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Contribution to the taxonomy of some cyanophyte genera

Príspevok k taxonómii niektorých rodov siníc

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Morphological variation of cells, colonies, pseudotrichomes and trichomes of some new or rarely occurring cyanophytes found in different countries and habitats have been studied and taxonomically evaluated. *Cyanotetras fusca*, gen. et sp. nov., resembles representatives of the genus *Merismopedia* MEYEN but differs from them by brown incrustated and spherical mucilaginous envelopes and formation of mostly 4-celled *Crucigeniella*-like colonies. *Johannesbaptistia pellucida* (DICKIE) TAYLOR et DROUET with *Radiofilum*-like pseudofilaments is a common inhabitant of brackish lagoons in SW Cuba. Three new members of the genus *Romeria* KOCZW. in GEITL. occurring in eutrophic gravel pit lakes in W Slovakia have been suggested: *R. simplex* (HIND.) comb. nova, and two new species: *R. cylindrocellularis* and *R. crassa*. *Arthronema africanum* (SCHWABE et SIMONS.) KOM. et LUK. studied from a laboratory culture is characterized by trichomes having irregular shape and markedly unequal cells. *Trichodesmium lacustre* KLEB. f. sampled in Lake Volvi, NE Greece, did not form bundles and solitary free floating trichomes consisted of discoid cells of different diameter, and occasionally cylindrical cells at one end of trichomes were formed. *Borzia trilocularis* COHN and *Katagnymene accurata* GEITL. control the length of trichomes/filaments by bipartition as soon as a certain length has been reached; they were found in *Sphagnum* littoral parts of dystrophic lakes in Switzerland and Austria, respectively.

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INTRODUCTION

In different countries and different types of aquatic habitats, some new or rare cyanophytes have been observed. A new representative of the subfamily *Merismopedioideae* (ELENK.) KOM. et ANAGN. 1986, *Cyanotetras fusca*, is proposed. It forms typical small few-celled *Merismopedia*-like colonies embedded in brown incrustated mucilaginous envelopes. *Johannesbaptistia pellucida* (DICKIE) TAYLOR et DROUET has been collected from shallow brackish waters in various countries; we sampled it in SW Cuba. The genus *Romeria* KOCZW. in GEITL. belonging into the subfamily *Synechococcoideae* KOM. et ANAGN. 1986, is enriched by three new members: one species is transferred from the genus *Tubiella* GOLLERB., *T. simplex* HIND. = *R. simplex* (HIND.) comb. nova, and the othersare new species, viz. *R. cylindrocellularis* and *R. crassa*. Trichomes with conspicuously different vegetative cells both in length as well as in width, are typical for *Arthronema africana* (SCHWABE et SIMONS.) KOM. et LUK. A rare planktic species, *Trichodesmium lacustre* KLEB. f., has been found in Lake Volvi, Greece; in contrast to literary data, trichomes did not join in *Aphanizomenon*-like bundles; solitary free floating trichomes consisted of discoid cells of distinctly different diameter, and occa-

