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Taxonomic survey of the genera *Fusola* (*Chlorococcales*), *Elakatothrix, Closteriospira* and *Chadefaudiothrix* (*Ulotrichales*)

Taxonomický prehľad rodov *Fusola* (*Chlorococcales*), *Elakatothrix, Closteriospira* a *Chadefaudiothrix* (*Ulotrichales*)

František Hindák

HINDÁK F. (1987): Taxonomic survey of the genera *Fusola* (*Chlorococcales*), *Elakatothrix, Closteriospira* and *Chadefaudiothrix* (*Ulotrichales*). — Preslia, Praha, 59 : 193—228.

A survey is given of the taxonomy of four genera of green algae (*Chlorophyceae*) characterized by fusiform, fusiform-oval or rode-like cells embedded in mucilage; they reproduce by autospores (*Fusola* SNOW), or by crosswise division into two parts (*Elakatothrix* WILLE, *Closteriospira* REVERDIN and *Chadefaudiothrix* BOURRELLY, previously classified in *Xanthophyceae*). In green algae reproduction by autospores is considered a feature characteristic of the order *Chlorococcales*, crosswise cell division as a feature of the order *Ulotrichales*. The main diagnostic features of the above mentioned and related genera in the *Chlorococcales* and *Ulotrichales* are discussed. Determination keys to the species and a survey of infrageneric taxa with figures from literature and the author's original drawings are presented. Within the genus *Elakatothrix* two new combinations are suggested: *E. ovalis* (ETTL) HIND. and *E. gelifacta* (CHOD.) HIND., and within the genus *Chadefaudiothrix* one: *Ch. pseudogelatinosa* (KORŠ.) HIND.

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INTRODUCTION

We revert to the taxonomy of the genera *Fusola* SNOW and *Elakatothrix* WILLE and related genera in connection with the preparation of determination keys for domestic and international editions. Herewith we draw upon our preceding studies (HINDÁK 1962, 1966, 1977, 1978a, b) as well as upon determination keys and textbooks written in the national language (HINDÁK et al. 1965, 1975, 1978). In this contribution the main literary data and the author's unpublished observations of the genera mentioned above are presented.

The genus *Elakatothrix* and some other genera having morphologically similar cells and colonies, have not had an unambiguous position within the system of green algae and even today their position continues to be not entirely clear. These algae are characterized by their cells living solitarily (being solitary also in the colony or in pairs after division) as some other chlorococcal algae, but not reproducing by typical autospores, but by crosswise division into two parts whereby the mother cell wall also splits up together with the protoplast. This difference was pointed out by several authors (PASCHER 1915, R. et F. CHODAT 1929, KORŠIKOV 1953, LUND 1956 etc.). So far, however, EM investigations of cell division are missing, as in the case

of other simple filamentous algae, for example *Stichococcus chloranthus* (Picket-Heaps 1975), or *Raphidiopsis* (*Raphidonema*) *sessilis* (Champpell et Floyd 1981), which would unambiguously determine their place among green algae.

Because of solitary cells in the colony the genus *Elakatothrix* Wille 1898 used to be included among coccal green algae. But 17 years later Pascher (1915) transfered the genus in the edition, Die Süsswasserflora Deutschlands, Österreichs und der Schweiz, from the order *Protococcales* (Brunnthaler 1915) into a particular group of genera of an uncertain position (Einige Chlorophyceengattungen unsicherer Stellung). The same was also done by Koršikov (1953) who, however, narrowed this group into the genera *Elakatothrix*, *Raphidonema* Lagerh. and *Glaucosphaera* Korš. Printz (1927) assigned the genus *Elakatothrix* (incl. *Fusola*) to the family *Pleurococcaceae* together with the genera *Pleurococcus* Menegh., *Coccomyxa* Schmidle, *Dispora* Printz. Some systematists, however, continue to consider the genus *Elakatothrix* a member of the order *Chlorococcales*, mostly of the family *Coccomyxaceae* (Lund 1956, Bourrelly 1966, Ettl 1968). Starmach (1972) did not include the genus among filamentous green algae (*Ulotrichales*), in contrast e.g. to *Koliella* Hind., in which cells would similary live solitarily, too.

In the author's first study of this genus (Hindák 1962) preference was given to the feature: crosswise protoplast division together with the mother cell wall division versus the feature: solitary cells or (solitarily) living cells in colonies. In consequence the genus was placed at the beginning of the system of the order *Ulotrichales* as its most primitive representative. The author adhered to this view also in his subsequent papers bearing upon this genus. His view was accepted e.g. by Nygaard (1977, 1979), Moškova (1979) and Moškova et Gollerbach (1986). The authors of the monograph on the order *Chlorococcales* Komárek et Fott (1983) similarly did not assign the genus *Elakatothrix* to coccal green algae and with the genus *Fusola* they emphasized that in contrast to the genus *Elakatothrix* the cells would reproduce by 2-4-8 autospores.

By elongate, fusiform cell shape and by the presence of a mucilaginous envelope the genus *Elakatothrix* resembles other genera, for example *Fusola* Snow, *Quadrigula* Printz, *Pseudoquadrigula* Lacoste de Diaz, *Closteriospira* Reverd. and *Chadefaudiothrix* Bourr. Because of the formation of autospores, the first three are unambiguously classified into the order *Chlorococcales* (Komárek et Fott 1983) the other two genera, in contrast, are characterized, just as the genus *Elakatothrix*, by crosswise cell division. As the sole representative of the genus, *Fusola viridis* Snow has cells with disk-shaped to short streaked chloroplasts merging, especially in older cells, into one massive whole, and 1—2 pyrenoids. *Quadrigula closterioides* (Bohl.) Printz, the type species of the genus, has cells without pyrenoids, in contrast to the preceding species/genus, and the autospores are not positioned consecutively but side by side in parallel. The genus *Pseudoquadrigula* with the single species

Fig. 1. — 1—8, *Fusola viridis* Snow [1, from Printz 1914 as *Elakatothrix viridis* (Snow) Printz, 2, from G. M. Smith 1920 (left) and Prescott 1951 (right) as *Elakatothrix viridis* (Snow) Printz, 3, from Skuja 1964 as *Elakatothrix viridis* (Snow) Printz, 4, from *Skuja* as *Elakatothrix viridis* (Snow) Printz = *Pseudoquadrigula* sp.?, 5, from Nygaard 1977 as *Elakatothrix viridis* (Snow) Printz, 6, from Koršikov 1953, 7, from Hindák 1977, 8 from Hindák 1962].


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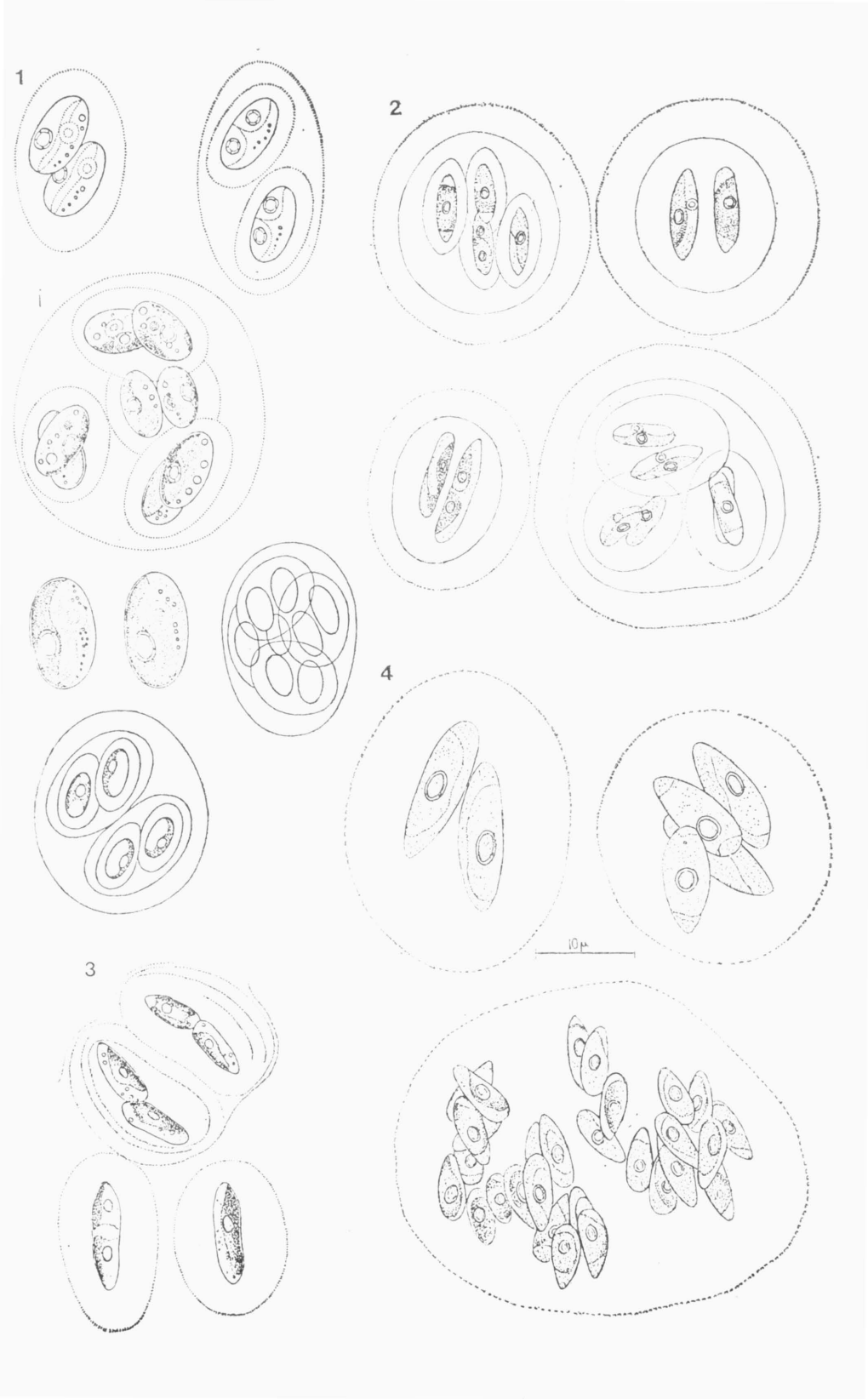
P. lagoensis LACOSTE de DIAZ has cells similarly without pyrenoids, but the autospores are positioned slightly sidewise in succession. *Ankistrodesmus gelifactum* (CHOD.) BOURR., *Elakatothrix viridis* sensu SKUJA 1948 (Fig. 1 : 4), *Quadrigula chodatii* (TANN.-FULLEM.) G. M. SMITH, *Q. jolyi* C. et R. BICUDO, *Q. lacustris* (CHOD.) G. M. SMITH and *Q. venezuelica* YACUBSON (see KOMÁREK et FOTT 1983) are designated as species similar to *P. lagoensis*. All these species named, however, have cells with a pyrenoid, the mode of cell division is not very well known. Some of them possibly belong rather to the genus *Elakatothrix*, in which the presence of at most pyrenoids in the cell (stage prior to protoplast division) and unequally long cell ends (young cells?) might be indicative.

The systematic position of the genus *Closteriospira* with the only species *C. lemanensis* REVERD. still remains uncertain. Because of the helically twisted chloroplast with pyrenoids this species was transferred (Printz 1927) to the genus *Spirotaenia* BRÉB. ex RALFS (*Conjugatophyceae, Saccordermae, Mesotaeniaceae*). GEITLER (1959) supported this view by stating that carotin bodies would be formed e.g. in the genus *Spirotaenia*, but were absent in representatives of *Chlorococcales*. In contrast, because of cell structure and division, the genus *Closteriospira* was classified by SKUJA (1948), BOURRELLY (1966) and ETTL (1968) into *Chlorococcales*. For the time being, the author is inclined to the view that the genus *Closteriospira* may be considered an independent one and differentiated from the genus *Elakatothrix* by thickened cell ends and by the localization of carotin bodies at the cell ends.

BOURRELLY (1957) established a new genus of xanthophycean algae — *Chadefaudiothrix* to which, in addition to the type species *Ch. gallica* BOURR., he also transferred the species *Elakatothrix minouchetti* BOURR. 1947 and the chlorococcal species *Ecballocystis fluitans* FRITSCH. No fact was presented by the author which would justify these species to be taken for members of Xanthophyceae, for example the composition of pigments or the assimilation product. He restricted himself only to noting that the chloroplasts in *Ch. gallica* were yellow-green and 1—2 in number. Similary of course, we lack the mentioned evidence for our statement that would unambiguously prove that the genus *Chadefaudiothrix* falls under *Chlorophyceae*. We do so on several grounds. The first is that we know from experience of our own that to judge the classification of some alga only by the colour of chloroplast is only subjective and may not be decisive. The species *Dichotomococcus lunatus* FOTT and *Nephrodiella nana* ETTL may serve as an example, having been originally classified into *Xanthophyceae* (*Mischococcales*) (see ETTL 1978). In unialgal cultures of these species the presence of the pigment chlorophyll *b*, was identified missing in *Xanthophyceae*, but present in *Chlorophyceae* (HINDÁK 1978). The second reason is the existence of species of the genus *Elakatothrix* without pyrenoids in the cells. These are both already mentioned in *E. minouchetti* BOURR. and *E. pseudogelatinosa* KORŠ. In agreement with the contemporary trend in the taxonomy of green algae it would be possible to classify these species into two genera differing only by the presence/absence of pyrenoids in cells, as it is e.g. in *Chlamydomonas-Chloromonas*, *Carteria-Provasoliella*, *Kirchneriella-Raphidocelis*. Already the existence of

Fig. 2. — 1, *Elakatothrix ovalis* (ETTL) HIND. (from ETTL 1968 as *E. gloeocystiformis* KORŠ. var. *ovalis* ETTL), 2, 3, *E. gloeocystiformis* KORŠ. (2, from KORŠIKOV 1953, 3, from HINDÁK 1962), 4, *E. subacuta* KORŠ. (from KORŠIKOV 1953).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the genus *Chadefaudiothrix* offers the practicability of such a genus parallel to the genus *Elakatothrix*. With this we thus wish to draw attention to the fact that no evidence has hitherto been offered for why the genus *Chadefaudiothrix* could not belong to green algae.

