The genus *Gloeocystis* (*Chlorococcales, Chlorophyceae*)

Rod *Gloeocystis* (*Chlorococcales, Chlorophyceae*)

František Hindák


The reasons are set forth why, in accordance with the International Code of Botanical Nomenclature, the genus *Palmogloea* Kütz. 1843 is to be rejected and the genus *Gloeocystis* Nägeli 1849 is to be maintained as the representative of those chlorococcal algae that reproduce only by autospores, have a pyrenoid and a concentrically layered colonial mucilage. The species of the genus *Gloeocystis* known to date often form green to dark greenish macroscopic mucilaginous coverings on subaerial to facultatively aerial habitats. In addition to the type species *G. vesiculosa* Näg., the genus *Gloeocystis* also includes *G. polydermatica* (Kütz.) Hind. The species *Gloeocystis* *planctonica* (W. et G. S. West) Lemm. 1915 was transferred to the genus *Ooenochloris* Kons. The species *Gloeocystis* *planctonica* sensu Škuja 1948 probably belongs to the genus *Sphaerocystis* Chod. (*Chlorococcales*) since occasional formation of zoospores has been reported.

Institute of Experimental Biology and Ecology, Slovak Academy of Sciences, Dúbravská cesta 26, 885 34 Bratislava 1, Czechoslovakia.

On subaerial to facultatively aerial habitats, especially on wet wood and rocks, macroscopic green to dark greenish mucilaginous coverings of algae are often formed. The representatives with the highest frequency in these coverings include "green coccoid cells" enveloped with concentrically layered mucilage. The genus *Gloeocystis* Näg., which will be dealt with in more detail in this paper, also is common in these mucilaginous areas.

The taxonomic review of the genus *Gloeocystis* resulted from an inquiry into an alga which had been studied in detail by Fott (1956, 1959, 1967, 1971) and by Fott et NovákOVÁ (1971) on material from northern Bohemia ("Bohemian-Saxonian Switzerland"). In the quoted textbooks of phycology, Fott specified this alga as *Gloeocystis vesiculosa* Näg., but in the paper Fott et NovákOVÁ (1971) they came to the conclusion that the correct name was *Palmogloea* *protuberans* (Smith et Sowerby) Kütz.

The taxonomic problems of palmelloid green algae were analyzed by Fott et NovákOVÁ (1971). In the taxonomy of these algae it is necessary to be conversant with the type of cell reproduction and with the so called vegetative, i.e. morphological status of cells prevailing in the life cycle of the alga. The original descriptions by authors mainly of the last century are often incomplete, unclear or incorrectly interpreted in subsequent literature, especially with regard to the two features mentioned.

The genus *Gloeocystis* is an example of such a misinterpretation. This is partly due to the original diagnosis which reads: "Zellen kugelig, mit dicken blasenförmigen Hüllmembranen, einzeln in kleine kugelige freiliegende Fami-
liefereinigt, die vor einer Blase umschlossen und im Innern in der Regel
aus wiederholt in einander geschachtelten Blasen gebildet sind; Theilung ab-
wechselnd in allen Richtungen des Raumes; alle Generationen entwickelt"
(NÄGELI 1849: 65). This diagnosis of the genus *Gloeocystis* NÄG. is incomplete.
If it is supplemented by features of the type species *G. vesiculosa*, which are
obvious from the figures provided (Tab. IV, Fig. F), one gets detailed charac-
teristics of the genus. This is true also in terms of contemporary criteria for
the taxonomy of green algae. The amended diagnosis of the genus would
read somewhat like this: Cells singular or by 2, 4 or 8, rarely by more in one
colony; bound by a broad, colourless, concentrically layered mucilage; cell
shape spherical, spherical-oval to ovate, after division semi-spherical;
chromatophore one, parietal with a pyrenoid; reproduction by 2–4–8–(16?)
autosporas, zoospores not observed. NÄGELI does not mention other features,
neither can they be deduced from his figures.