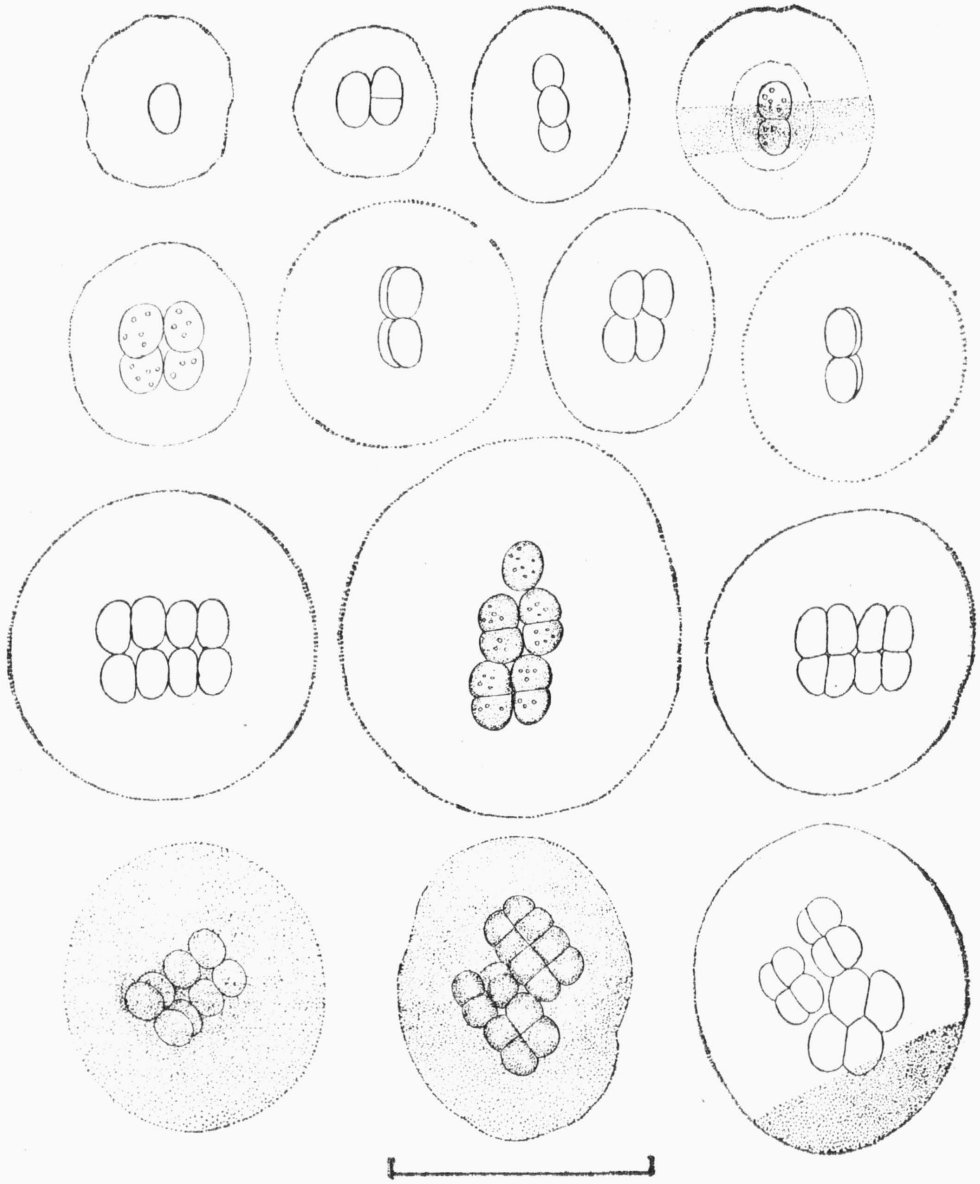

Fig. 1. — *Cyanotetras fusca* HIND., specimens from a forest pool at Biely kríž near Bratislava. Scale: 10 μm.

sionally cylindrical cells at one end of trichomes were formed and in such way heteropolar trichomes arose. The length of trichomes is limited and controlled in some genera, e.g. in *Borzia* COHN and *Katagnymene* LEMM. (GEITLER 1932, 1982). While the type species of the genus *Borzia*, *B. trilocularis* COHN 1883, has been recorded several times, another inhabitant of peat-

bog lakes, *Katagnymene accurata* GEITL. 1982, has been established quite recently.

Cyanotetras HINDÁK, gen. novum

Diagnosis: Coloniae microscopicae, liberae, tabulatae, unistratosae, *Merismopedia* similes. Tegumentum gelatinosum sphaericum usque ovatum, brunneum. Cellulae ovales, quaternae in colonias. Divisio cellularum in partes duas, in generationibus sequentibus in directiones duas; fragmentatio coloniarum in duas vel complures partes.

Typus generis: *C. fusca* HINDÁK, sp. nova.

Colonies microscopic, free, flat, tabular, one-layered, *Merismopedia*-like. Mucilaginous envelopes homogeneous, brown, with Fe-precipitates. Cells oval, in flat tetrads in colonies. Cell division into two equal parts, in subsequent generations in two perpendicular directions. Multiplication of colonies by fragmentation in two or more parts.

Type species: *C. fusca* HINDÁK, sp. nova.

