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Typification of the Glaucocystophyta

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## TYPIIFICATION OF THE GLAUCOCYSTOPHYTA

Ludwig Kies<sup>1</sup> and Bruno P. Kremer<sup>2</sup>

The taxonomic status of the Glaucocystophyta Kies et Kremer, nomen novum (synonym: Glaucophyta Skuja 1954, nomen descriptivum) and their subdivisional units are examined and defined at the light of new biochemical and ultrastructural characters. On this background, the taxon Glaucocystophyta and the taxa between the divisional and the generic levels are typified. Two new orders (Cyanophorales, Gloeochaetales) as well as one new family (Cyanophoraceae) are established.

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The Glaucocystophyta (synonym: Glaucophyta) are a distinctive group of colourless, unicellular eukaryotic algae with endosymbiotic (endocytobiotic) blue-green photosynthesizing prokaryotes termed cyanelles which function as chloroplasts. During the last decade particular interest was directed towards the diverse members of the Glaucocystophyta with special regard to physiology, biochemistry and ultrastructure (Trench, 1982; Kies, 1984a, b). Due to their unique features of cytology and cellular organization the glaucophytes occupy a somewhat isolated position within the algal subkingdom, but nevertheless are of general importance in theoretical biology because of their various implications with the serial endosymbiosis hypothesis of cell evolution.

In the course of the preparation of a more comprehensive review of the Glaucocystophyta (Kies and Kremer, 1986) it appeared necessary to redefine the glaucophytes on the background of a substantial amount of new data from biochemical and ultrastructural research. Moreover, it proved that the subdivisional taxonomy of these enigmatic organisms had hitherto been treated rather incompletely and unsatisfactorily. We therefore propose the following classification which, in contrast to Skuja (1954), takes into consideration some additional details: (1) The diagnosis of the division Glaucocystophyta and its only class Glaucocystophyceae are emended to include basic ultrastructural and biochemical characters; (2) the monadoid members (endocyanomes) which fully comply with the emended divisional diagnosis are included in the Glaucocystophyta; (3) separate orders are established for monadoid, capsalean, and coccoid genera of the Glaucocystophyta. As a consequence, all names above the generic level must be typified. In addition, a variety of further taxa are provisionally affiliated with the Glaucocystophyta on account of hitherto incomplete descriptions and/or widely lacking ultrastructural and biochemical evidence as genera et species inquirendae. The following compilation of glaucocystophycean taxa is not designed to represent a taxonomic revision of the division. This must be reserved to a later treatment.

Division **Glaucocystophyta** Kies et Kremer, *nomen novum*.

(Glaucophyta Skuja 1954, p. 56.)

Class Glaucocystophyceae Schaffner 1922, p. 131, *emend. nov.*

1. **Glaucocystales** Bessey 1907, p. 6.

Glaucocystaceae G. S. West 1904, p. 317.

(Glaucocystaceae Bohlin 1901, Table p. 25, *nomen nudum*.)

*Glaucocystis* Itzigsohn in Rabenhorst 1868, p. 417.

*G. bullosa* (Kütz.) Wille 1919, p. 38.

(*Palmella bullosa* Kütz. 1836, Alg. Decas XVI, Nr. 154.)

Note: According to Wille (1919) this species is identical with *Glaucocystis nostochinearum* var. *minor* Hansgirg 1892, p. 140.

*G. cingulata* Bohlin 1897, p. 13 (doubtful species).

*G. duplex* Prescott 1944, p. 371.

*G. geitleri* Pringsheim *nomen provis.* in Koch 1964, p. 414 (probably = *Glaucocystis nostochinearum*).

*G. nostochinearum* Itzigsohn in Rabenhorst 1868, p. 417.

*G. oocystiformis* Prescott 1944, p. 372.

(*G. caucasica* Tarnogradskij 1957.)

*G. simplex* Tarnogradskij 1959 (doubtful species).

Note: The following infraspecific taxa need revision:

*G. nostochinearum* var. *gigas* Gutwiński 1909, p. 543.

