Preslia, Praha, 50 : 3—11, 1978

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

Rod *Gloeocystis* (*Chlorococcales, Chlorophyceae*)

František Hindák

Hindák F. (1978): The genus *Gloeocystis* (*Chlorococcales, Chlorophyceae*). — Preslia, Praha, 50 : 3—11.

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 *Coenochloris* Korš. as *C. planctonica* (W. et G. S. West) Hind. The species *G. planctonica* sensu Skuja 1948 probably belongs to the genus *Sphaerocystis* Chod. (*Chlorococcales*) since occasional formation of zoospores has been reported.

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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 higest 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-

lien vereinigt, die vor einer Blase umschlossen und im Innern in der Regel aus wiederholt in einander geschachtelten Blasen gebildet sind; Theilung abwechselnd 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 characteristics 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?) autospores, 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, FRITSCH 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 former 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 commenting on the investigated type material *Ulva protuberans* SMITH et SOWERBY 1814 = *Palmogloea protuberans* (SMITH st 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 concentrically layered mucilage to be characteristic features of the genus

Coccomyxa SCHMIDLE 1901 with the type species *C. confluens* (KÜTZ.) FOTT (syn.: *C. dispar* SCHMIDLE). Similarly, the genus *Gloeocystis* with the type species *G. vesiculosa* is characterized by the concentrically layered mucilage, but the cells have pyrenoids.

The position of the genus *Gloeocystis* 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 coloniis 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 ..... *Gloeocystis* NÄGELI 1849
    3b. Cells without pyrenoid ..... *Coccomyxa* SCHMIDLE 1901
  2b. Cells lunately bent
    4a. Colonies singular ..... *Nephrocytium* NÄGELI 1849
    4b. Colonies composed of individual independent colonies adjacently clustered ..... *Gloeocystopsis* 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 *Dactylothece* 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 heterocontic 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 *Dactylothece* 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 *Dactylothece* would have to be transferred into the genus *Gloeocystis*.

From the available data it is difficult to determine how many species belong to the genus *Gloeocystis*. 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* (TEILING) 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 colonical 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* KORŠIKOV 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