Cyanotetras fusca HINDÁK, sp. nova (Fig. 1)

Diagnosis: Coloniae microscopicae, 2-4-16-cellulares, libere natantes, unistratosae, tabulatae, ± rectangulares. Tegumentum gelatinosum sphaericum usque ovatum, regulariter pallide brunneum usque fuscum, circa cellulas 6—13 μm in diametro. Cellulae late ovales, 1,5—2,5 × 1,2—1,8 μm, coloris pallide ad lucide coeruleo-viridis, sine pseudovacuolis. Divisio cellularum in partes duas, in generationibus sequentibus in duas directiones.

Habitatio: In stagnis in Biely kríž apud Bratislava, Slovacia occidentalis.

Iconotypus: Figura nostra 1.

Colonies microscopic, 2-4-16-celled, free floating, tabular, one-layered, ± rectangular. Mucilaginous envelopes spherical to oval, homogeneous, evenly pale to dark brown; round cells 6—13 μm in diam. Cells broadly oval, 1.5—2.5 × 1.2—1.8 μm, pale to brightly blue-green in colour, without gas vesicles. Cell division in two equal parts, in subsequent generations in two perpendicular directions.

Occurrence: In a small forest pool at Biely kríž near Bratislava, W Slovakia.

In summer plankton and metaphyton samples from a small forest pool in the Little Carpathians Mts. near Bratislava, the new species has been commonly found for several years. Colonies resembled representatives of the genus *Merismopedia* MEYEN but can be distinguished from them by following features: (i) mucilage was not hyaline but brown in colour; (ii) colonies were small, mostly 4-celled, only after division of cells up to 16-celled; (iii) mucilaginous envelopes were not flat but spherical to broadly oval.

Brown colour of the mucilage was conspicuous and varied from pale to dark shade. Coloration apparently due to Fe-precipitations was homogeneous and evenly distributed throughout all mucilaginous envelopes; only sometimes the centre of colonies was slightly darker but neither agglomerations of brown granules nor light central parts have been observed. In some cases coloration of mucilage became so intensive dark brown that the cells were distinct only by using high magnification (oil immersion). Brown coloration of mucilaginous envelopes was probably of the same character as e.g. in *Chroococcus siderochlamys* SKUJA 1948 with the exception of concentrically layered mucilage and a bright hyaline part just in the vicinity of cells. However, in *Chroococcus siderochlamys* cells divide in three directions in consequent generations and gas vesicles are present.

