagellate to the typically algal type, in respect of the dominance of the non-motile condition and the differentiation of a cell-wall.]

Genera.

1. *Chlorosaccus*. Luther, 1898.

Colony a large mucilaginous aggregate formed by repeated quartering of the constituent cells. Cells oval, each with a special wall which is dense towards the surface of the colony and thin or discontinued at the opposite pole. Short flagellum one-third to one-sixth the length of long one.

2. *Chlorobotrys*. Bohlin, 1901.

Cells spherical, 2 (-8) in mucilage. Cell-walls siliceous, but not brittle. Life-history uncertain, neither cell-division nor swarms yet observed.

Series II. Confervales.

Plant-body unicellular, multicellular or coenocytic. Cells *strictly algal in organisation* with several discoid parietal chromatophores. *Reproduction by zoospores with two unequal flagella* (the short one often only demonstrable by special methods); and *by similar isoplanogametes*. *Aplanosperes* occur in most genera.

[Until 1898 the zoospores of genera placed in this series were described as having only one long flagellum, which is the appearance they present when alive or when killed with most reagents. In that year Luther proved that the zoospores of *Conferva* and *Botrydiopsis* possess also a second, short flagellum which had been overlooked because it is generally pressed against the body. This brought the Confervales into line with the Chloromonadales in this most fundamental character as well as in many others, so that their phylogenetic connection seems now indisputable. The zoospores of most of the genera have not yet been re-examined in this matter, but a second short flagellum is assumed to be present in all cases and also in the gametes which were previously described as uniflagellate. Such gametes have been observed in the best known genera, but to some others gametes possessing clearly two flagella of approximately equal length have been attributed; this is, however, not yet established beyond doubt.]

Fam. I. CHLOROTHECIACEAE,

Plant-body unicellular and uninucleate. Cells either solitary and attached by a basal stalk, or united by mucilage to one another to form a small colony. Reproduction by swarmers which either germinate singly or conjugate in pairs (facultative gametes). The swarmers have one long conspicuous flagellum, and presumably a second short one (not yet demonstrated for any of the genera); and usually one lateral chromatophore (two in *Mischococcus*).

Genera.

*Cells solitary and attached by a thick or thin stalk. Vegetative division does not occur.

1. *Peroniella*. Gobi, 1887.

Cells rounded or pyriform, with a single chromatophore; quite imbedded in the mucilaginous investment of other Algæ and attached to the host by a long stalk of extreme fineness. Reproduction by pyriform zoospores which burrow into the mucilage anew and attach themselves by the long flagellum which then becomes the stalk. Gametes not known. Aplanospores occur.

2. *Stipitococcus*. West & G. S. West, 1901.

Chiefly distinguished from *Peroniella* by its much smaller size: should, perhaps, be united with it as a recently described species is not so small.

3. *Characiopsis*. Borzi, 1895.

Cells obovate or round, with several chromatophores; epiphytic by a short thick stalk. Reproduction by division of the cell-contents, either directly to eight zoospores (liberated by solution of the upper part of the mother-cell-wall) or to a large number of spherical aplanospores which when liberated, become at once gametangia, each producing two to four gametes. Zygote germinates to form zoospores.

4. *Chlorothecium*. Borzi, 1885.

Cells obovate containing one or a few chromatophores, but otherwise resembling the previous genus. In reproduction the cell-contents divide into a large number of spherical aplanospores (liberated by solution of the middle part of the mother-cell-wall) which at once become zoosporangia liberating two to four swarmers which are facultative gametes. Zygote germinates to form zoospores.

[It seems highly probable that the vegetative cell of *Chlorothecium* will be able to give rise to zoospores directly (at all events under certain conditions). If this is so, then the life-histories as well as the morphology of the two previous genera become so similar that no clear generic distinction remains between them. Borzi calls the liberated clusters of aplanospores *palmelloid states*, but apparently these never grow or multiply independently.]

** Cells united by mucilage to form colonies. Vegetative division abundant.

5. *Askenasyella*. Schmidle, 1902.