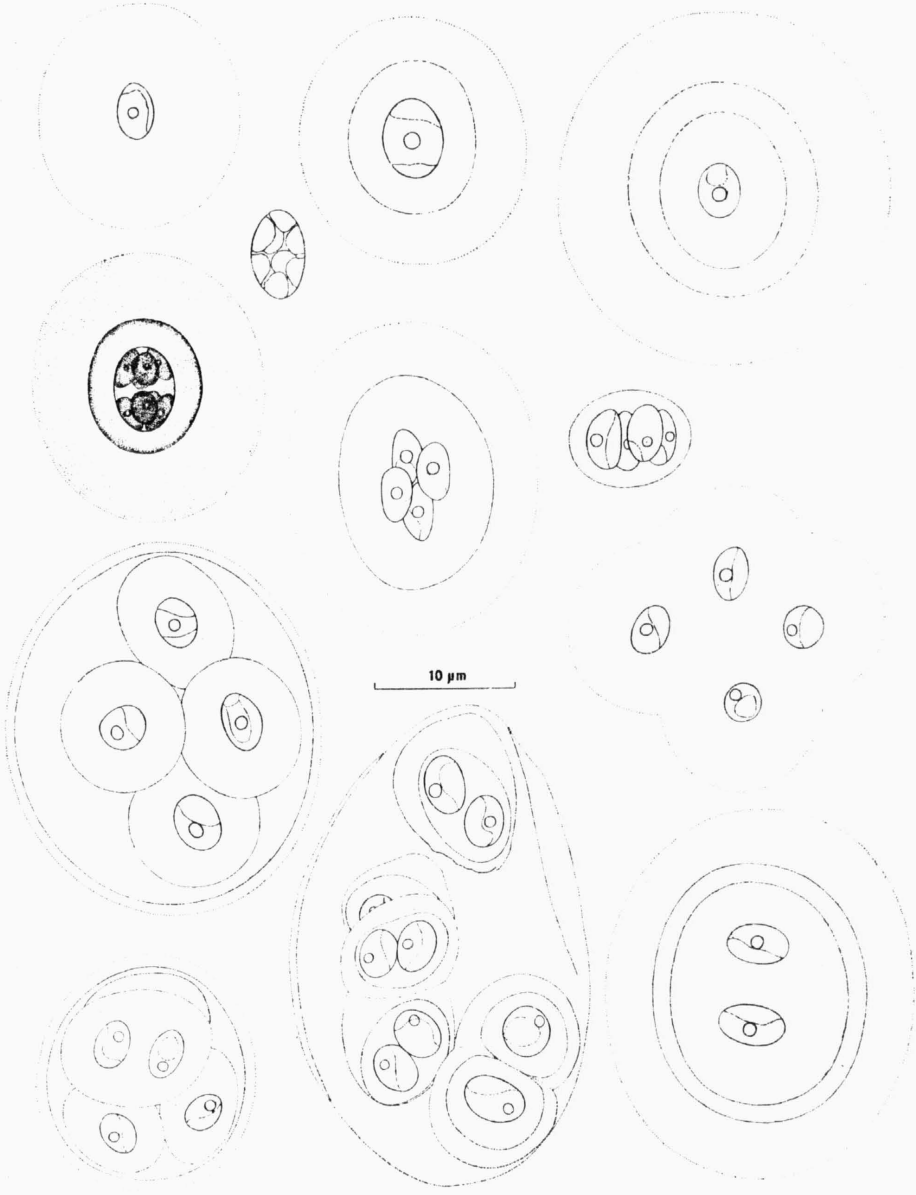

Fig. 1. — *Gloeocystis polydermatica* (KÜTZ.) HIND. Specimens from moist granitic cliffs above the Morskie Oko Lake, High Tatra, Poland. — Orig.

mucilage, colonies closely adjacent and forming almost polyhedral mucilaginous configurations without a conspicuous, common mucous sheat. 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:

1a. Cells from spherical, 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

1b. Cells oblong, oval to irregularly ovate, (3.5—)5—11.2×(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

Syn.: *Palmogloea* KÜTZING 1843 p. p. — *Palmogloea* KÜTZING 1843 sensu FOTT et NOVÁKOVÁ 1971. — Non: *Palmogloea* KÜTZING 1843 sensu DROUET et DAILY 1956.

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 macroscopic mucilaginous green sheaths, Zürich. 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

Bas.: *Gloeocapsa polydermatica* KÜTZING 1846 (1845—1849), p. 15, Tab. 20, Fig. III. — Syn.: *Gloeocystis vesiculosa* NÄG. sensu FOTT (1956, 1959, 1967, 1971). — *Palmogloea protuberans* (SMITH et SOWBERY) KÜTZING sensu FOTT et NOVÁKOVÁ 1971. — Non: *Gloeocapsa polydermatica* KÜTZING sensu WEST et FRITSCH 1927, GEITLER 1925, GOLLERBACH et al. 1953, STARMACH 1966 (as a synonym of *Gloeocapsa montana* KÜTZ.). — *Palmogloea protuberans* (SMITH et SOWERBY) KÜTZING sensu DROUET et DAILY 1956.

The concentrically layered colonial mucilage oval to irregularly oval; individual colonies 9—30×7—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×(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 Tatras, Poland, where it formed macroscopic mucilaginous green