Number of cells in colonies was controlled and limited. Mostly 4-celled

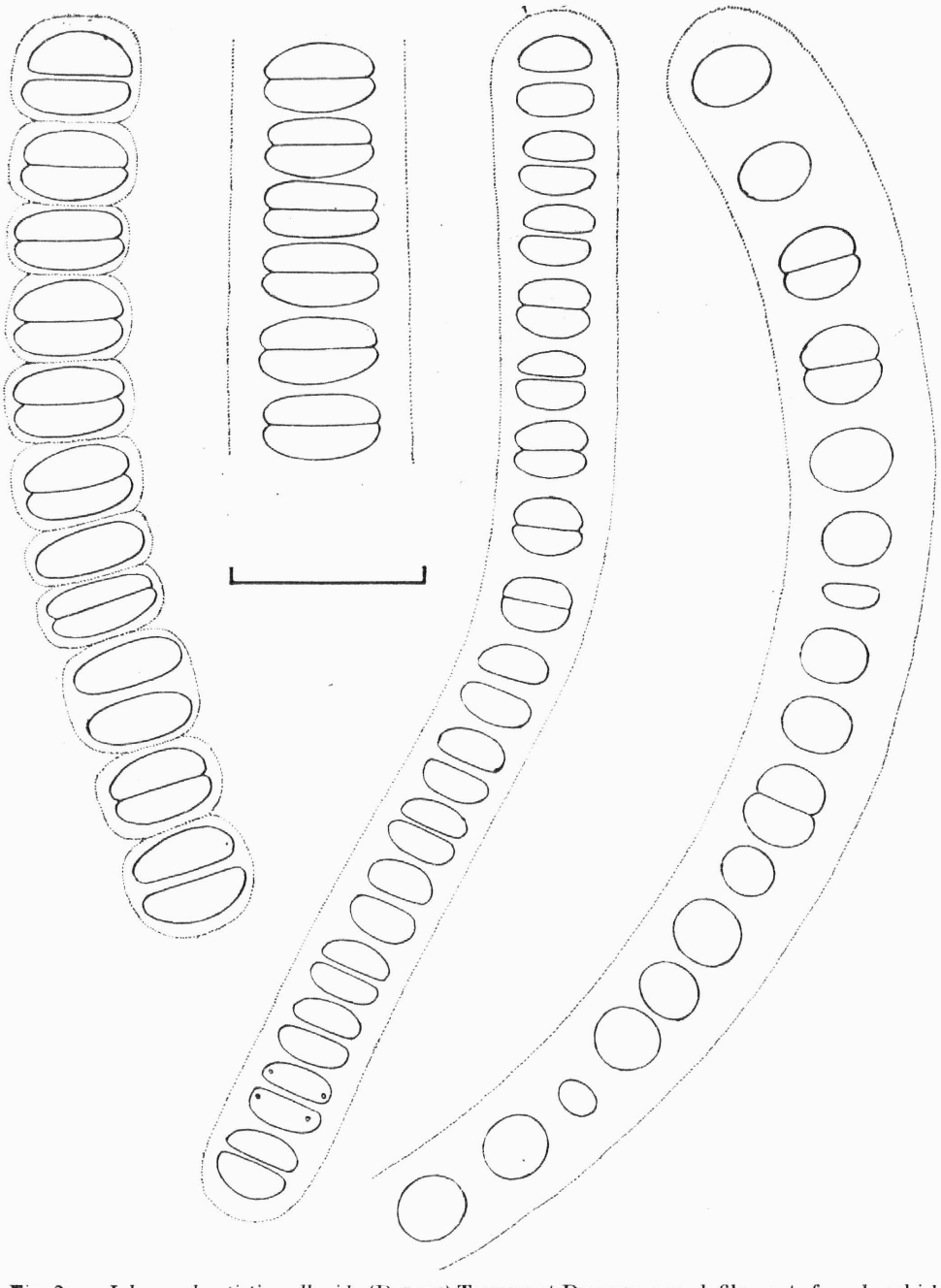

Fig. 2. — *Johannesbaptistia pellucida* (DICKIE) TAYLOR et DROUET, pseudofilaments from brackish pools on the shore of the Carribean Sea at Cabo Corrientes, SW Cuba. Scale: 10 μm.

colonies occurred and more than 16-celled colonies have not been found, i.e. from one cell tetrad four 4-celled colonies arose. However, these 16-celled colonies disintegrated soon into four tetrads again, sometimes even up to solitary cells. By the oval shape of cells, daughter tetrads bore resemblance to a chlorococcal genus *Crucigeniella* in which one axis of the coenobium is longer and the second one shorter, and also a central opening is formed.

Mucilaginous envelopes in the representatives of the genus *Merismopedia* follow the shape of tabular arrangement of cells in colonies, — they are flat in contrast to a new genus *Cyanotetras* in which they have been always spherical or broadly oval.

Johannesbaptistia pellucida (DICKIE) TAYLOR et DROUET (Fig. 2)

In consequence of a formation of uniseriate pseudofilaments, the genus *Johannesbaptistia* DE-TONI 1934 (syn.: *Cyanothrix* GARDNER 1927, *Heterohormogonium* COPELAND 1936) was classified by KOMÁREK and ANAGNOSTIDIS (1986) to the subfamily *Synechococcoideae* KOM. et ANAGN. The only species, *J. pellucida* (DICKIE) TAYLOR et DROUET 1956, has been described under several names (see GOLLERBACH et al. 1953, DESIKACHARY 1959) and recorded from many countries in Europe, Asia and America, always from brackish pools or estuarines of rivers.