In the following a taxonomic survey is given of the presented genera and infrageneric taxa, along with their diagnosis, occurrence and notes on their morphological variability.

THE GENUS *FUSOLA* SNOW 1903

Fusola SNOW U.S. Fish. Comm. Bull., p. 378—379, 1903

Synonyms:
Elakatothrix WILLE 1898 sensu auct. post. p.p.
Quadrigula PRINTZ 1915 sensu auct. post. p.p.
Ankistrodesmus CORDA 1838 sensu auct. post. p.p.

Cells free, singular or 2—4—8 in colony, placed with longer axis in one direction and slightly detached side by side in the mucilage. Chloroplast parietal, with a pyrenoid. One nucleus. Reproduction by autospores. — Type species: *F. viridis* SNOW.

Fusola viridis SNOW U.S. Fish. Comm. Bull., p. 378—379, Pl. II. Fig. VI, 1903.

Synonyms:
?*Elakatothrix americana* WILLE Rhodora 1 : 150, 1899.
Elakatothrix americana WILLE 1899 sensu Collins 1909.
Quadrigula viridis (SNOW) R. et F. CHODAT Veröff. Geobot. Inst. Rübel 29/3 : 450, 1925.
Ankistrodesmus viridis (SNOW) BOURRELLY Les Algues d'eau douce 1 : 183, 1966.

Cells ± fusiform, straight or slightly asymmetrical, narrowed and bluntly pointed towards the ends, 12—41—(57) × (5)—8.5—21 μm. Mucilage hyaline, homogeneous, not layered, around cells 5—15 μm. Many disk-shaped up to shortly striped chloroplasts, with one central pyrenoid; in older cells the chloroplasts merge into one. Reproduction by 2—4—(8) autospores released by the rupture of the mother cell wall into several parts which gelatinize. Formation of zoospores, akinetes and sexual reproduction not observed.

Occurrence: in the plankton and littoral of pure, mainly sphagnous lakes, relatively rare (in North America, Europe), a species of probably cosmopolitan distribution; in Czechoslovakia found in the littoral of tarns in the High Tatras Mts. and in Northern Slovakia (Suchá hora, Hindák 1962), in littoral of the inundation lake of Veľký les on the Danube at Gabčíkovo (HINDÁK 1977) and in Southern Moravia (KOMÁREK in litt.).

The species is variable especially in cell size, this being clearly connected with cell age. Data from the literature differ also as to the number and shape of chloroplasts. The authoress of the genus, SNOW, states that the chloroplast occupies the larger portion of the cell, leaving near the center only a small space for the nucleus. In wild material the chloroplast appears as one, relatively massive and thick. In cultured material (HINDÁK 1962) and sometimes

Fig. 3.—1, *Elakatothrix alpina* BECK-MANN. (left from BECK-MANNAGETTA 1926, right from BECK-MANNAGETTA 1929), 2, *E. linearis* PASCH. (from PASCHER 1915), 3, *E. linearis* PASCH.? (from NYGAARD 1979 as *E. genevensis* var. *tenuis* NYG.), 4—7, *E. acuta* PASCH. (4, from PASCHER 1915, 5, from KORŠIKOV 1953, 6, from ETTL 1968, 7, from HINDÁK 1962), 8, *E. inflexa* HIND. (from HINDÁK 1966).


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also in wild material from the plankton of pure lakes (SKUJA 1948, 1964), however, it may well be seen that the chloroplast is composed of many disks (Fig. 1 : 8) or longitudinal stripes (Fig. 1 : 3) which are probably joined together as in other algae.

The genus *Fusola* was assigned by KORŠIKOV (1953) unambiguously into *Chlorococcales* on the basis of the formation of 2—4—8 autospores, and into the family *Ankistrodesmaceae* because of fusiform shape, namely into the neighbourhood of the genus *Ankistrodesmus*. In doing so he expressed his view that the genus *Fusola* might be joined with the genus *Ankistrodesmus*. However, such fusion, as later affected by BOURRELLY (1966), has no justification, because in the genus *Ankistrodemus* the autospores are arranged in parallel side by side, and, serially in the genus *Fusola* as in the genus *Monoraphidium*. The transfer of the genus *Fusola* to the family *Oocystaceae*, as suggested by KOMÁREK et FOTT (1983) would need substantiation. In *F. viridis* the mother cell wall does not expand before release as in the genus *Oocystis*, but is torn in several portions which subsequently gelatinize (Fig. 1 : 6, 8). An EM investigation of the cell wall is obviously needed in order to bring this issue to a solution.

THE GENUS *ELAKATOTHRIX* WILLE 1898

Elakatothrix WILLE Biol. Centralbl. 18 : 302, 1898.

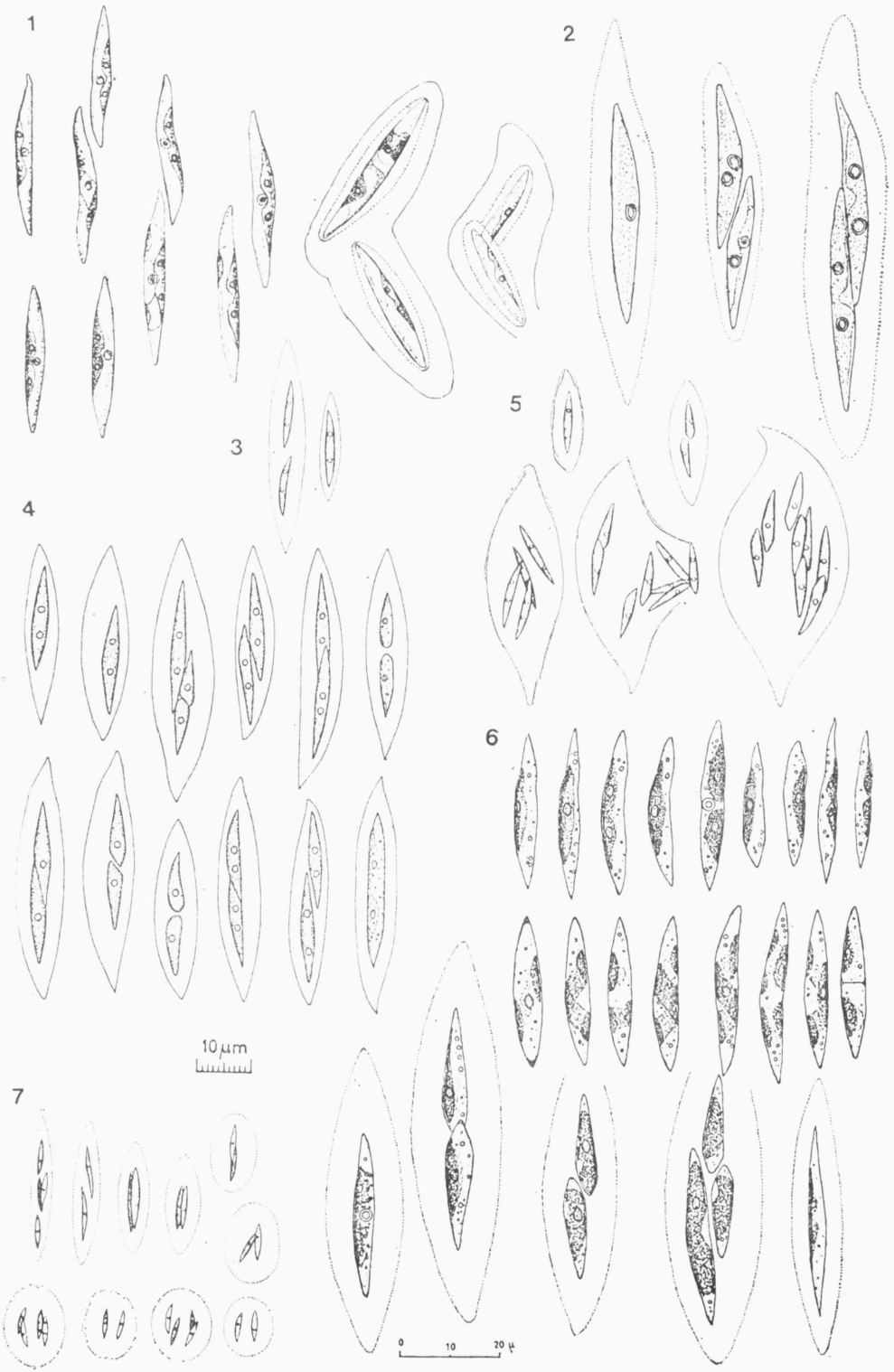
Synonyms:
Ankistrodesmus CORDA sensu auct. post. p.p.
Raphidium KÜTZING 1845 sensu auct. post. p.p.
Spirotaenia BRÉB. 1846 sensu auct. post. p.p.
?Gloeocystis NÄG. 1849 sensu auct. post. p.p.

Cells single or in colonies by 2—4—8 to several dozens embedded side by side, after each other or without a definite order in a hyaline, unlayered or layered mucous envelope; free or attached usually to aquatic plants. Cells fusiform, fusiform-cylindrical, oval or rod-like, straight or slightly curved or sigmoid, ends pointed, bluntly pointed or rounded, without conspicuous thickenings or carotin bodies at the ends. Cell wall smooth, hyaline and thin. Nuclei central, in young cells one, prior to protoplast division two. Chloroplast parietal, straight or helically twisted, with 1—2—(4) pyrenoids. Sometimes numerous vacuoles with inclusions are formed. Asexual cell reproduction by division into two equal parts, the cell wall also being involved in the division. Having been formed, the daughter cells separate or are joined into pairs for a certain time, sporadically they form catenate clusters. Aplanospores originate by one from the cell (monospores), having a spherical shape, two contractile vacuoles and are released by the rupture of the mother cell wall. Germination of spores was not observed. Sexual reproduction and zoospore formation unknown. — Type species: *E. gelatinosa* WILLE.

Fifteen species and two non-type varieties have been included in the genus. The majority of species occurs in plankton or littoral, a few live subaerically on wet rocks.

According to cell shape the genus *Elakatothrix* may be designated as a rather heterogeneous one. A common feature of all species is that the longi-

Fig. 4. — 1—6, *Elakatothrix genevensis* (REVERD.) HIND. (1, from REVERDIN 1919 as *Ankistrodesmus genevensis* REVERD. 1919, 2, from KORŠIKOV 1953 as *E. lacustris* KORŠ., 3, from NYGAARD 1979, 4, from NYGAARD 1977, 5, from NYGAARD 1979 as *Elakatothrix* sp., 6, from HINDÁK 1962), 7, *Elakatothrix* sp. (from NYGAARD 1979).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tudinal axis of cells is longer than the transverse axis. The cells are narrowly rod-like, cylindrical, cylindrical fusiform up to fusiform or widely oval. Cells multiply by transverse division and no typical autospores are formed. The exact process of cytokinesis will still have to be studied, optimally with the type species *E. gelatinosa*.

The species may be roughly divided into two groups according to whether the cells separate soon after division or remain joined together in pairs for awhile. *E. genevensis* may be labelled as the representative of the first group, in consequence of the growth of newly formed ends the daughter cells shift laterally side by side; in this stage of cell growth it might appear that cell division is not transverse but oblique. Here also belongs *E. spirochroma* in which cells exhibit a slightly sigmoid shape, the ends being shortly rostrately attenuated and the chloroplast often helically twisted. The author of the species REVERDIN (1917) drew remnants of the old cell wall at the free (old) ends of daughter cells (Fig. 13 : 1). We too have similarly observed the same "shanks" as if they were divided halves of the mother cell wall. This species would particularly need an EM study of cell division. One of the possibilities is that even if the mother cell wall divides transversely together with the protoplast into two portions, it does not remain permanently part of the cell wall of daughter cells and separates after a certain time from the ends and gelatinizes. This would be the case when daughter cells form the wall *de novo* and the mother cell wall forms the outer layer of the cell wall only temporarily. The second group of species in which the daughter cells remain joined for a certain time and form pairs (sometimes in tubular mucilage), will clearly stand closer to the genus *Koliella* in which occasionally, especially in cultures, filamentous cell clusters are formed (pseudofilaments).

Similar filamentous cell clusters were observed with the second group of species, namely *E. gelatinosa*. The species of this group have the cells joined into pairs after division for a certain time. If the cells divide quickly in succession as in the case of the laboratory material of the mentioned species, there arise in the tubular mucilage catenate uniseriate clusters of cell pairs touching mutually with their narrowed ends (Fig. 10 : 2).

The formation of zoospores and sexual reproduction were not observed. WILLE (1898) indicates the formation of brownish akinetes in *E. gelatinosa*, neither providing a drawing, nor a more detailed description of them, however. LUND (1956) studied in detail the formation of aplanospores with *E. gelatinosa* var. *aplanospora* LUND (Fig. 9 : 8). Aplanospores originate endogenously by one, i.e. the entire protoplast transforms into a spore (monospore), so that the name cyst could also be considered. The protoplast contracts into an oval to ellipsoid mass in the centre of the cell and at the same time two contractile vacuoles are formed; no eyespot was observed. The spore is liberated after the transverse division of the cell wall into two parts and partly also after its gelatinization. After a time, the spore becomes globose, produces a relatively thick wall and loses its contractile vacuoles. Germination of spores was not observed.

In the subsequent key for determination of species and varieties, emphasis is placed upon the main differentiating diagnostic features, to which mainly belong the morphology and size of cells/colonies and the capability of cells to stay in pairs for a time after division. Names with asterisk are doubtful species, probably not belonging to Chlorophyceae.