*G. nostochinearum* f. *immanis* Schmidle 1902, p. 79.

*G. nostochinearum* var. *incrassata* Lemmermann 1908, p. 178.

*G. nostochinearum* var. *minor* Hansgirg 1892, p. 140.

*G. nostochinearum* var. *moebii* Gutwiński 1901, p. 19.

Note: Coccoid endocyanomes of uncertain affiliation with the Glaucocystales (genera et species inquirendae) are:

*Archaeopsis* Skuja 1954, *nomen nudum, invalid.*

*A. monococca* (Kütz.) Skuja 1954, *nomen invalid.* (Art. 43.1).

(*Palmogloea monococca* (Kütz.) Kütz. 1849, p. 229.)

(*Gloeocapsa monococca* Kütz. 1843, p. 175.)

*Glaucocystopsis* Bourrelly 1960, p. 416.

*G. africana* Bourrelly 1960, p. 416.

2. **Cyanophorales** Kies and Kremer, *ordo novum*.

Cyanophoraceae Kies and Kremer, *familia nova*.

*Cyanophora* Korshikov 1924, p. 57.

*C. paradoxa* Korshikov 1924, p. 71.

*C. tetracyanea* Korshikov 1941, p. 26.

Note: Monadoid endocyanomes of uncertain affiliation with the Cyanophorales (genera et species inquirendae) are:

*Peliaina* Pascher 1929, p. 458.

*P. cyanea* Pascher 1929, p. 459.

Note: *Peliaina* was considered to be a cryptomonad by Bourrelly (1970).

*Strobilomonas* Schiller 1954, p. 119.

*S. cyaneus* Schiller 1954, p. 120.

Note: According to Schiller (1954) *Strobilomonas* is either a cryptomonad or a chloromonad. The author, however, made no mention of the reserve material or of the ejectosomes typical of cryptomonads.

3. **Gloeochaetales** Kies and Kremer, *ordo novum*.

Gloeochaetaceae Skuja 1954, p. 56.

(Gloeochaetaceae Bohlin 1901, Table p. 25, *nomen nudum*.)

*Gloeochaete* Lagerheim 1883, p. 39.

*G. wittrockiana* Lagerheim 1883, p. 39.

(*G. bicornis* Kirchner 1888, p. 165.)

(*Schrammia barbata* Dangeard 1889, p. 158.)

Glaucosphaeraceae Skuja 1954, p. 56.

*Glaucosphaera* Korshikov 1930, p. 222.

*G. vacuolata* Korshikov 1930, p. 222.

Note: McCracken et al. (1980) held that *Glaucosphaera vacuolata* is a red alga belonging to the Porphyridiales and contains only one deeply lobed chloroplast without a pyrenoid. Korshikov (1930), however, described several lens-shaped blue-green chloroplasts. *Glaucosphaera vacuolata* lacks the typical heterosides of red algae (Kremer et al., 1979).

*Cyanoptyche* Pascher 1929, p. 459.

*C. gloeocystis* Pascher 1929, p. 460.

*C. gloeocystis* f. *minor* Starmach 1939, p. 140.

*C. gloeocystis* f. *dispersa* (Geitler) Starmach 1966, p. 7.

(*C. dispersa* Geitler 1959, p. 469).

Notes: A detailed ultrastructural study of *Cyanoptyche gloeocystis* f. *dispersa* will be published elsewhere (Kies, in prep.).

A capsalean endocyanome of uncertain affiliation with the Glaucosphaeraceae (genus at species inquirendae) is:

*Chalarodora* Pascher 1929, p. 460.

*C. azurea* Pascher 1929, p. 460.

*Diagnoses and typification:*

Division **Glaucocystophyta** Kies et Kremer, *nomen novum*.

(Glaucophyta Skuja 1954, p. 56.)

(Glaucophyta Skuja 1948, *nomen nudum*.)

T.: *Glaucocystis* Itzigsohn in Rabenhorst 1868, p. 417.