The present author believes such a diagnosis to be sufficient to maintain
the genus *Gloeocystis* NÄG. The way the genus has been conceived by later
authors may not be decisive and these misconceptions cannot invalidate
the genus *Gloeocystis*, as proposed by FOTT and NOVÁKOVÁ. The two latter
authors, however, were right in emphasizing that, according to its type, the
genus does not belong to the *Tetrasporales* to which it has been often referred
(e. g. LEMMERMANN 1915, FRITSCHE 1935, SKUJA 1948, G. M. SMITH 1950 etc.),
but to the *Chlorococcales*, where, however, in their view, the genus *Palmogloea*
KÜTZ. has priority. The species of the genus *Gloeocystis*, with cells resembling
those of the genus *Chlamydomonas*, though without flagella in the vegetative
stage, were transferred by FOTT (1972a) into the new genus *Chlamydocapsa*
FOTT (*Tetrasporales*).

Whereas the genus *Gloeocystis*, in the present author’s opinion, is a well
described one, this is not the case with the genus *Palmogloea* KÜTZING 1843.
In presenting their arguments on the priority of the genus *Palmogloea*, it is
both DROUET et DAILY (1956: 137) and VAN DEN HOEK (1963: 285) whom
FOTT and NOVÁKOVÁ cite. In a Latin diagnosis of the genus *Palmella*, the for-
mer two authors mention the absence of a pyrenoid in the cells and
(with a question mark) the reproduction by zoospores which, however, is in contrast with NÄGELI’s diagnosis of the genus *Gloeocystis*. In com-
menting on the investigated type material *Ulva protuberans* SMITH et SOW-
ERBY 1814 = *Palmogloea protuberans* (SMITH et SOWERBY) KÜTZING 1843,
VAN DEN HOEK reports: “This material appeared to be heterogeneous and
to contain (at least) two different *Coccomyxa*-like species”. One of these
species has a pyrenoid and resembles the type *Gloeocapsa polydermatica*
KÜTZ. 1846, the other is without a pyrenoid and quite similar to the type of
*Gloeocapsa confluens* KÜTZ. 1846.

In terms of Art. 9 of the Code, it certainly would be possible to select one
component of the exsiccate as a type, if it would be obvious according to the
original diagnosis. Since such a significant feature as the pyrenoid was not
mentioned by KÜTZING in the diagnosis (the illustration is missing), it cannot
be decided with certainty which of the two species is to be looked upon as
the type of the genus *Palmogloea*. According to Art. 70 of the Code, the name
may be rejected in such cases because of its being the source of confusion.
FOTT (1974) considers the absence of the pyrenoid in the cells and the con-
centrically layered mucilage to be characteristic features of the genus
Coccomyxa Schmidle 1901 with the type species C. confluenta (Kütz.) Fott (syn.: C. dispar Schmidle). Similarly, the genus Gloecystis with the type species G. vesiculosa is characterized by the concentrically layered mucilage, but the cells have pyrenoids.

The position of the genus Gloecystis within the system of Chlorococcales was refined by Fott (1956, 1959, 1967, 1971) and is obvious also from the paper of Fott et Nováková (1971). The need for the rejection of the genus Palmogloea implies that the name Palmogloeaceae Fott 1974 may not be applicable. For this family use can be made of the name Radiococcaceae Fott 1959 established previously. For the group of genera with stratified mucilage and reproduction by autospores, the present author proposes the subfamily Radiococcoideae.

Radiococcoideae Hindák, subfam. nova

Cellulae in coloniiis dispositae, tegumentum gelatinosum radialiter vel circulariter striatum. Typus subfamiliae: Radiococcus Schmidle 1902.

In his opinion, the subfamily includes five genera that may be distinguished according to the following features:

1a. Colonial mucilage concentrically layered
   2a. Cells spherical to oval or ovate
      3a. Cells with pyrenoid ........................................ Gloecystis Nägeli 1849
      3b. Cells without pyrenoid .................................... Coccomyxa Schmidle 1901
   2b. Cells lunate ly bent
      4a. Colonies singular ........................................ Nephrocystium Nägeli 1849
      4b. Colonies composed of individual independent colonies adjacent ly clustered .............. Gloecystopsis G. M. Smith 1916
1b. Colonial mucilage radially layered .................................... Radiococcus Schmidle 1902