1a Cells oval: 1. *E. ovalis* (Ettl) Hind.
1b Cells of another shape.
2a Cells arcuately bent, narrowed toward the ends: 3. *E. inflexa* Hind.
2b Cells straight or only slightly bent.
3a Mucilage of cells/colonies conspicuously layered: 2. *E. gloeocystiformis* Korš.
3b Mucilage of cells/colonies not layered or only slightly layered.
4a Cells cylindrical to rod-like.
5a Cells robust, 64—114 × 15—22 µm: *4. *E. alpina* Beck-Mann.
5b Cells smaller.
6a Cells longthily cylindrical to rod-like, 15—22 × 2—3 µm: *5. *E. linearis* Pasch.
6b Cells shortly cylindrical, the ends pencil-like, tapered and pointed, 8—21 × 3—4 µm: 6. *E. acuta* Pasch.
4b Cells fusiform or fusiformly cylindrical.
7a Chloroplast straight or only slightly twisted.
8a Daughter cells not forming pairs, soon shifting obliquely side by side due to the growth of newly formed ends.
9a Cells straight, chloroplast as a rule with one pyrenoid: 7. *E. genevensis* (Rev.) Hind.
9b Cells slightly bent, less straight, chloroplast usually with two pyrenoids: 8. *E. gelifacta* (Chod.) Hind.
8b Daughter cells remaining relatively long in pairs, after separation remaining embedded the longitudinal cell axis.
10a Colonial mucilage narrowly and lengthily fusiform: 9. *E. gracilis* Hortob.
10b Colonial mucilage spherical, fusiform or irregular.
11a Colonial mucilage spherical or widely oval: 10. *E. subacuta* Korš.
11b Colonial mucilage fusiform or irregular.
12a Colonial mucilage fusiform, cylindrical or irregular; cells regularly fusiform or fusiformly cylindrical up to slightly asymmetrical, 11—25—(30) × 2,5—4—(6) µm: 11. *E. gelatinosa* Wille
13a Formation of aplanospores unknown; cells regularly fusiform: *E. gelatinosa* Wille var. *gelatinosa*
13b Formation of aplanospores known; cells fusiformly cylindrical, slightly asymmetrical: *E. gelatinosa* Wille var. *aplanospora* Lund
12b Colonial mucilage usually irregular; cells irregularly fusiform and relatively small.
14a Cells 6—15 × 1,5—2,2 µm, colonial mucilage deliquesced and obscure: 12. *E. arvernensis* R. et F. Chod.
14b Cells 7—28 × 2,5—5,5 µm, boundaries of colonial mucilage conspicuous or up to markedly thickened: 13. *E. biplex* (Nyg.) Hind.
15a Boundaries of colonial mucilage inconspicuous, frequently deliquesced: *E. biplex* (Nyg.) Hind. var. *biplex*
15b Boundaries of colonial mucilage markedly thickened: *E. biplex* (Nyg.) Hind. var. *conglutinata* Nyg.
7b Chloroplast slightly to several times helically twisted.
16a Cell ends abruptly narrowed, thinly attenuated and hyaline: 14. *E. spirochroma* (Reverd.) Hind.
16b Cells toward ends bluntly pointed: 15. *E. parvula* (Archer) Hind.

1. *Elakatothrix ovalis* (Ettl) Hindák, comb. nova Fig. 2 : 2

Basionym: *Elakatothrix gloeocystiformis* Koršikov var. *ovalis* Ettl. Ber. Nat.-Med. Ver. Innsbruck 56 : 336, Fig. 33 : 3—5, 1968.

Cells seldomly solitary, usually by 2—4—8 in the colony. Colonies broadly oval to irregularly spherical, up to 25 µm in diam., with cells usually in groups by pairs; particular cells or pairs of cells have their own conspicuously limited mucilaginous envelope. Cells oval to ovally cylindrical, with broadly rounded ends, 6—8 × 3—4.5 µm. Chloroplast with one central pyrenoid.

Iconotype: Fig. 2: 1i (after Ettl 1968)

Occurrence: in a peat-bog near Obergurgl, Tyrol, Austria.

With its broadly oval cells this species is well differentiated from *E. gloeo-*

cystiformis Korš., in which cells are fusiform up to fusiformly-cylindrical, narrowed at the ends and bluntly pointed (Koršikov 1953, Hindák 1962) and, in addition, considerably larger and living in the plankton of fishponds. With the broadly oval cell shape *E. ovalis* stands at the periphery of the genus and rather resembles a representative of the genus *Dactylothece* Lagerh. (see Pascher 1915).

2. *Elakatothrix gloeocystiformis* Koršikov Vizn. Prisnovodn. Vodor. Ukr. RSR 5 : 410, Fig. 411, 1953 Fig. 2 : 2,3

Synonym: *Gloeocystis rehmani* Wołoszyńska 1914?

Colonies spherical or spherically oval, 2—4—8-celled, up to 60 μm in diam., singular cells or pairs of cells having a conspicuously limited mucilaginous envelope in the colony. Cells fusiform to fusiformly cylindrical, sometimes slightly asymmetrical, narrowed at the ends, bluntly pointed to pointed, 10—21 × 3.5—5.5 μm. Chloroplast parietal, with one pyrenoid.

Occurrence: in the fishponds near Lyubotin, Kharkov Distr., USSR; in Czechoslovakia it was found in a village fishpond at Světice near Prague (Hindák 1962). Guarrera et al. (1972) refer to it from Argentina.

3. *Elakatothrix inflexa* Hindák Preslia 38 : 83, Tab. 6 : 1, 1966 Fig. 3 : 8

Cells usually singular or in pairs, sometimes up to eight after division, fusiform, slightly to arcuately bent, gradually attenuated from the centre toward the ends, bluntly pointed to pointed, seldom slightly rounded, 17—28 × 3.2—4 μm, with a hyaline structureless mucilage, 38—52 × 5.5—7 μm in width together with the cell. Chloroplast parietal, with 1—2 pyrenoids at the dorsal side of cell. Daughter cells remain joined in pairs for awhile, then separate.

Occurrence: subaerically on wet rocks near Harrachov, Krkonoše Mts. (Giant Mts.), Czechoslovakia.

A pronounced feature of the species are arcuately bent cells and the occurrence on wet granite rocks.

*4. *Elakatothrix alpina* Beck-Mannagetta Arch. Protistenk. 55 : 181, Fig. 1, 1926 Fig. 3 : 1

Cells solitary or in pairs after each other or shifted slightly side by side in unlayered or slightly layered mucilage; cylindrical, fusiform-cylindrical or fusiform, with widely rounded ends, 63.8—162 × 15.5—22.4 μm, mucilage around cells up to 10.3 μm. The chloroplast fills the entire parietal perimeter of the cell, often with one small pyrenoid (?) in each cell half.

Occurrence: in swamps, wells, on wet rock walls and in the plankton of lakes [Carinthia in Austria, Špindlerov Mlýn in the Krkonoše Mts. (Giant Mts., Czechoslovakia) Beck-Mannagetta 1926, 1929].

In this species the cells are extremely long and broad, several times larger than in the type species *E. gelatinosa* or *E. genevensis*. Although Beck-Mannagetta found this species in both Carinthia, Southern Austria (1926) and in Northern Bohemia (1929), there is doubt about its belonging to green algae (Hindák 1962). The author made a drawing of the chloroplast shape and, even more, he questioned the presence of a pyrenoid in cells. In addition, he drew two pairs of cells from Carinthia, one having cells of a fusiform

shape, the other regularly cylindrical (and also longer) ones with broadly rounded, not attenuated ends (Fig. 3 : 1, left). From the Krkonoše Mts. he drew only cells similar to the first cell pair from Carinthia (Fig. 3 : 1, right). This gives rise to the suspicion if whether, just as in the case of the subsequent species, this is not a representative of blue-green algae.

*5. *Elakatothrix linearis* PASCHER Süsswasserfl. Deutschlands, Österreichs und der Schweiz 5 : 221, Fig. 28—29, 1915 Fig. 3 : 2

?Synonym: *E. genevensis* (REVERD.) HIND. var. *tenuis* NYGAARD Bot. Tiddsskrift 73 : 215, Fig. 211—224, 1979 (Fig. 3: 3)

Colonies elongate, up to 80—100 μm long, and up to 16-celled. Cells narrowly rod-like, with rounded ends, 15—22×2—3 μm. The chloroplast fills almost the entire cell, pyrenoid not observed, but probably present.

Occurrence: in the plankton of Lake Máchovo jezero, Northern Bohemia, Czechoslovakia.

Because of long rod-like cells and doubts as to the presence of a pyrenoid, the inclusion of the species in the genus *Elakatothrix* is questionable. This might also be some planktic blue-green alga current in our country, e.g. *Rhabdoderma* cf. *lineare* SCHMIDLE et LAUT., in which cells are of similar size: 6—18×0.8—2.5 μm.

A similar alga was described by NYGAARD (1979) from a lake at the Narsaaq area, South Greenland, under the name *E. genevensis* var. *tenuis* NYG. (Fig. 3 : 3). The cells were rod-like or faintly curved or sigmoid, 8—17×0.9 to 1.5 μm. Also the integuments could be sigmoid, 21.5—50×4—15 μm. A pyrenoid was nor observed. Because of the probable absence of a pyrenoid there is suspicion that in this case, too, the alga in question might rather be a blue-green one.

6. *Elakatothrix acuta* PASCHER Süsswasserflora Deutschlands, Österreichs und der Schweiz 5 : 220, Fig. 27, 1915 Fig. 3 : 4—7

Cells rarely singular, usually 2—10 in colonies, shortly cylindrical to shortly cylindrical-fusiform; ends abrubpty pencil-like tapered and pointed, 8—21×3—4 μm. Colonies elongate, up to 120 μm in length, with cells shifted one after the other. Chloroplast parietal, with one central pyrenoid. Daughter cells remain joined only for a short time, their newly formed ends grow sidewise obliquely against each other; in this stage it might appear that the cross wall was not perpendicular but oblique.

Occurrence: in the plankton of stagnant and running waters in Czechoslovakia (PASCHER 1915) and the USSR (KORŠIKOV 1953), in the littoral of small water reservoirs and fishponds (HINDÁK 1962) and in lakes (Tyrol, Austria, ETTL 1968).

Elakatothrix acuta is well differentiated from other species by short cylindrical cells, with the ends tapered, pencil-like and pointed. Daughter cells do not form pairs of the *E. gelatinosa*, but of the *E. genevensis* type.

7. *Elakatothrix genevensis* (REVERDIN) HINDÁK Preslia 34 : 287, 1962 Fig. 4 : 1—6; 5; 11 : 4

Basionym: *Ankistrodesmus genevensis* REVERDIN Arch. Sci. Phys. Nat. 1 : 81, Fig. 76—83, 1919.

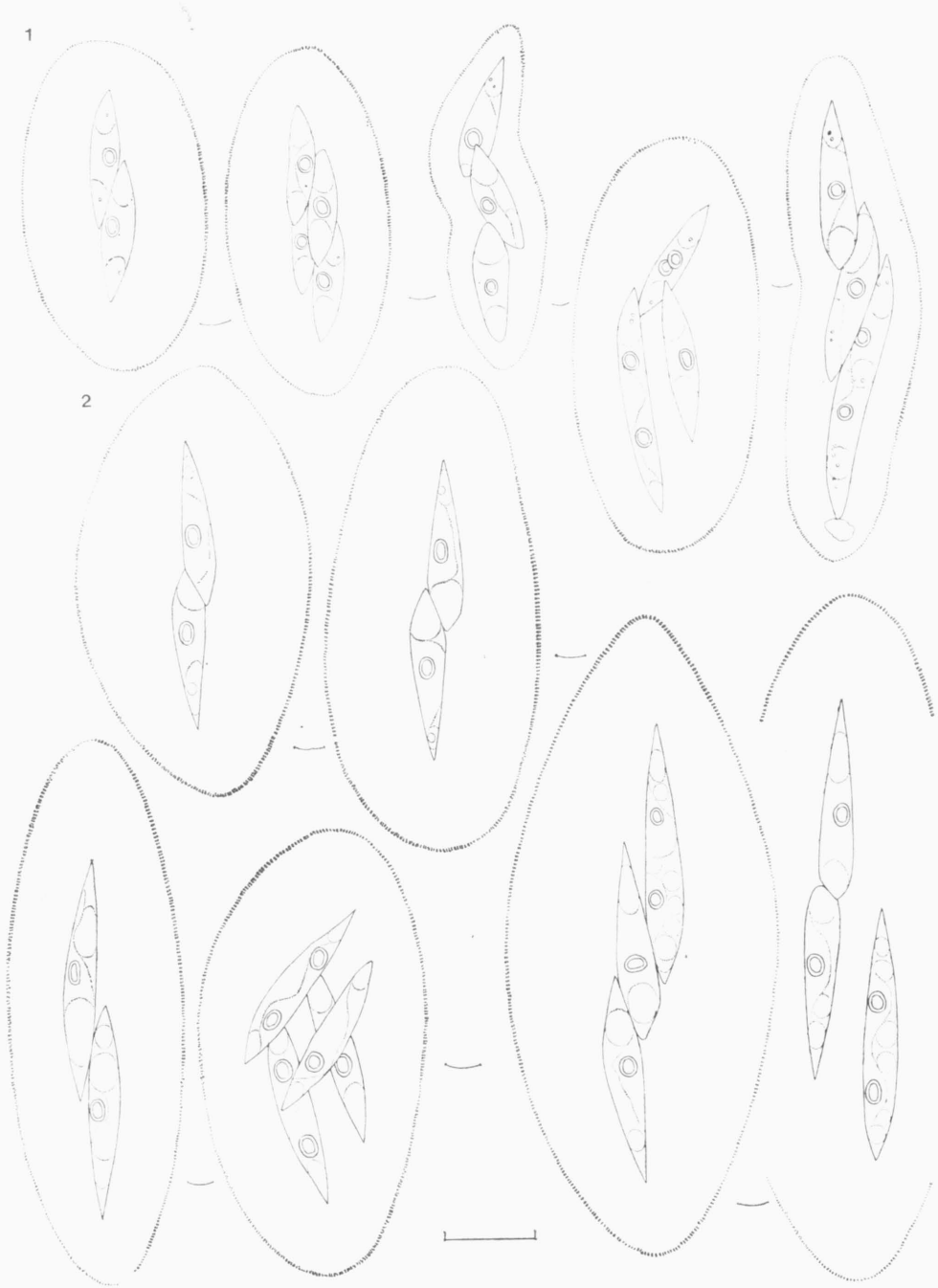

Fig. 5. — 1, 2, *Elakatothrix genevensis* (Reverd.) Hind. (1, specimens from the fishpond Stávek at Stupava, 2, specimens from the lake Popradské pleso, the High Tatras). Scale: 10 μm.