Our findings come from shallow pools with higher water plants situated directly on the shore of the Caribbean Sea at Cabo Corrientes, nature reservation Guanahacabibes, Prov. Pinar del Río, SW Cuba, autumn 1979. Pseudofilaments of this species occurred abundantly among diatoms and periphytic filamentous algae or in sediments of pools with brackish (to marine?) water. They were usually very long and formed clusters. Transversally oval cells were solitary or in pairs after division, arranged in single series and embedded in hyaline mucilaginous envelopes, 6—10 μm wide. These envelopes were distinct, homogeneous, transparent, usually firm and only in some cases diffient or with concentrical layers round cells or pairs of cells. Occasionally pseudofilaments consisted of series of single cells with their mucilaginous envelopes only, no common envelopes were present. Old cells were broadly transversally oval to spherical (namely in pseudofilaments with distant cells); young cells were hemispherical to narrowly transversally oval. Dimensions of cells varied in agreement with literary data: (2.5)-3.5-6 × 2-3-(4) μm. Cell contents were homogeneous or only slightly granulated, pale blue-green to olivaceous in colour. Cell division was in one direction, perpendicular to the long axis of pseudofilaments, i.e. to the shorter axis of cells. Daughter cells remained together for some time and than slightly separated. Pseudofilaments with solitary or geminated cells embedded in hyaline mucilage resembled an ulotrichacean genus *Radiofilum* but old cells were neither joined nor connected by strands.

THE GENUS *ROMERIA* KOCZWARA in GEITLER 1932

According to GEITLER (1932) the main diagnostic feature of the genus *Romeria* KOCZW. in GEITL. (syn.: *Raciborskia* KOCZW. 1928, *Amalia* DE-TONI 1934) is a formation of simple isopolar, usually coiled or arcuated pseudofilaments with or without mucilaginous envelopes. The genus was originally placed into the family *Oscillatoriaceae*, usually in the neighbourhood of *Spi-*

rulina TURPIN (GEITLER 1932, HUBER-PESTALOZZI 1938, GOLLERBACH et al. 1953, KOMÁREK 1958, STARMACH 1966). New idea of its classification was suggested by KOMÁREK (1976) who merged the genus *Romeria* with *Synechococcus* NÄG. and proposed a new combination *Synechococcus gracilis* (KOCZW.) KOM. This taxonomic view was also supported by BOURRELLY (1970). In our preceding contribution to the knowledge of planktic cyanophytes of W Slovakia (HINDÁK 1975) we considered *Romeria* as an independent genus, and, futhermore, *Spirulina okensis* (MEYER) GEITLER 1932 was transferred into *Romeria* as *R. okensis* (MEYER) HIND. Apart from coiled solitary pseudofilaments, colonies with disintegrated pseudofilaments (*Rhabdoderma*-stages) have also been observed. For these reasons the genus *Campylotropium* HORTOB. et HILLIARD 1965 with the only species *C. alascense* was considered as synonymous to the genus *Romeria*. Later it was emphasized that the formation of pseudofilaments and thus the absence of typical hormogonia are main diagnostic features distinguishing *Romeria* from *Spirulina*/*Arthrospira* (HINDÁK 1985). KOMÁREK and ANAGNOSTIDIS (1986) re-accepted the genus *Romeria* (syn.: *Campylotropium* HORTOB. et HILLIARD) again and classified it into the subfamily *Synechococcoideae* KOM. et ANAGN. 1986.

Summarizing our knowledge on six accepted species of *Romeria*, the main diagnostic features of the genus should be as follows: Cells joined in free floating, isopolar, bent, circular to coiled pseudofilaments embedded in hyaline mucilaginous envelopes, without motion; cells without gas vesicles; cell division by binary fission in two equal parts; without nanocytes and involution cells. — Type species: *R. elegans* WOŁOSZ. in GEITL. (a newlby proposed lectotype, see later).

Infrageneric taxonomy has not been sufficiently solved. Because no type species from three species originally placed into the genus was designated by KOCZWARA in GEITLER 1932, the species *R. leopoliensis* (RACIB.) KOCZW. in GEITLER 1932 was later chosen by GEITLER (1942). In this species, however, a facultative formation of filamentous involution cells was observed, and therefore the species was assigned by KOMÁREK (1970, 1976) to the genus *Synechococcus* NÄG. as *S. leopoliensis* (RACIB.) KOM. (= „*Anacystis nidulans*"). This was what made KOMÁREK and HINDÁK (in prep.) to propose *R. elegans* WOŁOSZ. in GEITL. 1932, perhaps the best known species of the genus, as a new lectotype. *Romeria chlorina* BÖCHER 1949 was also transferred to *Synechococcus* as *S. chlorinus* (BÖCHER) KOM. 1970. *Romeria austriaca* CLAUS is an unclear species probably belonging to *Borzia* COHN (see p. 305). In this article two new species are suggested: *R. cylindrocellularis* and *R. crassa*, and a new combination, *R. simplex* (HIND.) HIND., is proposed. Thus the genus *Romeria* comprises six species which could be differentiated according to the following key:

1a Cells small, shortly cylindrical, 1—1.4 × 0.6—0.8 μm, with flat ends:
R. cylindrocellularis HIND. sp. nova

1b Cells bigger.