The genus Phacomyxa Skuja 1956 with the species Ph. sphagnicola Skuja (Skuja 1956, Fott et Nováková 1965, Fott 1974) does not belong to the subfamily Radiococcoideae because the cells do not reproduce by autospores but by vegetative division in two portions (Hindák et al. 1965, 1975). The genera Gloeobotrys Pasch., Chlorobotrys Bohl. and Dactylotheca Lagerh. also are similar by exhibiting concentrically layered mucilage. The first two genera belong to the Xanthophyceae. They differ in that the genus Gloeobotrys reproduces by zoospores while the genus Chlorobotrys reproduces by autospores. Whereas the inclusion of the genus Gloeobotrys into Xanthophyceae is justified by the presence of heteroconic zoospores, it is questionable in the case of the genus Chlorobotrys (the presence of chlorophyll b has not been reported). The position of the genus Dactylotheca within the system of green algae is uncertain since the mode of cell reproduction is unknown. The genus should be retained only if evidence is available that the cells divide into two parts vegetatively as is the case e. g. in the genus Stichococcus. Should the cells reproduce by autospores, the species of the genus Dactylotheca would have to be transferred into the genus Gloecystis.

From the available data it is difficult to determine how many species belong to the genus Gloecystis. In addition to the type species G. vesiculosa, several species were described within this genus or assigned to it. Lemmermann (1915), in contrast to Nägeli, conceived this genus in a very broad sense and referred six species to it. The characteristics of the species G. vesiculosa were not in agreement with the original diagnosis of the genus. In
three species Lemmermann indicated reproduction by autospores [G. planctonica (W. et G. S. West) Lemm., G. botryoides (Kütz.) Näg., G. rupestris (Lyngb.) Rabenh.], in three subsequent species by zoospores (G. vesiculosa Näg., G. ampla Kütz., G. major Gerneck). As already mentioned, Fott 1972 (cf. also Fott 1974) transferred the species with chlamydomonadic cells to the genus Chlamydocapsa Fott [Ch. ampla (Kütz.) Fott, Ch. bacillus (Telling) Fott, G. planctonica (W. et G. S. West) Fott]. Chlamydocapsa planctonica, however, does not belong to the genus Chlamydocapsa, which is referred to the order Tetrasporales, because this combination was not based on type material but on samples from Swedish lakes studied by Skuja (1948). The observations of Skuja differ from the original data supplied by W. et G. S. West (1906) who laid emphasis, among others, on the tetrahedral mucilaginous envelop, on the structure of colonies and on cell reproduction only by autospores. The species Schizochlamys planctonica Skuja 1956, however, may be looked upon as being identical with the species Gloeocystis planctonica (W. et G. S. West) Lemm. In the present author’s opinion, G. planctonica sensu Skuja 1948 belongs neither to the genus Chlamydocapsa, nor to the order Tetrasporales, since its vegetative cells lack contractile vacuoles and an eye-spot, which are characteristic structures of these green algae. This alga reproduces by autospores and occasionally by zoospores which, as a matter of fact, is typical of several genera of the order Chlorococcales. Of the genera of the order Chlorococcales, the most closely related to this alga is the genus Sphaerocystis Chodat 1897. Like Skuja, Chodat reports relatively large spherical, ovate or oval biflagellate zoospores for S. Schroeteri.

The species Gloeocystis planctonica (W. et G. S. West) Lemmermann 1915 [bas.: Gloeocystis gigas (Kütz.) Lagerh. 1883 var. planctonica W. et G. S. West Trans. Roy. Irish Acad. 33 B, p. 71, 1906; syn. Radiococcus planctonicus Lund 1956, Schizochlamys planctonica Skuja 1956, Radiococcus planctonicus Lund sensu Fott 1974] is distinguished by the formation of four tetrahedrally arranged autospores on the release of which the mother cell wall cracks into four approximately equal parts. The colonial mucilage also is tetrahedral. Since this mode of autospore release and the relatively distinct remnants of the cell wall in the colonial mucilage are characteristic of the genus Coenochloris Korsíkov 1953, the author proposes a new combination: Coenochloris planctonica (W. et G. S. West) Hindák, comb. nova. By the above features this species differs from the other species of the genus Coenochloris (cf. Hindák 1977).