Synonyms:
Raphidium planctonicum Wołoszyńska Hedwigia 55 : 202, 1914; incl.?
Elakatothrix gelatinosa Wille? sensu Taylor et Colton 1928.
Elakatothrix lacustris Beck-Mannagetta Beih. Bot. Centralbl. 47/2 : 241, 1931; incl.
Ankistrodesmus lacustris (Chodat) Ostenfeld sensu Huzel 1937.
Ankistrodesmus biplex (Reinsch) G. S. West sensu Messikommer 1943.
Elakatothrix lacustris Koršikov Vizn. Prisnovodn. Vodor. Ukr. RSR 5 : 412, Fig. 414, 1953.

Cells singular or by 2—4—8—12, rarely by 20—40 in the colony, regularly fusiform to slightly asymmetrical, narrowed and pointed towards the ends, 20—35—(45)×3—5.5 μ, in the colony slightly detached side by side, cell pairs are formed only shortly after division, then they are shifted in parallel obliquely versus one another due to newly formed ends ("oblique cross wall"). Chloroplast parietal, straight or slightly helically twisted (max. one winding), with 1—2 pyrenoids.

Occurrence: in the plankton and littoral or stagnant and running waters, seldom in peat-bogs; Europe and North America, probably of a cosmopolitan distribution; in Central Europe the most frequent representative of the genus, namely in rivers and fishponds.

By shape and cell size the species resembles *E. gelatinosa* in which, however, the daughter cells form pairs for a long time and, after separation, they do not shift sidewise but one after the other along the lengthwise axis of the cell/colony. An additional related species is *E. subacuta* in which, however, cells are relatively shorter and broader (Fig. 2 : 4), as well as *E. gelifacta* (see below). Provided that material will be available in sufficient abundance and mathematical methods are going to be applied, it will possibly appear to be justified to stablish some infraspecific taxa or also so called "small species" (Fig. 4 : 7). The cell length/width ratio is especially variable not only from various geographic areas, but also from various populations (see Fig. 5).

8. *Elakatothrix gelifacta* (Chodat) Hindák, comb. nova Fig. 6, 7 : 8—11

Basionym: *Raphidium pyrenogerum* Chodat var. *gelifactum* Chodat Matér. Flore Crypt. Suisse 1(3) : 201, 1902 = *Ankistrodesmus longissimus* (Lemmermann) Wille var. *gelifactum* (Chodat) Brunnthaler Süsswasserflora Deutschlands, Österreichs und der Schweiz 5 : 191, 1915 = *Ankistrodesmus gelifactum* (Chodat) Boureelly Bull. Mus. Paris, ser. 2, 23(6) : 678—679, 1951.
Synonyms:
Raphidium Braunii Nägeli var. *lacustre* Chodat Bull. Herb. Boiss. 5: Pl. 11, Figs 9, 10. 1897 = *Ankistrodesmus lacustre* (Chodat) Ostenfeld Hedwigia 46 : 384, 1907 = *Quadrigula lacustris*, (Chodat) G. M. Smith Wisc. Geol. Nat. Hist. Survey 57 : 139, Fig. 33 : 4—6, 1920.
Raphidium Chodati Tanner-Fullemann Bull. Herb. Boiss. 2 Ser. 6 : 156, Figs. 1—11, 1906 = *Ankistrodesmus Chodati* (Tanner-Fullemann) Brunnthaler Süsswasserfl. Deutschlands, Österreichs und der Schweiz 5 : 193, Fig. 306, 1915 = *Quadrigula Chodati* (Tanner-Fullemann) G. M. Smith Wisc. Geol. Nat. Hist. Survey 57 : 138, Fig. 33 : 3, 1920; incl.?

Colonies fusiform to fusiformly oval, 2—4—8—16-celled as well as multicelled, sometimes composed of partial 2—4-celled colonies conspicuously limited by their own mucilaginous envelope. Cells spindle-shaped, subfusiform, straight or slightly arcuate, with pointed ends, 11—27.5×3—5 μm. Chloroplast one, parietal, at the dorsal cell side, with 1—2 pyrenoids. Before division the cells contract slightly in the centre and then divide into two equal parts. The daughter cells formed do not remain in pairs for a long time but shift obliquely side by side.

Iconotype: Fig. 6 : 1 (after Chodat 1897).

Occurrence: in the plankton of larger lakes in Europe (Switzerland, Austria, Denmark) and Northern America (USA).

In KOMÁREK's and FOTT's view (1983) *Ankistrodesmus gelifactum* (CHOD.) BOURR., *Quadrigula chodatii* (TANN-FULLEM.);G. M. SMITH and *Q. lacustris* (CHOD.) G. M. SMITH are *Pseudoquadrigula*-like species. In all the species mentioned reproduction was either not indicated (BRUNNTHALER 1915, G. M. SMITH 1918, 1920, NYGAARD 1977), or incorrectly interpreted as autospore formation (BOURRELLY 1951, 1966, KOMÁREK et FOTT 1983). From the pictures of these algae it is clear, however, that the process in question was rather cell division into two portions than autospore formation of the *Quadrigula* or *Ankistrodesmus* type. This is proved both by cell constriction in the central portion prior to division and by the unequally long cell ends as well as by the daughter cells in pairs. The chloroplast is *Elakatothrix*-like, parietal, in young cells with one pyrenoid, in maturing and adult cells with two pyrenoids. In this alga, too, just as in other representatives of the genus *Elakatothrix*, the pyrenoid divides first in the cell, followed by the chloroplast and by the protoplast with the cell wall in the end. In the process of quick consecutive cell division in the colony there arise groups by 4—8 cells (Fig. 6 : 5,6) interpreted by some authors (BOURRELLY 1951, 1966) as autospore formation. NYGAARD (1977) presented such colonies in his drawing of *Q. lacustris*, composed of partial small colonies with 2—4 cells. However, his accurate figures would unambiguously document the division of cells into two parts (Fig. 6 : 7).

The material from the Carinthian lakes Wörthersee and Feldsee, Austria (Fig. 7 : 8—10), examined by the author, is in agreement with BOURRELLY's (1951, 1966) observation of *Ankistrodesmus gelifactum*. The pyrenoid divides relatively soon before chloroplast division, still in the maturing process of young cells; sporadically two pyrenoids were found on each chloroplast in cells with an already divided chloroplast (Fig. 7 : 9). Young cells, however, have regularly one pyrenoid. The cells were $15-25 \times 3-4$ µm in size, this being in relation with data from the literature. The constriction of cells in the median portion before division is a feature found only with in this species. The cells were slightly arcuate or ± straight; the maximum number of cells in the colony was 16.

Two names came most into consideration for this alga: *E. lacustris* and *E. gelifacta*. In the first case the basionym is: *Raphidium braunii* NÄG. var. *lacustre* CHOD. = *Ankistrodesmus lacustris* (CHOD.) OSTENF. = *Quadrigula lacustris* (CHOD.) G. M. SMITH. In transferring this taxa to the genus *Elakatothrix* there would arise the combination *E. lacustris*. The name *E. lacustris*, however, had already been used twice: by BECK-MANNAGETTA 1931 and by KORŠIKOV 1953 (these being in both cases later homonyms to *E. genevensis*), and therefore would have to be turned down. Other closest synonyms to be taken into account are *Ankistrodesmus longissimus* var. *gelifactum* CHOD. = *A. gelifactum* (CHOD.) BOURR. and *Raphidium chodatii* TANNER-

Fig. 6. — 1, 2, 4—7, *Elakatothrix gelifacta* (CHOD.) HIND. (1, from CHODAT 1897 as *Ankistrodesmus longissimus* (LEMM.) WILLE var. (f.) *gelifactum* CHOD., 2, from CHODAT 1897 as *Raphidium braunii* NÄG. var. *lacustre* CHOD., 4, from G. M. SMITH 1918 as *Ankistrodesmus lacustris* (CHOD.) OSTENF., 5, from G. M. SMITH 1920 as *Quadrigula lacustris* (CHOD.) G. M. SMITH, 6, from G. M. SMITH 1920 as *Quadrigula chodatii* (TANN.-FULL.) G. M. SMITH, 7, from NYGAARD 1977 as *Quadrigula lacustris* (CHOD.) G. M. SMITH), 3, *Raphidium chodatii* TANN.-FULL. (after TANNER-FULLEMANN 1906 from BRUNNTHALER 1915).


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Fullem. = *Ankistrodesmus chodatii* (Tanner-Fullem.) Brunnth. What speaks in favour of the first alternative is not only Chodat's priority (1897), but also the figures of this alga by G. M. Smith (1920), Bourrelly (1951) and Nygaard (1977), which are in agreement with our observations from the Carinthian lakes. Chodat's iconotype of var. (f.) *gelifactum* (Fig. 6 : 1) could be judged within the frame of morphological variability as *Raphidium braunii* var. *lacustris* Chod. (Fig. 6 : 1,2,4—6). Against the second alternative are both the iconotype of Tanner-Fullemann (Fig. 6 : 3) in form of a semilunate *Closterium*-like cell, and the essentially larger cell dimensions: 30—80 × 5—7 μm. G. M. Smith (1920) drew for *A. chodati* = *Q. chodati* a cell shape characteristic of *A. lacustris* = *Q. lacustris*, and not of *A. chodati*. The cell dimensions presented by this author: 30—80 × 3.5—7 μm are almost identical with the diagnosis for *A. chodati*, i.e. essentially larger than with *A. lacustris* (20—25 × 3—5 μm). On these grounds it is clear that the problems around *Ankistrodesmus/Quadrigula chodati* continue to be open, both sensu Tanner-Fullemann 1906 and sensu G. M. Smith 1920. However, in no case is there a representative of the genus *Ankistrodesmus*, or of the genus *Quadrigula* involved in the way they are conceived today (see Komárek et Fott 1983).

9. *Elakatothrix gracilis* Hortobágyi Acta Bot. Acad. Sci. Hung. 18 : 122, Fig. 7—10, 1973 Fig. 11 : 5

Colonies 2—4—celled, with uniseriate cells in close succession, cells rarely singular, mucilage thin, narrow and elongately attenuated into a point, up to 90 μm in length. Cells fusiform or cylindrical spindle-shaped, bluntly pointed at the ends, 5.3—10.4 × 1.3—1.5 μm. The chloroplast fills the entire inner perimeter of the cell; pyrenoid, central. Daughter cells remain joined up in pairs for a relatively long time.

Occurrence: in basins of the Budapest Waterwork fed with Danube water, Hungary.

The characteristic feature of the species is the narrow and elongate spindle-shaped mucilaginous envelope, indicative of the shape of some species of the genus *Koliella/Monoraphidium*. The cells are completely pressed into the mucilage one after the other along the lengthwise axis of the colony. Varaibility in colony shape is little known. The mucilaginous envelope is rather indicative of a sheath because its thickness practically equals the width of cells. The formation of resting stages of the genus *Koliella* might also be taken into account; in this case, however, the point under discussion would not be the mucilaginous envelope of the colony, but the mother cell wall.

10. *Elakatothrix subacuta* Koršikov Uč. Zap. Gorkov. Gos. Univ. 9 : 112, Fig. 11, 1939 Fig. 2 : 4; 7 : 1—7; 8

Colonies 2—4—32-celled, cells rarely singular; cells placed in the colonial mucilage singularly or in pairs without a definite order. Colonial mucilage spherical to oval or irregularly oval, structurless, 30—70 μm in diam., sometime even more. Cells widely spindle-shaped up to fusiformly oval, the ends widely rounded or roundly pointed, (10)—16—30 × 3.5—5 μm. Chloroplast parietal, with one large central pyrenoid. In the protoplast there are many vacuoles. Daughter cells separate soon from each other, forming no pairs.

Occurrence: in the plankton of lakes (European part of the USSR); in Czechoslovakia it was found in fishponds and rivers near Bratislava.