2a Pseudofilaments regularly and densely coiled:
R. okenis (MEYER) HIND.

2b Pseudofilaments bent, semicircular, irregularly or slightly coiled.

3a Cells sausage-like, S-, Y-, L-, T-shaped or irregular.

4a Cells (5)-6-12 × 1.2—1.6 μm, mostly regularly S-shaped or sausage-like bent:
R. simplex (HIND.) HIND. comb. nova

4b Cells 3-5-(7) × (2)-2.5—2.8 μm, mostly irregular:
R. crassa HIND., sp. nova

3b Cells cylindrical, straight to slightly bent.
5a Cells 3.5—4.6 × 1.2—1.5 μm:
R. gracilis KOCZW. in GEITL.

5b Cells 4—9 × 1.3—1.5 μm:
R. elegans WOLOSZ. in GEITL.

By disintegration of pseudofilaments and thus formation of colonies (comp. *R. okensis*, HINDÁK 1975) *Romeria* stands near *Rhabdoderma* SCHMIDLE et LAUTERBORN 1900. Transition types between formation of simple uniseriate pseudofilaments and colonies with several pseudofilaments in common mucilaginous envelopes are evident e.g. from our preceding observations (HINDÁK 1975, Abb. 9) and also from Fig. 3: 2, 3 and 4: 4. However, they are known from literature as well. Within the colonies of *Rhabdoderma lineare* SCHMIDLE et LAUTERB., KOMÁREK (1958) observed formation of pseudofilaments resembling pseudofilaments of *Romeria* (cf. *elegans*), and, on the contrast, *Rhabdoderma*-stages occur in *Romeria elegans*. Perhaps one of the most important differentiating feature should be the appearance of pseudofilamentous involution cells in *Rhabdoderma* and their absence in *Romeria*.

Romeria ***cylindrocellularis*** HINDÁK, sp. nova (Fig. 3: 1)

Diagnosis: Pseudofilamenta libere natantia, solitaria, ordine uno, ± irregulariter contorta, pluricellulares. Tegumentum gelatinosum hyalineum, circa cellulas 1,8—2 μm latum. Cellulae breviter cylindricae, rectae, apicibus planis, 1—1,4 × 0,6—0,8 μm, apicibus vel partibus apicibus tangentes. Protoplastum cellularum homogeneum, pallide coeruleo-viride, sine pseudovacuolis. Multiplicatio cellularum in partes duas et fragmentatione pseudofilamentorum.
Habitatio: In plancto lacus eutrophici glareosi in Kľúčovec, Slovacia occidentalis
Iconotypus: Figura nostra 3: 1.

Pseudofilaments free floating, solitary, uniseriate, ± irregulariter coiled, multicelled. Mucilaginous envelopes hyaline, homgeneous, 1.8—2 μm round cells. Cells shortly cylindrical, straight, 1—1.4 × 0.6—0.8 μm, with flat ends, in pseudofilaments slightly shifted each other. Cell contents homogeneous, pale blue-green, without gas vesicles Cell division by binary fission in two parts; multiplication of pseudofilaments by their fragmentation.

Occurrence: In summer plankton of an eutrophic gravel pit lake at Kľúčovec, W Slovakia.

The new species is marked by relatively tiny cells, considerably smaller than e.g. in *R. gracilis* or *R. elegans*. Cells were shortly cylindrical, after division nearly quadratic in outline, with flat ends and slightly shifted each other in pseudofilaments. In spite of this weak connection between the cells, pseudofilaments reached 100 μm in length. Cells were arranged into uniseriate rows showing simple type of irregular coiling. Pseudofilaments were not regularly coiled, e.g. as in *R. okensis* but the tendency of coiling was clearly manifested. Distance between coils was ± regular but diameter of helices varied markedly.