In addition to the type species, only one other species with similar ecology as G. vesiculosa should be included in the genus Gloeocystis. The investigation of the type material of the species Gloeocapsa polydermatica Kützing 1846 by Van den Hoek (1963), the description of the type (p. 287) and detailed figures (Tab. 8, Fig. 52—57) make it clear that this species belongs to the genus Gloeocystis. In both the dimensions and oval shape of its cells it differs from G. vesiculosa. Nägeli’s illustration of the colonies of the type species shows spherical cells (Fig. F: a-r) but in the individual cells (drawn under double magnification as colonies), the shape varies from widely oval to broadly ovate and even to slightly asymmetrical (Fig. F: s). The shape of the concentrically layered mucilage may also serve as a distinguishing feature of these two species. In G. vesiculosa the present author observed a regular
mucilage, colonies closely adjacent and forming almost polyhedral mucilaginous configurations without a conspicuous, common mucous sheath. Contrary to this type *Gloeocystis polydermatica* Kütz., that may be identified with the material of Fott, Fott and Nováková and with our investigated material from the High Tatras (Fig. 1), the mucilage appeared spherical only
when the cell was viewed from above. The mucilage deposition was oval to irregularly oval, and the individual mucilaginous colonies often did not touch but were detached in a common amorphous mucilage of the sheath. The features of these species may be summarized in the following key:

la. Cells from spherically, broadly oval or broadly ovate to slightly asymmetrical, 6–8 µm; mucilage of individual colonies ± spherical to polyhedral; common mucilaginous envelop of sheath lacking .................................. G. vesiculosa Nägeli

lb. Cells oblong, oval to irregularly ovate, (3.5–)5–11.2 x (2.5–)3.7–6.2(–8) µm; mucilage of individual colonies oval to irregularly oval; colonies often not contiguous but lying detached in the amorphous mucilage of the sheath........ G. polydermatica (Kütz.) Hindák

Gloeocystis Nägeli Gattungen einzelliger Algen, p. 65, 1849


Cells singular or by 2, 4, 8, rarely by more in one colony, enveloped with wide colourless concentrically layered mucilage; colonies often forming macroscopical green to dark greenish mucilaginous sheaths. Cells spherical to widely oval or oblong-oval, slightly asymmetrical. Cell wall smooth. Chloroplast parietal, with a pyrenoid. Reproduction by 2–4–8(–16?) autospores; the mother cell wall gelatinizes upon autospore release and its remnants may not be seen in the colonial mucilage.

Type species: G. vesiculosa Nägeli 1849.

Gloeocystis vesiculosa Nägeli Gattungen einzelliger Algen, p. 66, Tab. IV: F, 1849 Fig. 2 : 1

Non: Gloeocystis vesiculosa Näg. sensu auct. post.

The concentrically layered colonial mucilage ± spherical to polyhedral; individual colonies up to 50 µm in diameter, ± closely adjacent. Cells spherical, widely oval to widely ovate, asymmetrical, 6–8 µm in size. Chromatophore cup-shaped, with one pyrenoid.

Occurrence: On wet wooden beams and corks, forming macroscopical mucilaginous green sheaths, Züri. Not observed since it was described; Kol (1957, Tab. 2, Fig. 28) draws similar colonies with spherical cells without pyrenoid and with spherical mucilage, naming them Gloeocystis botryoides.

Gloeocystis polydermatica (Kützing) Hindák, comb. nova Fig. 1; 2 : 2–3


The concentrically layered colonial mucilage oval to irregularly oval; individual colonies 9–30 x 7–25 µm (even more) often not touching but detached in the amorphous mucilage of the sheath; cells oblong to irregularly ovate, (3.5–)5–11.2 x (2.5–)3.7–6.2(–8) µm. Chromatophore cup-shaped to widely stripe-shaped, with one pyrenoid.

Occurrence: Subaerial to facultatively aerial, on moist acid rocks and on sandstone or on moist wood, mosses, soil etc. The investigated material was collected on wet granite cliffs over the Morskie Oko Lake, High Tatra, Poland, where it formed macroscopic mucilaginous green
Fig. 2. — 1, Gloeocystis vesiculosa Näg. (iconotype, from Nägeli 1849). 2—3, *G. polydermatica* (Kütz.) Hind. [2, from Van den Hoek 1963, as the type of *Gloeocapsa polydermatica* Kütz.; 3, from Fott et Novákova 1971, as *Palmogloea protuberans* (Smith et Sow.) Kütz.; scale: 10 µm].
coverings. Frequent in the High Tatras; for other localities in Czechoslovakia and elsewhere, see Fott et Novákova (1971 : 329).

The cells in our material were about 3.5–8 × 2.5–4.5 µm, thus a bit smaller than ascertained by Van den Hoek in the type (5–11.2 × 3.7–6.2 µm) and by Fott et Novákova (6–10 × 6–8 µm). No other morphological differences were observed.

SÜHRN


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Andrej Kmeť

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Ing. Jan Nevole

* 10. 3. 1878 † 12. 1. 1951