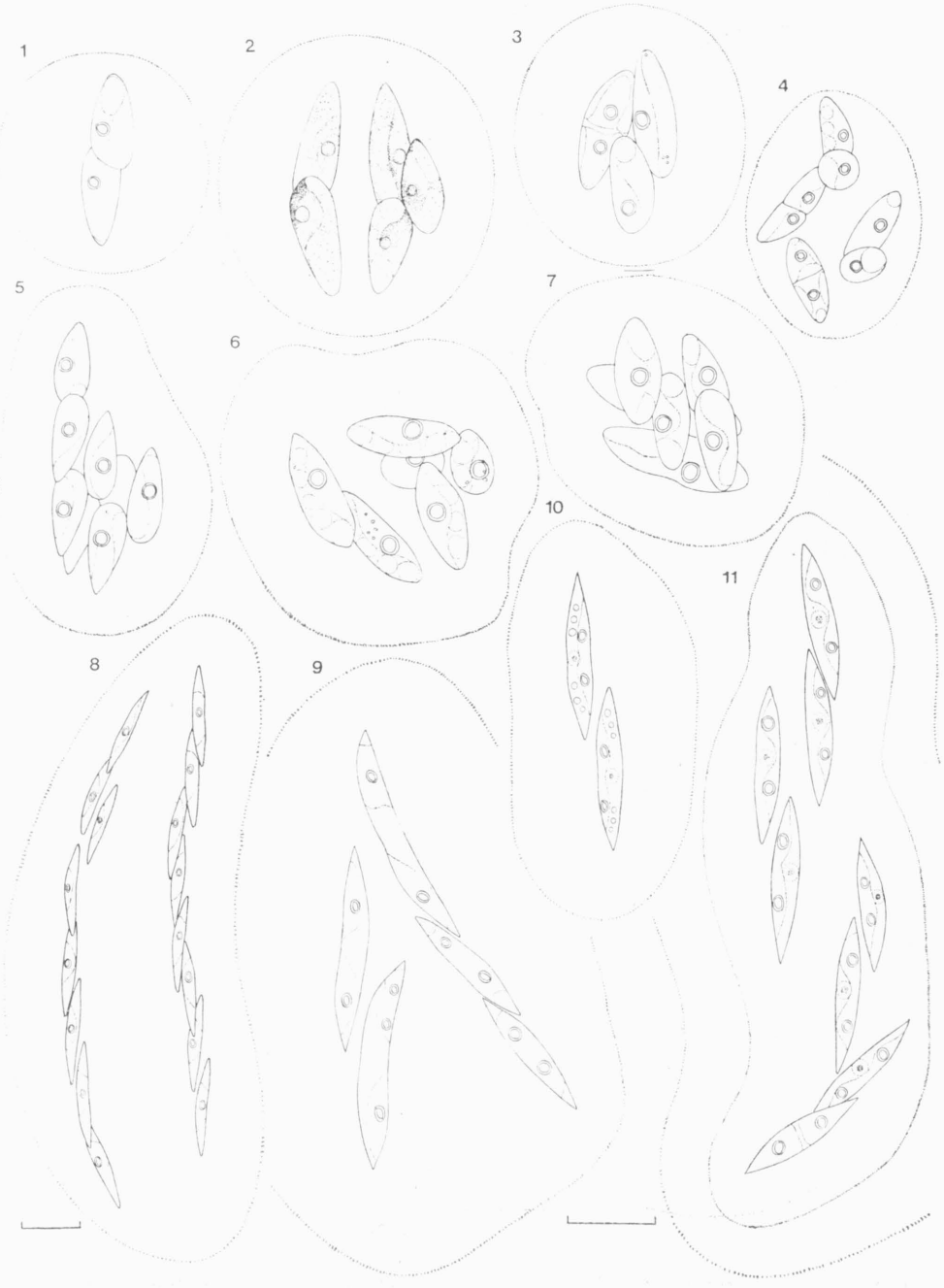


Fig. 7. — 1—7, *Elakatothrix subacuta* KORŠ. (1—3, specimens from water reservoir Tomky at Borský Jur, 4—7, specimens from the river Danube in Bratislava), 8—11, *E. gelifacta* (CHOD.) HIND. (specimens from the Carinthian lakes Wörthersee and Feldsee, Austria). Scale: 10 μm.

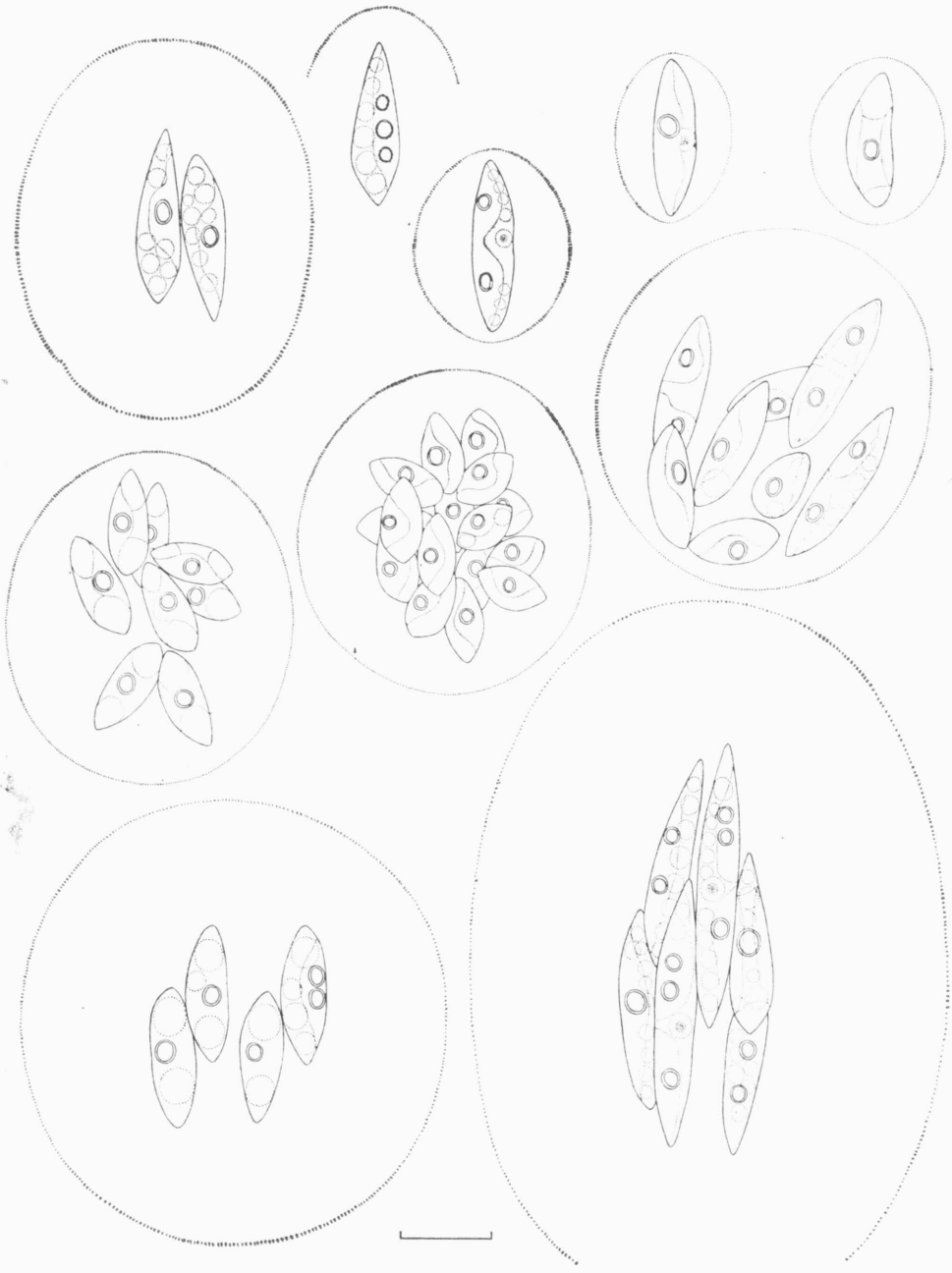


Fig. 8. — *Elakatothrix subacuta* Korš. (specimens from the fishponds in Bratislava-Železná Studienka). Scale: 10 μm.

The species was originally described from lake Veliko kolo near the Pustinskaya Biological Station, the Gorkii District, USSR (KORŠIKOV 1939, 1953), later it was found in the Ukrainian SSR (MOŠKOVA 1979) and in other republics of the USSR (MOŠKOVA et GOLLERBACH 1986). The specimens from the Danube (Fig. 7 : 4—7) and from the water reservoir at Tomky (Fig. 7 : 1—3) found by the author were in agreement with the diagnosis of the species in terms of cell shape and size. The cells shortly and widely spindle-shaped up to fusiformly oval, 10—18 × 3.5—5 μm, with rounded ends, only young cells were conical and the ends bluntly pointed. The cells in fishponds (Fig. 8), in contrast, were more variable both in size and in the shape of ends. At the adult cell end they were rarely rounded, usually they were bluntly pointed. Cell size varied not only in dependence on age, but also in the individual populations. In one colony the cells were short, only 8—9 × 4—4.5 μm, but their ends were equally pointed (Fig. 8, centre). In a neighbouring colony cells with equally pointed ends were essentially longer: 20—21 μm (Fig. 8, bottom right). Between these extreme types the transition was continuous. On some chloroplasts there were up to pyrenoids and the cytoplasm was considerably vacuolized, a phenomenon current with other species, too, however. The characteristic feature was the prevailing spherical to spherically oval mucilaginous envelope, also on solitary cells.

11. *Elakatothrix gelatinosa* WILLE Biol. Centralbl. 18 : 302, 1898 Fig. 9; 10

Synonyms:

Raphidium planctonicum WOŁOSZYŃSKA Hedwigia 55 : 202, 1914; incl.?
Raphidium planctonicum WOŁOSZYŃSKA sensu PRINTZ 1927.

Cells seldomly singular, usually by 2—32, sometimes up to 80 in the colony, arranged in the mucilage usually one after the other in pairs along the lengthwise axis of the colony. Colonies fusiform, elongate up to cylindrical or irregular; mucilage homogeneous, unlayered. Cells spindle-shaped or fusiform-cylindrical, straight or only slightly bent, the ends pointed or bluntly pointed. Chloroplast parietal, with one central pyrenoid. The daughter cells remain in pairs for a certain time, then they become detached from each other along the longitudinal cell axis. Sporadically a junction of cell pairs into pseudofilaments was observed.

A characteristic of the species is that the daughter cells remain in pairs for a relatively long time, and that cylindrical colonies are frequently formed. In the laboratory material from lake Patalakti in Central Finland cell pairs were found linked up into uniseriate pseudofilaments (Fig. 10 : 2). Such colonies were reminiscent of some representatives of the genera *Geminella* TURP. or *Radiofilum* SCHMIDLE (*Ulotrichales*), in which cell pairs are similarly placed after each other in the mucilaginous sheath.

Elakatothrix gelatinosa is rather a collective species to which ellipsoidal as well as long cylindrical colonies are assigned with *E. genevensis*-like cells that remain together in pairs for a certain time after division. It is probable that, in addition to two known varieties, other infraspecific taxa or indipendent species are going to be established (see NYGAARD 1977, 1979 sub *Elakatothrix* spp.).

Two varieties have been established:

a) var. gelatinosa Fig. 9 : 1—7; 10

Colonies fusiform, fusiformly cylindrical or cylindrical, 30—120 μm in

length. Cell ± fusiform, straight or slightly bent up to sigmoid, the ends pointed or bluntly pointed, 13—30 × 2.5—6 μm. Cell pairs sporadically joined into uniseriate pseudofilaments. The formation of brownish aplanospores (WILLE 1898) was not confirmed.

Occurrence: in the plankton of stagnant and running waters, probably distributed throughout the world; in Czechoslovakia it was found in Lake Máchovo jezero in Northern Bohemia (PASCHER 1915) and in the river Danube in Bratislava (HINDÁK 1962; see also Fig. 10 : 1). The author had the opportunity to find it in lakes in Austria, the German Federal Republic, Finland, Canada and Cuba.

b) var. *aplanospora* LUND. J. Linn. Soc. London Bot. 55(361) : 596, Fig. 2, 1956 Fig. 9 : 8

Colonies oval, spindle-shaped, cylindrical or irregular, up to 80-celled, up to 260 × 170 μm. Cells irregularly fusiform to fusiform, slightly asymmetrical, the ends bluntly pointed, 12—36 × 3—4 μm, not forming pseudofilaments. Aplanospores (monospores) spherical, in the beginning with two contractile vacuoles; later, without contractile vacuoles and with a thick wall.

Occurrence: in the plankton of the English Lake District, United Kingdom.

The variety *aplanospora* differs from the type variety by slightly asymmetrical fusiform to spindle-shaped — cylindrical cells, by the formation of large and often irregular colonies and by the formation of aplanospores (monospores). Aplanospores are formed in cells with one or two pyrenoids. The formation of aplanospores is unique not only in the genus *Elakatothrix*, but also among green algae. The formation of two contractile vacuoles, which dissolve later, is unique in the resting stages. Their presence would rather be indicative of the formation of mobile reproduction stages or of the sexual process, contingently of autogamy.

12. *Elakatothrix arvernensis* R. et F. CHODAT Veröff. Geobot. Inst. Rübel 29/3 : 448, Fig. 8—10, 1925 Fig. 11 : 1, 2

Synonym:

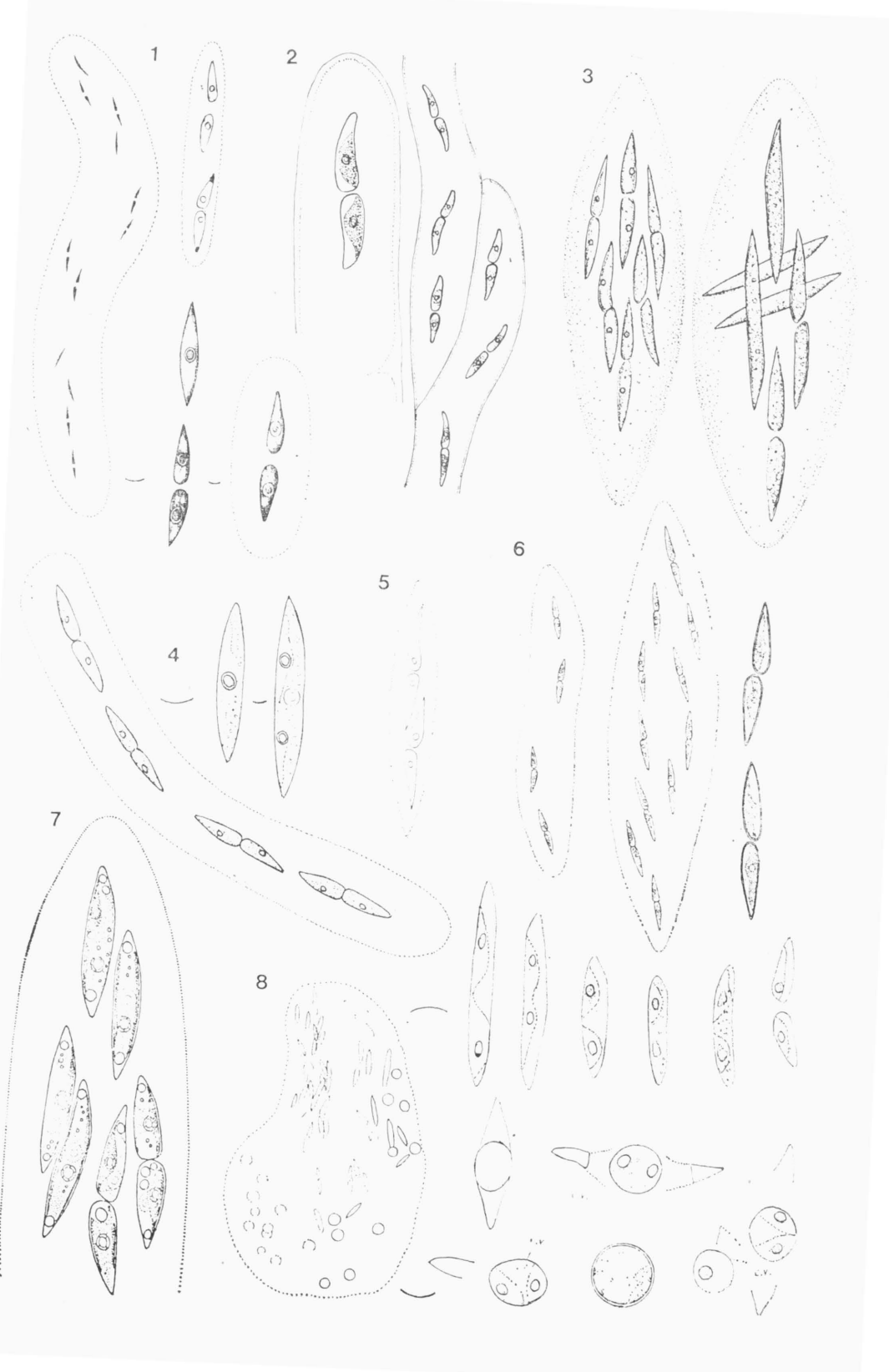
Elakatothrix minima BECK-MANNGETTA Arch. Protist. 66 : 6, 1929; incl.?