By the formation of simple coiled and easily disintegrating pseudofilaments embedded in mucilage the new species is closely related to some representatives of the genus *Rhabdoderma* in which pseudofilamentous configuration of cells is commonly formed within spherical, oval to irregular colonies. As it has been already discussed, transition types have been found in both

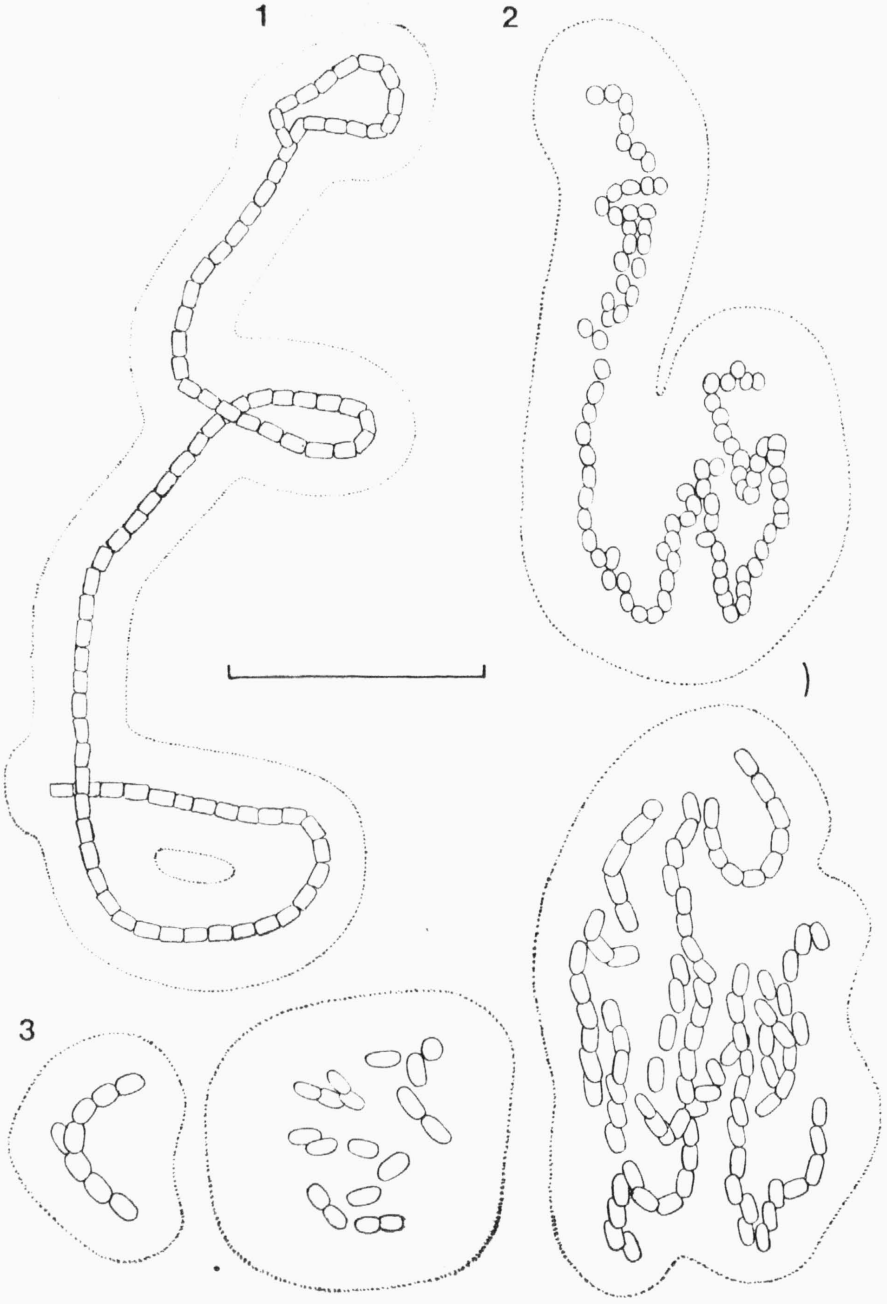

Fig. 3. — 1, *Romeria cylindrocellularis* HIND., pseudofilaments from plankton of an eutrophic gravel pit lake at Kľúčovec, W Slovakia, 2, 3, *Rhabdoderma* cf. *lineare* SCHMIDLE et LAUTERB. (2, colonies from a fishpond at Jukubov near Malacky, 3, from a sand pit lake in Bratislava-Devín). Scale: 10 μm.