Algae eukaryotes sine chloroplastis, sed armatae compluribus corporibus inclusis coloris glauci formaliter similibus cellulis prokaryotis endosymbioticis et cyanellae designatis. Pigmenta photosynthetica cyanellarum chlorophyllo a cum diversis phycobilinis et carotenoidibus sine echinenone et myxoxanthophyllo. Cyanellae globosae aut leviter curvatae et residuo parietis peptidoglucanosi inclusae. Cellulae plerumque solitariae aut coloniis, monadoides, capsales aut coccoides. Cellulae nudaee aut pariete inclusae. Pellicula composita strato unico vesicularum applanatarum associato microtubulis. Cellulae motiles flagellis binis e fovea antica ortis. Flagella mastigonemibus non-tubularibus bilateraliter dispositis instructa. Radix flagelli forma cruciata quattuor aut duo partibus multum stratificatis (MLS) compositus. Corpusculum Golgianum saepe parabasale. Mitochondria cristis applanatis instructa. Granula polyglucanosa cytoplasma cellulae eukaryoticae nullis membranis contentis deposita extra cyanellas. Nullae centriolae et nullum phycoplastum cellula dividente. Propagatio sexualis innota. Propagatio vegetativa per bipartitionem aut per divisionem in zoosporas vel autosporas effecta.

Eukaryotic algae without own chloroplasts, but containing several inclusion bodies of blue-green colour, in form resembling endosymbiotic prokaryotes called cyanelles. Photosynthetic pigments of cyanelles comprising chlorophyll a along with diverse phycobiliproteins and carotenoids, but lacking echinenone and myxoxanthophyll. Cyanelles globose or slightly curvate, surrounded by remnants of a peptidoglycan cell wall. Organisms unicellular or colonial, monadoid, capsalean or coccoid. Cells either naked or with a cell wall. Pellicula composed of one layer of flat vesicles associated with microtubules. Motile cells with two heterodynamic flagella originating in an apical groove. Both flagella with non-tubular mastigonemata. Flagellar root system cruciate with four or two multilayered structures (MLS). Dicytosomes mostly parabasal. Mitochondria with flattened cristae. Starch granules lying freely in the cytoplasm of the host cell. Centrioles and phycoplast absent. Sexual reproduction unknown. Asexual reproduction by binary fission or formation of zoospores or autospores.

Class Glaucocystophyceae Schaffner 1922, p. 131, *emend. nov.*

T.: *Glaucocystis* Itzigsohn in Rabenhorst 1868, p. 417.

Diagnosis of the class identical with that of the division.

1. Glaucocystales Bessey 1907, p. 6, *emend. nov.*

T.: *Glaucocystis* Itzigsohn in Rabenhorst 1868, p. 417.

Glaucocystophyta coccoides solitariae aut coloniis (contentis intra parietem cellulae maternas). Cellulae vegetativae crassa pariete cellulosa inclusae. Cyanellae complures, maximam parte collocatae forma asteroidea. Propagatio per divisionem in autosporas (vel zoosporas?) effecta.

Unicellular or colonial coccoid Glaucocystophyta (retained in their common mother cell wall). Vegetative cells thick-walled. Cyanelles typically arranged in a star-like pattern. Asexual reproduction by autospores (or zoospores?).

2. **Cyanophorales** Kies et Kremer, *ordo novum*.

T.: *Cyanophora* Korshikov 1924, p. 57.

Glaucocystophyta unicellulares monadoides cellulis cylindricis et dorsiventraliter applanatis. Cellulae nudaе. Flagella aequalia bina e fovea antica orta et heterodynamica. Propagatio bipartitionem effecta.

Unicellular monadoid Glaucocystophyta, dorsiventrally constructed without a cell wall. Two heterodynamic, equal flagella arising in an apical groove. Asexual reproduction by binary fission.

Cyanophoraceae Kies et Kremer, *familia nova*.

T.: *Cyanophora* Korshikov 1924, p. 57.

Diagnosis of the family identical with that of the order.