Colonies ± cylindrical, straight to slightly bent or bifurcated, with diffusing and weakly conspicuous mucilage, composed of several to 32 cells, with cells placed one after the other or irregularly, up to 250 μm in length. Cells spindle:shaped to slightly asymmetrical, straight up to slightly bent or sigmoid, the ends narrowed and pointed, 6—5 × 1.5—2.2 μm. The chloroplast fills almost the entire cell; pyrenoid one, small, often scarcely conspicuous. Daughter cells remain in pairs only for a short time and become detached from each other along the longitudinal cell axis.

Occurrence: in plankton of lakes (France, Denmark).

Charakteristics of the species are relatively small cells with diffusing, often inconspicuous mucilage in which the cells are usually placed uniseria-

Fig. 9. — 1—7, *Elakatothrix gelatinosa* WILLE var. *gelatinosa* (1, from WILLE 1898, 2, from BOURRELLY 1966, 3, from SKUJA 1948, 4, from KORŠIKOV 1953, 5, from COMPÈRE 1976, 6, from G. M. SMITH 1920, 7, from ETTL 1968), 8, *E. gelatinosa* var. *aplanospora* LUND (from LUND 1956).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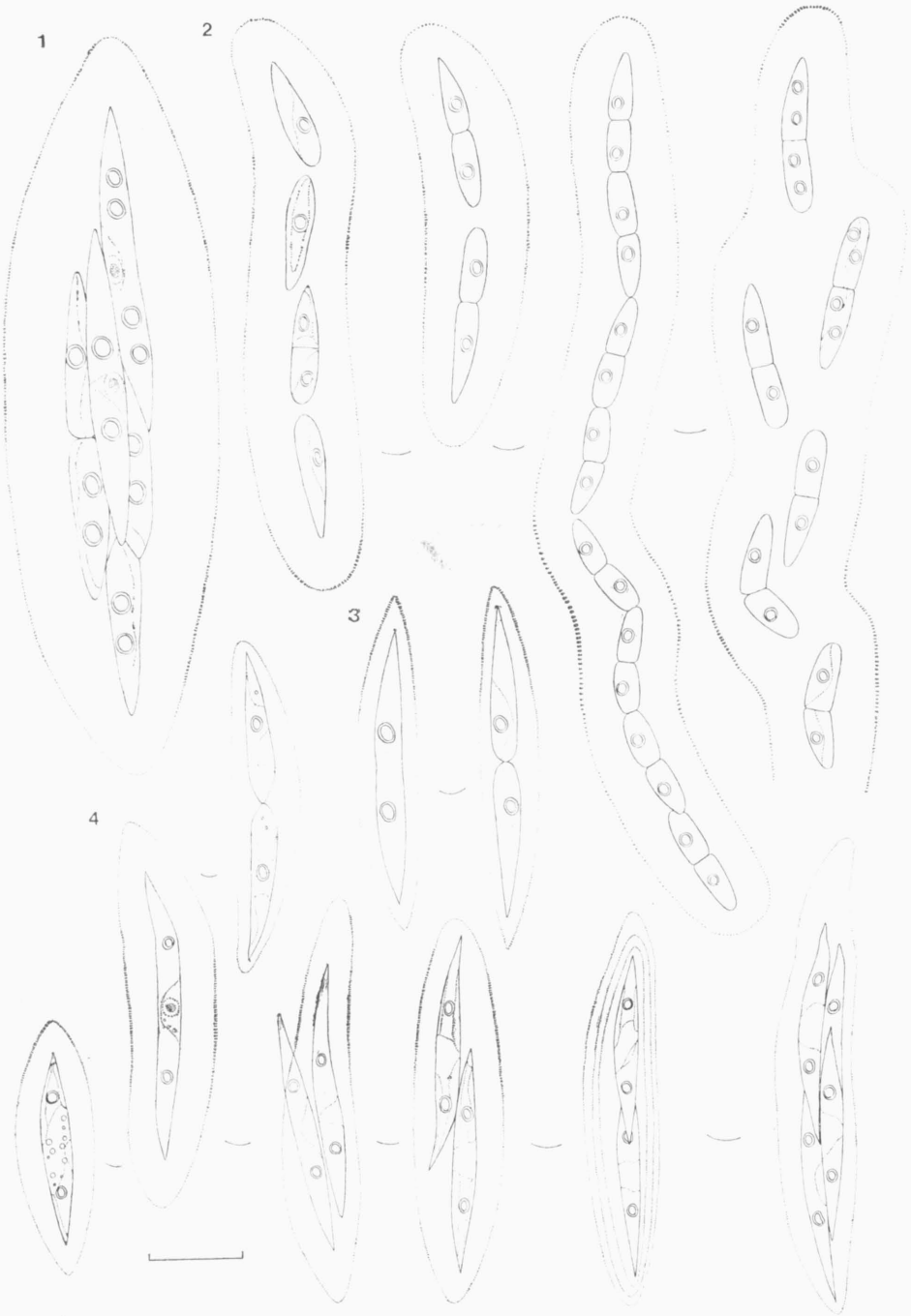

Fig. 10. — 1—4, *Elakatothrix gelatinosa* WILLE var. *gelatinosa* (1, specimensfro ui the river Danube in Bratislava, 2, from the lake Patalakti, Finfland, 3, from the pool Eisl ochnear Seeon, F.R.G., 4, from South Indian lakes, Canada). Scale: 10 μm.

tely. BECK-MANNAGETTA (1929) found a similar species in a peat-bog near Špindlerův Mlýn, Krkonoše Mts. (Giant Mts.), Czechoslovakia, and gave it the name *E. minima* obliously because of small cell dimensions (Fig. 11 : 3). The cells were only 5.5—8.5×1.5—1.8 μm and their arrangement in the colonial mucilage was also similar to *E. arvenensis*. No reference was made by BECK-MANNAGETTA to the presence of a pyrenoid and to the shape of the chloroplast. In thus cannot be stated with complete accuracy that the alga in question was *E. arvernensis* or a green alga at all.

13. *Elakatothrix biplex* (NYGAARD) HINDÁK Preslia 34 : 285, 1962 Fig. 12

Basionym: *Elakatothrix gelatinosa* WILLE f. *biplex* NYGAARD Dansk Planteplankton, p. 46, t. 4, Fig. 3, 1945.

Colonies 2—4—8-celled, rarely with more cells or cells solitary. Mucilage diffused, inconspicuous or up to tough and pronounced, up to 100 μm diam.; cells in the mucilage placed in a row one after the other. Cells fusiform to irregularly fusiform, straight or slightly bent, narrowed towards the ends and bluntly pointed. The daughter cells remain in pairs for a relatively long time.

Species with two varieties: type var. *biplex* and var. *conglutinata* NYG.

a) var. *biplex* Fig. 12 : 1—3

Cells singular or 2—8, rarely more in the colony, 7—17.5—(27)×2.5—3 to (5.5) μm. Colonies with two cells 21—51×6—19 μm, with 8 cells up to 100 μm in length. The mucilaginous envelope is weakly visible or differentiated into an inner rather conspicuous layer and an outer diffusing layer (HINDÁK 1962). Chloroplast parietal, with one pyrenoid.

Occurrence: in the plankton of lakes in Denmark (Nygaard 1945, 1977) and in the High Tatras, Czechoslovakia (Hindák 1962).

The specimens from Danish lakes had colonies of several cells and a hyaline structurless mucilage (Fig. 12 : 1, 2). From Štrbské pleso-lake, in contrast, they were usually 1—2-celled and their mucilage was differentiated into an internal ellipsoid layer and an external diluted and irregular layer (Fig. 12 : 3). Cell shape and dimensions from both Denmark and Czechoslovakia were in good agreement.

b) var. *conglutinata* NYGAARD Kong. Dansk Vid. Selkab, Biol. Skriftler 21, 1 : 81, Fig. 74, 1977 Fig. 12 : 4

Colonies two-celled, contigently of solitary cells with tough and elongate, oval to irregular and conspicuously limited mucilaginous envelopes of their own, 32—65×7—11 μm. Cells 7—13.8×2.5—3.4 μm. The chloroplast fills the entire inner perimeter of the cells; pyrenoid one.

Occurrence: in the plankton of the very shallow *Lobelia-Litorella*-dune lake, Denmark.

A significant diagnostic feature of var. *conglutinata* is the tough and homogeneous mucilage found only in this taxon within the genus *Elakatothrix*.

14. *Elakatothrix spirochroma* (REVERDIN) HINDÁK Preslia 34 : 288, Fig. 29 : 1—9, 23 : 1—5, 1962 Fig. 13 : 1, 2; 14

Basionym: *Raphidium spirochroma* REVERDIN Bull. Soc. Bot. Genève 9 : 4, Fig. I; I—VI, 3 1917.

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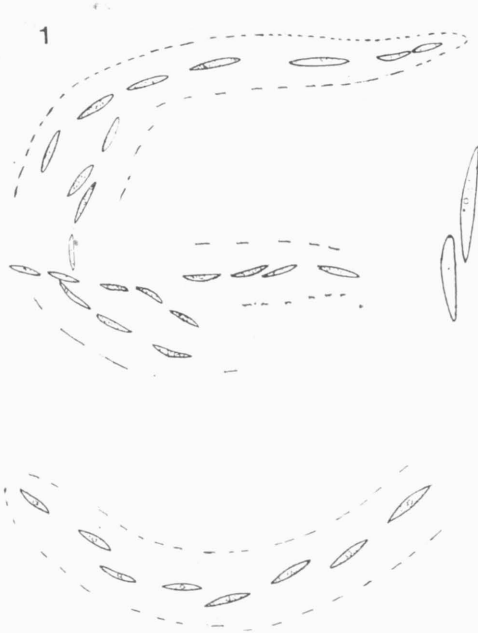

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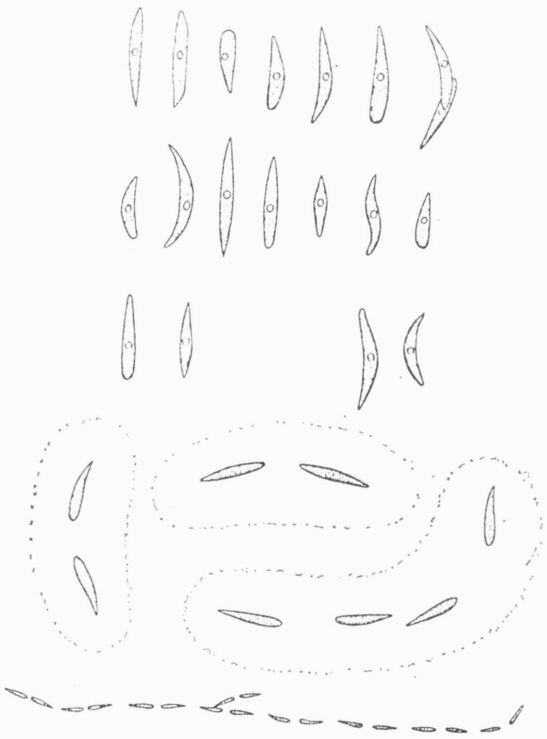

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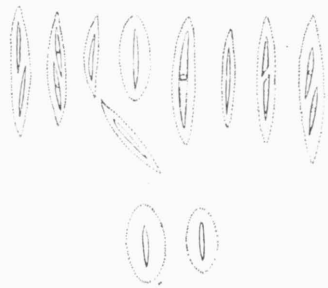


Synonym: *Ankistrodesmus spirochroma* (REVERDIN) REVERDIN Arch. Sci. Phys. Nat. 1 : 78, Fig. 63—75 1919.