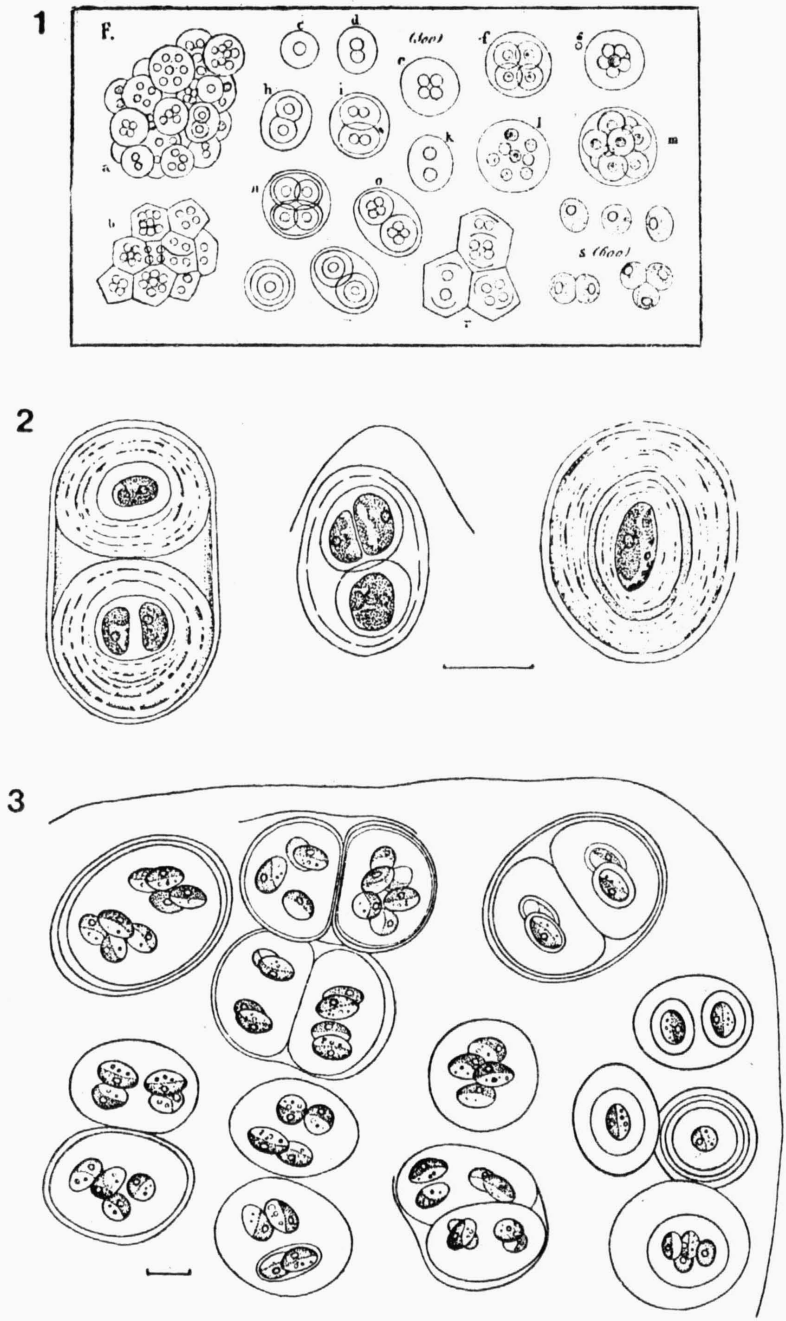

Fig. 2. — 1, *Gloeocystis vesiculosa* Näg. (iconotype, from Nägeli 1849). 2—3, *G. polydermatica* (Kütz.) Hind. [2, from Van den Hoek 1963, as the type of *Gloeocapsa polydermatica* Kütz.; 3, from Fott et Nováková 1971, as *Palmogloea protuberans* (Smith et Sow.) Kütz.; scale: 10 μm].

coverings. Frequent in the High Tatras; for other localities in Czechoslovakia and elsewhere, see FOTT et NOVÁKOVÁ (1971 : 329).

The cells in our material were about $3.5-8 \times 2.5-4.5$ μm, thus a bit smaller than ascertained by VAN DEN HOEK in the type ($5-11.2 \times 3.7-6.2$ μm) and by FOTT et NOVÁKOVÁ ($6-10 \times 6-8$ μm). No other morphological differences were observed.