Colony spherical, mucilaginous, free or attached. Cells pyriform, the pointed end directed centrally, and passing into an ill defined stalk, which loses itself in the mucilage. Chromatophore single, and lining the whole of the thin cell-wall except at the pointed end. Each cell may give rise to four to sixteen zoospores which escape by a lateral hole. On germination of the zoospore the long flagellum becomes mucilaginous.

6. *Oodesmus*. Schmidle, 1902.

Colony free-floating, consisting usually of four oval cells united together in one plane by very short thin bands of mucilage. Cell-wall thick; chromatophores one or two. Reproduction by division of the cell-contents into four bodies (uniflagellate zoospores?), which (after very briefly swarming?) unite together (by their flagella?)

7. *Mischococcus*. Nägeli, 1849.

Cells round with one to four chromatophores; united to form an attached dendroidal cluster by stout tubular mucilaginous stalks, the cells occurring only at the ends of the branches. Reproduction by zoospores, and by gametes. The zygote typically, and the zoospores sometimes, germinate to form a so-called palmelloid state in which the cells are oval, divide in two directions, and have very short broad basal mucilaginous stalks, by means of which all the daughter-cells remain fused together side by side to form a large epiphytic cushion.

Fam. II. CONFERVACEAE.

Plant-body unicellular or filamentous. Cells uninucleate or sub-coenocytic. *Reproduction by zoospores with one long and one short flagellum and with two lateral chromatophores* (several in *Polychloris*); also by *planogametes*, which in some cases have been described as possessing two equal flagella.

Genera.

1. *Polychloris*. Borzi, 1892.

Cells distinct, spherical or polygonal by compression, with numerous discoid chromatophores; dividing in three directions. Reproduction by zoospores, arising eight to sixteen from a cell, and having each three or more chromatophores.

2. *Botrydiopsis*. Borzi, 1889.

Cell spherical unattached, with a single nucleus and a large number of discoid chromatophores. Vegetative division does not occur. Reproduction by division of

cell-contents to form a number of spherical aplanospores or a larger number of zoospores. The zoospores have been proved to possess two lateral chromatophores and two unequal flagella. The aplanospores may become zoosporangia or, after resting, gametangia. The gametes are described as having a single chromatophore and two approximately equal flagella.

3. *Ophiocytium*. Nägeli, 1849.

Cell sub-coenocytic free or attached, cylindrical, straight, or spiral, containing several nuclei and several large parietal chromatophores. No vegetative division occurs. Reproduction by division of the contents to oval aplanospores or to eight zoospores which are liberated by the splitting-off of the upper end of the cell as a lid. In the attached species the lower part of the cell remains as an empty open tube, on the rim of which the zoospores come to rest and develop as a whorl of new tubes. Repetition of this generates a polytomous branch-system of empty tubes. Existence of gametes uncertain.

4. *Conferva*. Lagerheim, 1888.

Cells with one or two nuclei, and several chromatophores; united to form uniseriate filaments. Reproduction by the formation of oval aplanospores or by zoospores (one or two from each cell), provided with one long and one very short flagellum and a number of discoid chromatophores. Zoospores escape by the cells splitting cleanly across at the middle. A long filament may thus split up to a number of so-called H-pieces. The gametes are all alike and of the same appearance as the zoospores, yet they conjugate anisogamously, one coming to rest and rounding up before another swarms up to it and fuses with it.

[The very special structure of the cell-wall common to these two genera unites them closely together. The H-pieces of *Conferva* are made up of a number of apposed layers of pectic compounds, which can be distinguished by staining. The *Ophiocytium* cell is to be regarded as made up of a small homogeneous lid closing a long tube which has the structure of half such an H-piece.]

5. *Bumilleria*. Borzi, 1895.

Closely resembles *Conferva* in life-history and in appearance, but the H-pieces do not apparently possess the same special structure and do not divide the cells sharply into halves. More than two zoospores may arise in one cell. Nature of gametes uncertain.

(To be concluded.)

This document is a scanned copy of a printed document. No warranty is given about the accuracy of the copy. Users should refer to the original published version of the material.