Colonies 2—4-celled, rarely with more cells; mucilage hyaline, structureless, 3—5 μm around cells, with cells positioned obliquely side by side. Cells irregularly fusiform, slightly asymmetrical, or slightly bent to slightly sigmoid, attenuated toward the ends, and the ends tapered into a short hyaline, sometimes sidewise bent projection, 21—59×3—5.5 μm. Chloroplast parietal straight to helically twisted (max. 1 3/4 of a thread), with 1—2 pyrenoids. In the cytoplasm there are numerous large vacuoles, sometimes with inclusions. Daughter cells do not form pairs for a long time, they soon separate from each other and hift sidewise next to each other.

Occurrence: in the plankton of water reservoirs (the Lake Léman in Switzerland, REVERDIN 1917, 1919; fishponds and water reservoirs in Czechoslovakia) and rivers (the Danube in Bratislava, both HINDÁK 1962); in stagnant waters in Zapata, Cuba, (KOMÁREK in litt.).

The species can be recognized easily according to asymetrical and relatively large cells, the helical chloroplast, and the large number of vacuoles in the cytoplasm. In addition to such characteristic cells, however, there also occur at the same time regularly spindle-shaped and scarcely vacuolized cells with a straight, parietal chloroplast (Fig. 13 : 2). Such variability was observed several times in Czechoslovakia (HINDÁK 1962, Fig. 14 : 1, 2). The figures made available by Dr. KOMÁREK, Třeboň (Fig. 14 : 3) are also indicative of the relatively broad variability of this species as to cell shape and size. In addition to "normal" adult cells up to 30 μm in length, we have also found cells twice that length, around 60 μm. According to our experience, in Czechoslovakia the species belongs to the most frequent representatives of the genus in both running and stagnant waters and obviously it will currently occur in other countries, too.

15. *Elakatothrix parvula* (ARCHER) HINDÁK Preslia 34 : 289, Fig. 29 : 10—15, 34 : 1—7, 1962 Fig. 13 : 3

Basionym: *Spirotaenia parvula* ARCHER Proc. Dubl. Nat. Hist. Soc. 3/2 : 84, 1863.

Colonies 2—4-celled, 60—115×17—20 μm, cells rarely singular; mucilage homogeneous, with cells in succession or obliquely side by side. Cells ± fusiform, slightly asymmetrical, narrowed towards the ends and bluntly pointed, 25—40×3.1—5.8—(6.5) μm. Chloroplast parietal, helically twisted (3/4 — 2 threads), with one central pyrenoid. Vacuoles and oily drops are frequent in the cytoplasm.

Occurrence: in sphagnum bogs; in Czechoslovakia it was found in the peat-bog of Slepé pleso-lake near Štrbské pleso-lake, the High Tatras (HINDÁK 1962).

As already indicated, some species of the genus *Spirotaenia* BRÉB. ex RALFS (*Mesotaeniales*) should perhaps rather belong to the genus *Elakatothrix*. The helical shape of the chloroplast, characteristic of the genus *Spirotaenia*, is also encountered in representatives of the genus *Elakatothrix* (e.g. *E. spirochroma*). In addition, the formation of zygotes in *Spirotaenia* was observed

Fig. 11. — 1, 2, *Elakatothrix arvernensis* R. et F. CHOD. (1. from R. et F. CHODAT 1925, 2, from NYGAARD 1977), 3, *E. minima* BECK-MANN. (from BECK-MANNAGETTA 1929), 4, *E. genevensis* (REVERD.) HIND. f. (from NYGAARD 1979).

in some representatives. It would thus be necessary to trace other features than the shape of the chloroplast, namely in those species which exhibit a fusiform shape and a chloroplast with a relatively low number of threads as in the case of *S. parvula* ARCH.

THE GENUS *CLOSTERIOSPIRA* REVERDIN 1917

Closteriospira REVERDIN Bull. Soc. Bot. Genève 9 : 8—10, 1917
(sec. *Closteriospira* REVERDIN Arch. Sci. Phys. Nat. 1 : 86—90, 1919)

Cells free floating, spindle-shaped, with pointed ends, solitary or in 2—4 in colonies. Cell wall smooth, hyaline, cell ends with conspicuously short, cap-like thickenings. Nucleus one, in the centre of the cell. Chloroplast parietal, helically twisted, with one or more pyrenoids. Carotin bodies concentrated at the cell ends. Asexual reproduction by crosswise division into two equal portions. Other multiplication modes as well as the formation of resting stages not observed. — Type species: *C. lemanensis* REVERDIN.

The hitherto uncertain taxonomic position of the genus was already discussed in the introduction to this paper. Particular emphasis should be given to the necessity of EM cytological investigations which might decide the position of the genus within the system of green algae.

The only species:

Closteriospira lemanensis REVERDIN Bull. Soc. Bot. Genève 9 : 8—10, Fig. I, II, 1—3, 1917 (sec. *C. lemanensis* REVERDIN Arch. Sci. Phys. Nat. 1 : 86—90, Fig. 86—92, 1919) Fig. 15

Synonym: *Spirotaenia lemanensis* (REVERDIN) PRINTZ Engler-Prantl's Nat. Pflanzenfam., p. 352, 1927.

Cells spindle-shaped to fusiformly-cylindrical, straight or only slightly bent, ends narrowed, rounded to bluntly pointed, (18)—50—55 × (2.5)—5—6 μm. The mucilag'nous envelope hyaline, structurless, 2—3 μm around cells. Chloroplast parietal, helicaly twisted, with 1—3 threads. Owing to the asymmetric growth of newly formed end, the daughter cells shift side by side not forming pairs, and only later do they shift after one another along the lenghthwise axis of cells.

Occurrence: in the plankton and littoral of lakes, in overgrown waters and peat-bog (Europe); in Czechoslovakia it was found in the peat-bog of Slepé pleso-lake near Štrbské pleso-lake in the High Tatras (Hindák 1962).

From the genus *Elakatothrix*, *E. parvula* stands closest, from the genus *Spirotaenia S. erythrocephala* ITZIG. ex BRAUN (see HINDÁK 1962). The species is relatively variable in cell length. Other characteristic features, such as the cap-like thickened cell ends, the location of carotin bodies at the cell ends are the same as in populations from the plankton of large lakes as well as from the littoral of small peat-bogs.

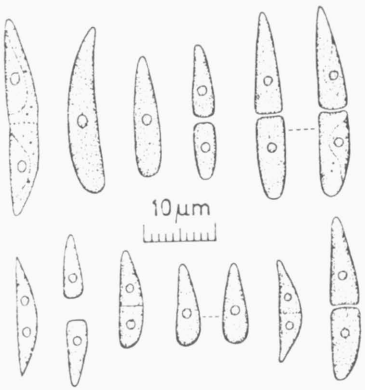
THE GENUS *CHADEFAUDIOTHRIX* BOURRELLY 1957

Chadefaudiothrix BOURRELLY Rev. Algol. 3 : 97—102, 1957.

Synonyms:

Elakatothrix WILLE 1898 sensu auct. post. p.p.
Ecballocystis BOHLIN 1897 sensu auct. post. p.p.

Fig. 12. — 1—3, *Elakatothrix biplex* (NYG.) HIND. var. *biplex* (1, 2, from *Nygaard* 1977, 3, from HINDÁK 1962), 4, *E. biplex* var. *conglutinata* NYG. (from NYGAARD 1977).



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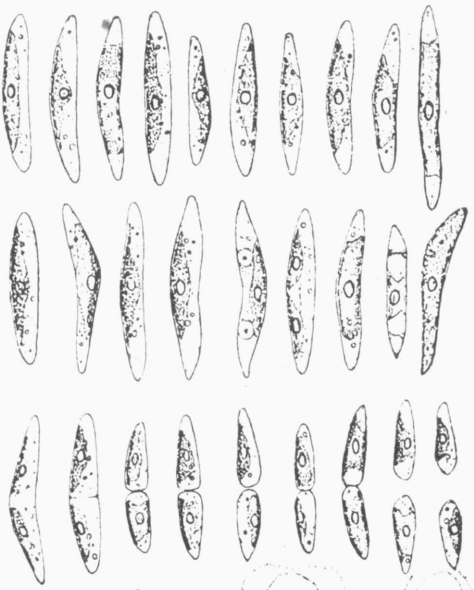

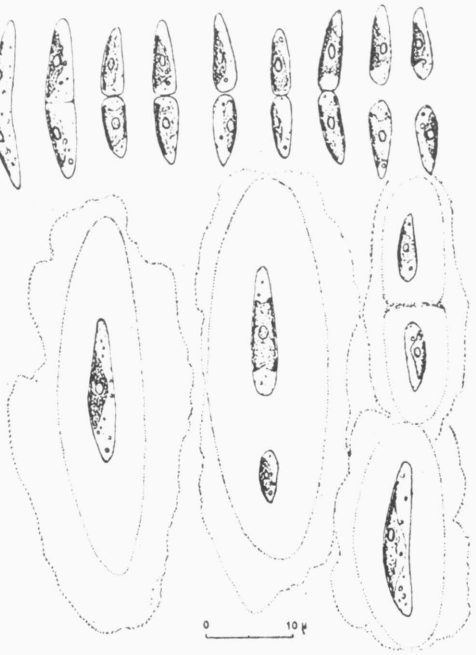

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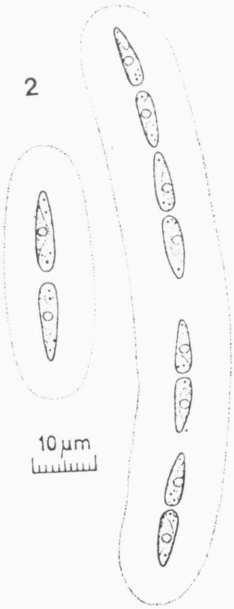

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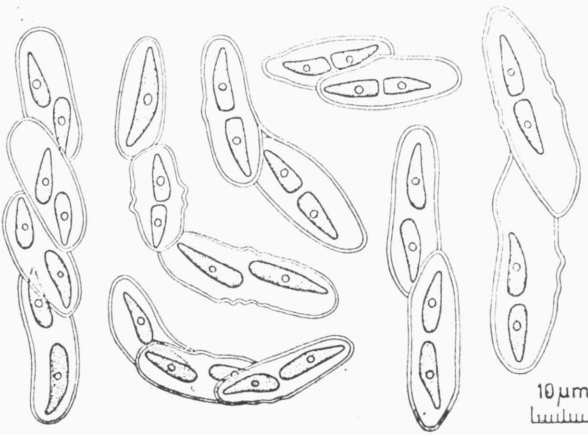

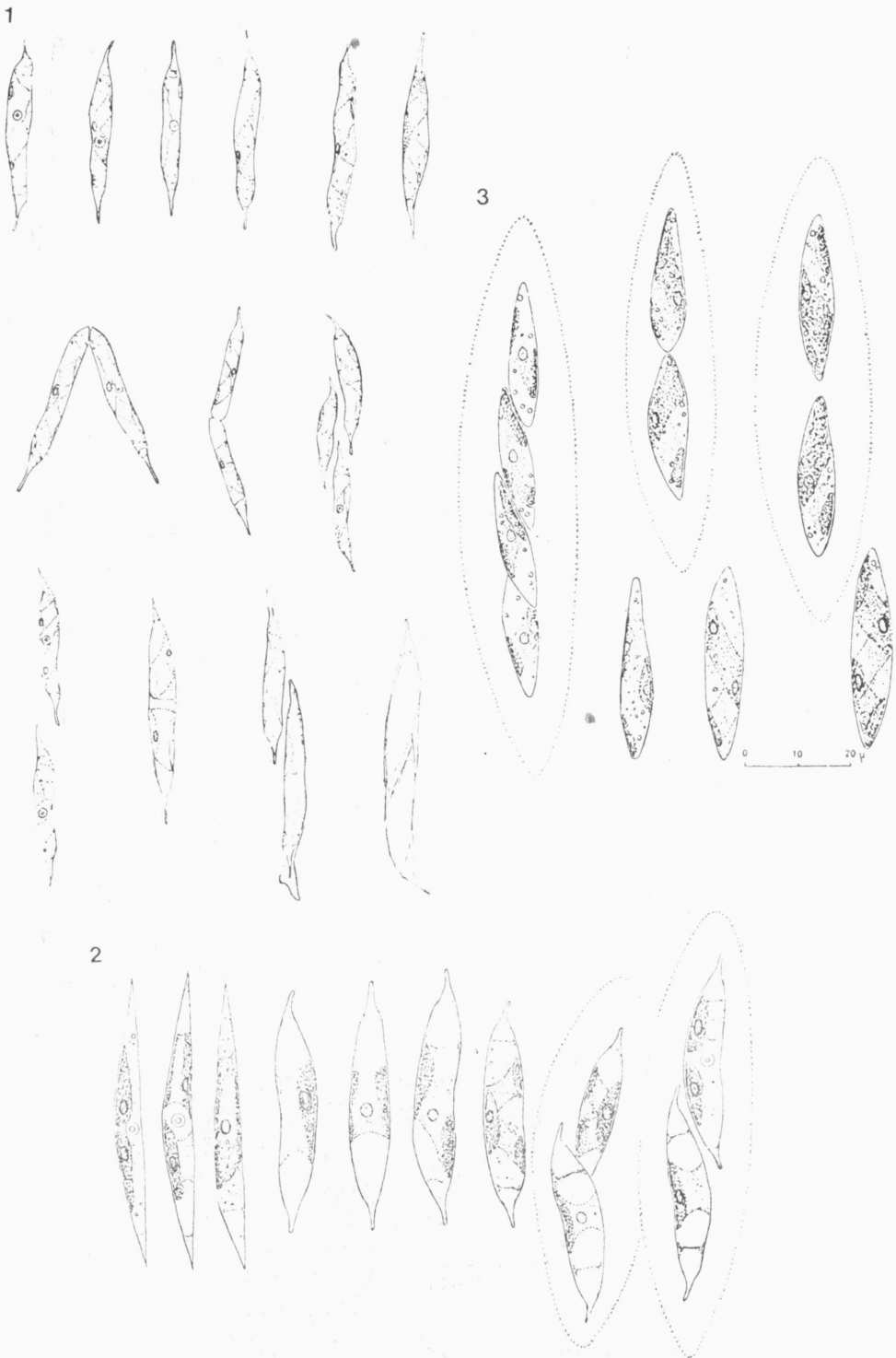

Fig. 13. — 1, 2, *Elakatothrix spirochroma* (Reverd.) Hind. (1, from Reverdin 1917 as *Raphidium spirochroma* Reverd., 2, from Hindák 1962), 3, *E. parvula* (Arch.) Hind. (from Hindák 1962).