SÚHRN

Poukazuje sa na príčiny, prečo podľa nomenklatorických pravidiel treba rod *Palmogloea* KÜTZ. 1843 zamietnuť a pridržovať sa rodu *Gloeocysis* NÄG. 1849 ako reprezentanta tých chlorokokálnych rias, ktoré sa rozmnožujú iba autospórami, majú pyrenoid a koncentricky vrstvovitý sliz kolónií. Doteraz známe druhy rodu *Gloeocystis* často tvoria zelené až tmavozelené makroskopické slizové nárasty na subaerických až fakultatívne aerických stanovištiach. Do rodu *Gloeocystis* patrí okrem typového druhu *G. vesiculosa* NÄG. ešte druh *G. polydermatica* (KÜTZ.) HIND. Druh *Gloeocystis planctonica* (W. et G. S. WEST) LEMM. 1915 bol preradený do rodu *Coenochloris* KORŠ. 1953 ako *C. planctonica* (W. et G. S. WEST) HIND. a *G. planctonica* sensu SKUJA 1948 bude asi patriť do rodu *Sphaerocystis* CHOD., vyznačujúci sa príležitostnou tvorbou zoospór.

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Received February 8, 1977

Výročí 1978

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* 19. 11. 1841 † 16. 2. 1908

Pokrokový kněz a buditel na Slovensku, význačný florista. Vystudoval teologii v Ostřihomi, od r. 1865 působil jako kaplan v Senoradzi, od r. 1868 jako farář v Konišově a od r. 1878 v Prenčově. Již jako student gymnasia v Banské Štiavnici se zajímal o botaniku a zakládal vlastní herbář. Zájmy Kmeťovy byly vždy velmi široké — od národohospodářství přes archeologii, geologii až k botanice. Patřil mezi přední šiřitele osvěty v širokých vrstvách lidu, byl horlivým propagátorem pokrokových metod v zemědělství i ovocnářství, zajímal se podrobně o lidovou tvorbu. Značnou část svého pracovního úsilí však věnoval botanice. Hlavní oblastí jeho floristických výzkumů byl kraj v okolí Sitna. Tam se soustřeďuje jednak na houby, lišejníky a mechy, z vyšších rostlin podrobně studuje růže. V mykologii úzce spolupracuje s bratislavským J. A. Bäumlerem. Zvláštní pozornost věnuje např. houbám důlních šachet. Z botanických prací jsou známy jeho popisy nových druhů růží, floristické zpracování Sitna (1893 a 1901), kritická revize Csereyho práce o flóře okolí Banské Štiavnice aj. Z bohatých sběrů růží, které Kmeť nashromáždil, publikoval část prof. V. Borbás. Jméno Kmeťovo dostalo několik druhů hub i růží. Svůj vzorný herbář, čítající více než 15 000 položek, daroval společně se sbírkou hub a s ostatními svými sbírkami Slovenskému národnímu muzeu v Martině, o jehož rozvoj měl prvořadé zásluhy. V devadesátých letech minulého století, kdy bylo zvláště třeba podpořit vědecký život na Slovensku, podařilo se mu po mnoha neúspěších založit Muzeální slovenskou společnosť, v níž se stal prvním předsedou.

Ing. Jan Nevole

* 10. 3. 1878 † 12. 1. 1951

Středoškolský profesor, geobotanik. Studoval na technice a univerzité ve Vídni a v Praze, mezi jeho učiteli botaniky byli R. Wettstein a J. Velenovský. Hlavní jeho zájem se soustřeďoval k systematické botanice a fytogeografii. Učil nejprve na střední škole v Knittenfeldu ve Štýrsku, později v Brně-Králově Poli. Jako jeden z prvních začal s geobotanickým mapováním v Alpách; spolupracoval s vídeňským botanikem A. Hayekem na díle Flora styriaca. Řadu prací věnoval flóře a vegetaci Alp a jejich východnímu okraji, např. „Verbreitungsgrenzen einiger Pflanzen in den Ostalpen" (1908, 1910), „Studien über die Verbreitung von sechs südeuropäischen Pflanzenarten" (1909), „Die Wald- und Steppenflora am Ostrande des Wiener Beckens" (1934, 1939) apod. Z našeho území uveřejnil např. „Studii o lučních porostech Bílých Karpat" (1948) a obsáhlejší práci o rostlinných společenstvech v okolí Smolenice a Jablonice v Malých Karpatech (1931). Ze systematických prací je známa např. studie o rodu *Heracleum*.