3. **Gloeochaetales** Kies et Kremer, *ordo novum*.

T.: *Gloeochaete* Lagerheim 1883, p. 39.

Glaucocystophyta capsales unicellulares aut coloniis binis, quaternis aut octonis cellulis compositis et strato gelatinosi communis inclusis. Cellulae pariete inclusae. Propagatio per bipartitionem aut divisionem in zoosporas vel autosporas effecta.

Unicellular or colonial capsalean Glaucocystophyta. Walled cells surrounded by a common mucilaginous sheath. Asexual reproduction by bipartition, by zoospores or autospores.

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### AN EARLIER NAME FOR *PARMOTREMA PERLATUM* “(HUDS.) CHOISY” (ASCOMYCOTINA: PARMELIACEAE)

Mason E. Hale<sup>1</sup> and Teuvo Ahti<sup>2</sup>

*Parmotrema perlatus* “(Huds.) Choisy” (*Parmelia perlata* “(Huds.) Ach.”) is a common, easily recognized foliose lichen in temperate zones of both hemispheres. The name is based on *Lichen perlatus* Huds. (1762), which Hale (1961) lectotypified with Dillenius’ (1742, p. 147) phrase name “lichenoides glaucum perlatus, subtus nigrum et cirrosus” and the associated specimen in OXF illustrated in table 20, fig. 39B.

In perusing the older Scandinavian literature, however, the second author (aided by Dr. P. Isoviita) discovered a book published in Swedish (later also in German and English) by Pehr Osbeck (1757) which validated the name *Lichen chinensis*. While we have not examined the actual specimen from China which Osbeck collected, if indeed it is still extant, the name is to be typified by an element selected from the context of the validating description (Art. 32.2, ICBN). This is in fact the same Dillenian phrase name that Hudson used. We consider *Lichen perlatus* Huds. to be an illegitimate name (see Art. 63, ICBN) and to be automatically typified on the type of the name (*L. chinensis*) that ought to have been adopted. Consequently the correct name for this common, long-recognized lichen must be changed to *Parmotrema chinense*, with changes in author citations of synonyms, as follows:

***Parmotrema chinense*** (Osbeck) Hale and Ahti, comb. nov.

*Lichen chinensis* Osbeck, *Ostindisk resa*, 221, 1757.

Type: Specimen in the Dillenian herbarium (OXF) (illustrated in pl. 20, fig. 39B of Dillenius, *Hist. Musc.* 147, 1742).

*Lichen perlatus* Huds., *Fl. Angl.* 448. 1762, nom. illeg. (incl. type of *Lichen chinensis* Osbeck).

*Parmelia perlata* Ach., *Meth. Lich.* 216. 1803, nom. illeg. (incl. type of *L. chinensis* Osbeck). [Note:

Under Art. 49, parenthetic author citation is correct only if the epithet-bringing name is legitimate.

Under Art. 72, Note 1 and Ex. 2–3, parenthetic author citation is deleted if the epithet-bringing name is illegitimate.]

*Parmelia coniocarpa* Laurer, *Linnaea* 2: 39. 1827. Lectotype: *Sieber*, Australia (M) (Hale, 1961).

*Parmelia coriacea* var. *perlata* Eschw. in Martius, *Fl. Bras.* 1(1): 206. 1833. Type: Same as *Lichen chinensis* Osbeck. [Note: This trinomial is legitimate, *Lichen chinensis* having no priority at this rank.]

*Parmelia trichotera* Hue, *J. Bot. (Paris)* 12: 245. 1898. Lectotype (new): France, Vendée, Île de Noirmoutier, *Viaud-Grand-Maraïs* (PC); see Hale, 1961, fig. 4.

*Parmotrema perlatus* (Eschw.) Choisy, *Bull. Mens. Soc. Linn. Lyon* 21: 174. 1952.

*Parmotrema trichoterum* (Hue) Choisy, *Bull. Mens. Soc. Linn. Lyon* 21: 175. 1952.

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