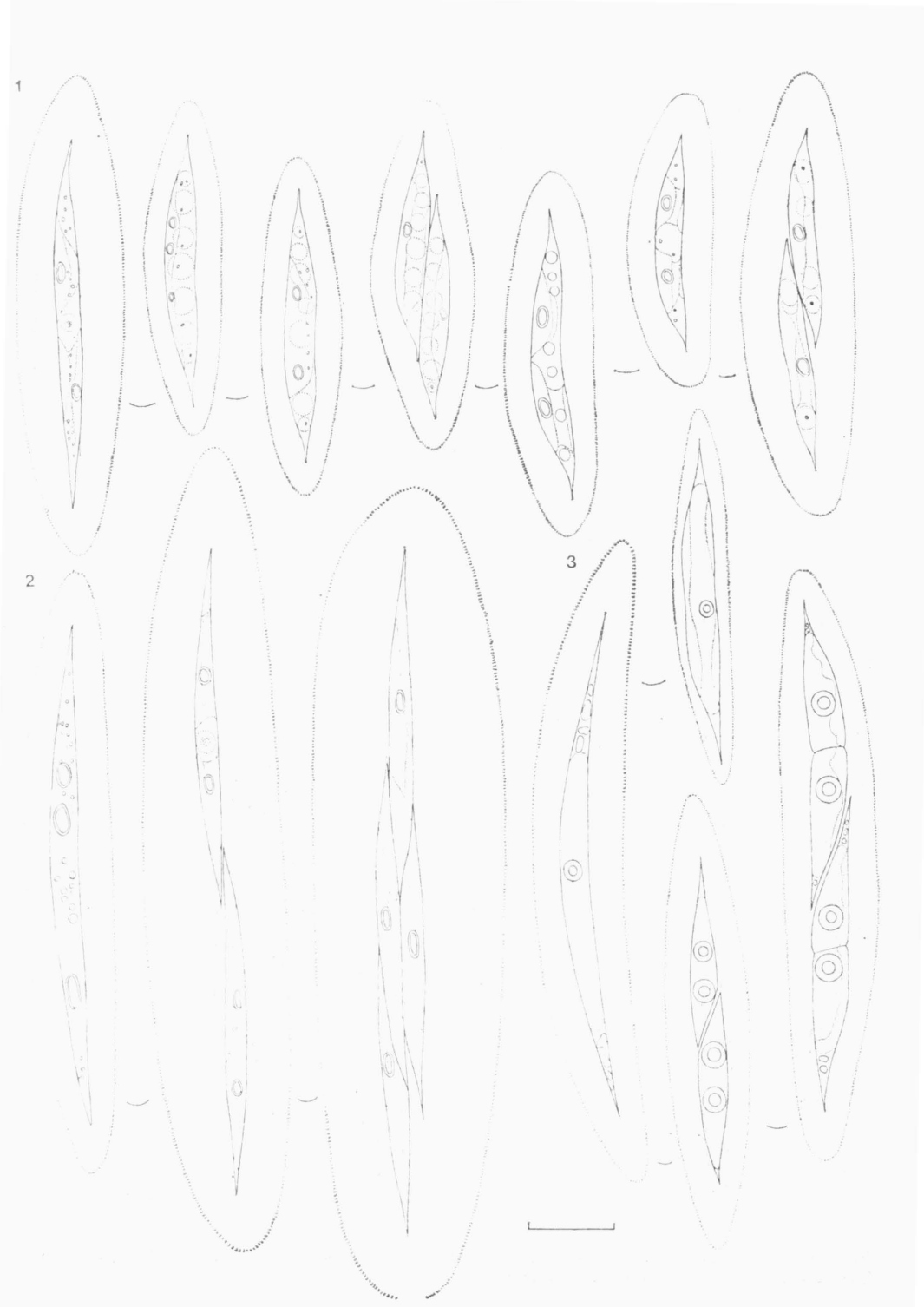

Fig. 14. — 1—3, *Elakatothrix spirochroma* (Reverd.) Hind. (1, specimens from the fishpond in Bratislava-Železná Studienka, 2, from a small water reservoir at Modra, W. Slovakia, 3, from water reservoirs at Zapata, Cuba, after Komárek in litt.). Scale: 10 μm.

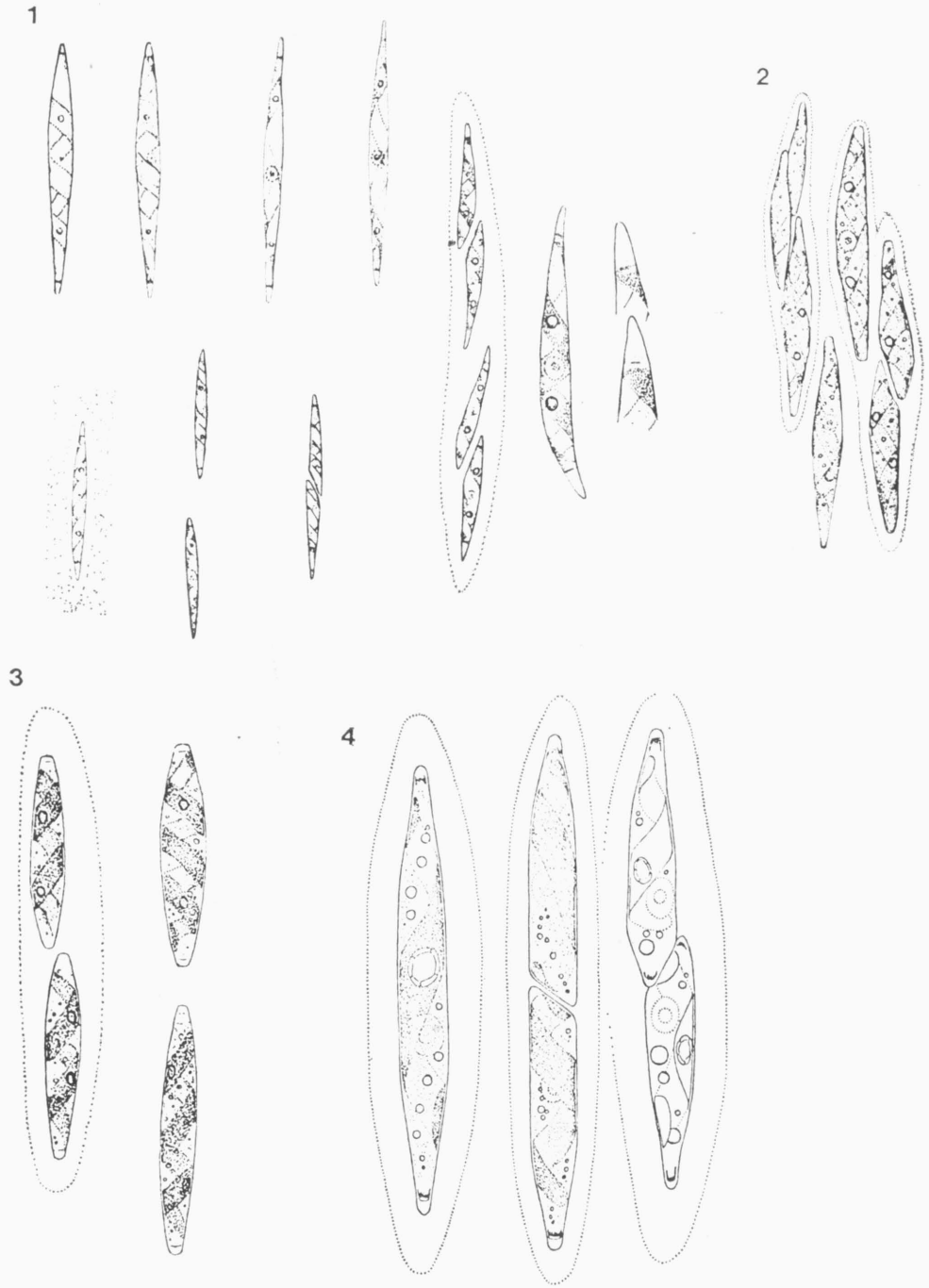

Fig. 15. — 1—4, *Closteriospira lemanensis* Reverd. (1, from Reverdin 1917 sec. 1919, 2, from Skuja 1948, 3, from Hindák 1962, 4, from Ettl 1968).

Colonies free floating or attached to a substrate, with cells placed in rows after each other in a hyaline, sometimes structureless mucilaginous envelope. Cell fusiform to fusiform-cylindrical, the ends bluntly pointed or pointed. Nucleus one. Chloroplast parietal, plate-shaped, 1—2—(4) in number, without a pyrenoid. Asexual reproduction by transverse cell division into two equal parts; daughter cells may be joined in pairs for a certain time. Other reproductive modes or resting stages were not observed. — Type species: *Ch. gallica* BOURRELLY.

As already indicated, in the author's conception the genera *Elakatothrix* and *Chadefaudiothrix* differ only by the pyrenoid which is present in the first genus and missing in the latter. In addition to the type species *Ch. gallica*, two other species have been included in the genus *Chadefaudiothrix* by BOURRELLY: *Elakatothrix minouchetti* BOURR. and *Ecballocystis fluitans* FRITSCH. ETTL (1978), in the monograph on *Xanthophyceae*, however, does not mention the last species referred to; but KOMÁREK and FOTT (1983) presented *Ecballocystis fluitans* among the *Chlorococcales*. We transfer *Elakatothrix pseudogelatinosa* KORŠ., in which cells have no pyrenoid, to the genus *Chadefaudiothrix*. None of the three species of the genus *Chadefaudiothrix* have again been found since their establishment; additional data on morphological variability of cells and colonies are therefore needed.

Key for the determination of species:

1a Cell ends blunt.
2a Cells 6—8 μm wide, chloroplast 1—2: 1. *Ch. gallica* BOURR.
2b Cell 2 μm wide, chloroplast one: 2. *Ch. minouchetii* (BOURR.) BOURR.
1b Cell ends pointed: 3. *Ch. pseudogelatinosa* (KORŠ.) HIND.

1. *Chadefaudiothrix gallica* BOURRELLY Rev. Algol. 3 : 97—102, Fig. 1—4, Pl. 3 : 1, 2, 1957 Fig. 16 : 1

Colonies free floating, elongate, irregular, up to 1 mm in length, with cells in one or two rows one after the other in layered soft mucilage; each cell or pairs of cells has a markedly limited mucilage of its own. Cells spindle-shaped-cylindrical, ends broadly rounded, 27—30 × 6—8 μm. Chloroplast 2—(3), disk-shaped, green-yellow.

Occurrence: in a small peat bog with pH 6.5, Seine-et-Oise, France.

2. *Chadefaudiothrix minouchetii* (BOURRELLY) BOURRELLY Rev. Algol. 3 : 101, 1957 Fig. 16 : 2

Basionym: *Elakatothrix minouchetii* BOURRELLY Rev. Gen. Bot. 54 : 10, Pl. VI, Fig. 54—56, 1947.

Colonies attached with a mucous disk to immersed aquatic plants, short, 4—32-celled, with cells positioned uniseriately after each other in a hyaline mucilage 13—15 μm in width; each cell or pair of cells has a conspicuously limited mucilaginous envelope of its own. Cell long and cylindrically-fusiform, the ends bluntly pointed, 12—16 × 2 μm. Chloroplast one, elongately parietal.

Occurrence: in a fishpond in the Forêt de Fontaineblau, France.

3. *Chadefaudiothrix pseudogelatinosa* (KORŠIKOV) HINDÁK, comb. nova Fig. 16 : 3

Basionym: *Elakatothrix pseudogelatinosa* KORŠIKOV Vizn. Prisnovodn. Vodor. Ukr. RSR 5 : 413, Fig. 416, 1953.

Fig. 16. — 1, *Chadefaudiothrix gallica* Bourr. (from Bourrelly 1957), 2, *Ch. minouchetii* (Bourr.) Bourr. (from Bourrelly 1947 as *Elakatothrix minouchetii* Bourr.), 3, *Ch. pseudogelatinosa* (Korš.) Hind. (from Koršikov 1953 as *Elakatothrix pseudogelatinosa* Korš.).

Cells placed in one row in hyaline mucilage around 14 μm in width. Cells fusiform, the ends pointed, 14—28 × 3 μm. Chloroplast one, parietal, without a pyrenoid.

Occurrence: in the plankton of lakes in the European part of the USSR (Koršikov 1953, Mošková et Gollerbach 1986).

SÚHRN

Podáva sa prehľad taxonómie 4 rodov zelených rias (*Chlorophyceae*) vyznačujúcich sa vretenovitými bunkami uloženými v slize; rozmnožujú sa buď autospórami (*Fusola* Snow), alebo priečnym delením na dve časti (*Elakatothrix* Wille. *Closteriospira* Reverdin, *Chadefaudiothrix* Bourrelly). Rozmnožovanie autospórami sa pri zelených riasach pokladá za znak charakteristický pre rad *Chlorococcales*. priečne delenie buniek za znak radu *Ulotrichales*. Diskutujú sa hlavné diagnostické znaky týchto rodov ako aj iných morfologicky podobných zelených rias. Uvádzajú sa určovacie kľúče na druhy a prehľad infragenerických taxónov s obrázkami z citovanej literatúry a s pôvodnými obrázkami autora. V rode *Elakatothrix* sa navrhujú 2 nové kombinácie: *E. ovalis* (Ettl) Hind. a *E. gelifacta* (Chod.) Hind., v rode *Chadefaudiothrix* jedna: *Ch. pseudogelatinosa* (Korš.) Hind.

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