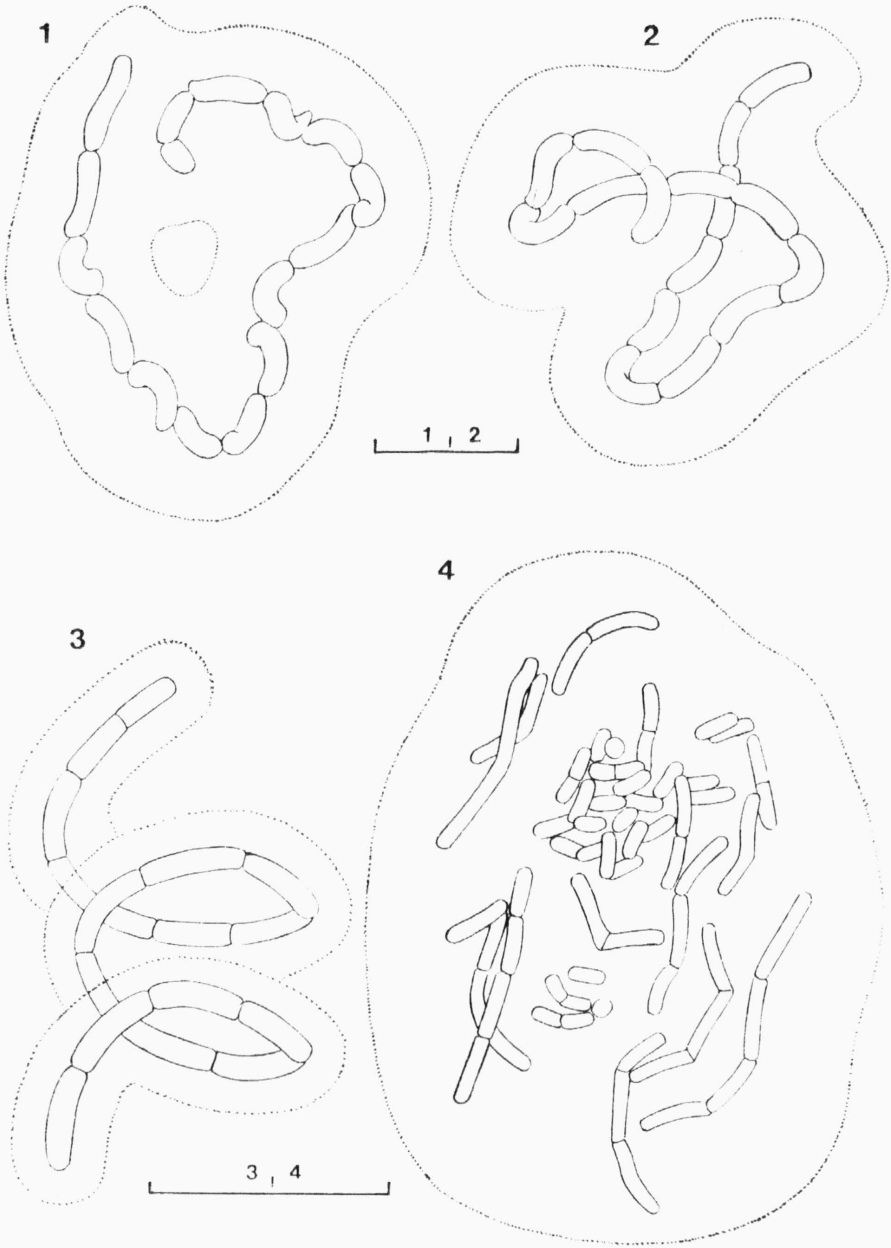

Fig. 4. — 1, 2, *Romeria simplex* (Hind.) Hind., specimens from a gravel pit lake at Medvedov, 3, *R. okensis* (Meyer) Hind., a pseudofilament from the River Danube in Bratislava, 4, *Rhabdoderma lineare* Schmidle et Lauterb., a colony from a water reservoir at Boleráz near Trnava. Scale: 10 μm.

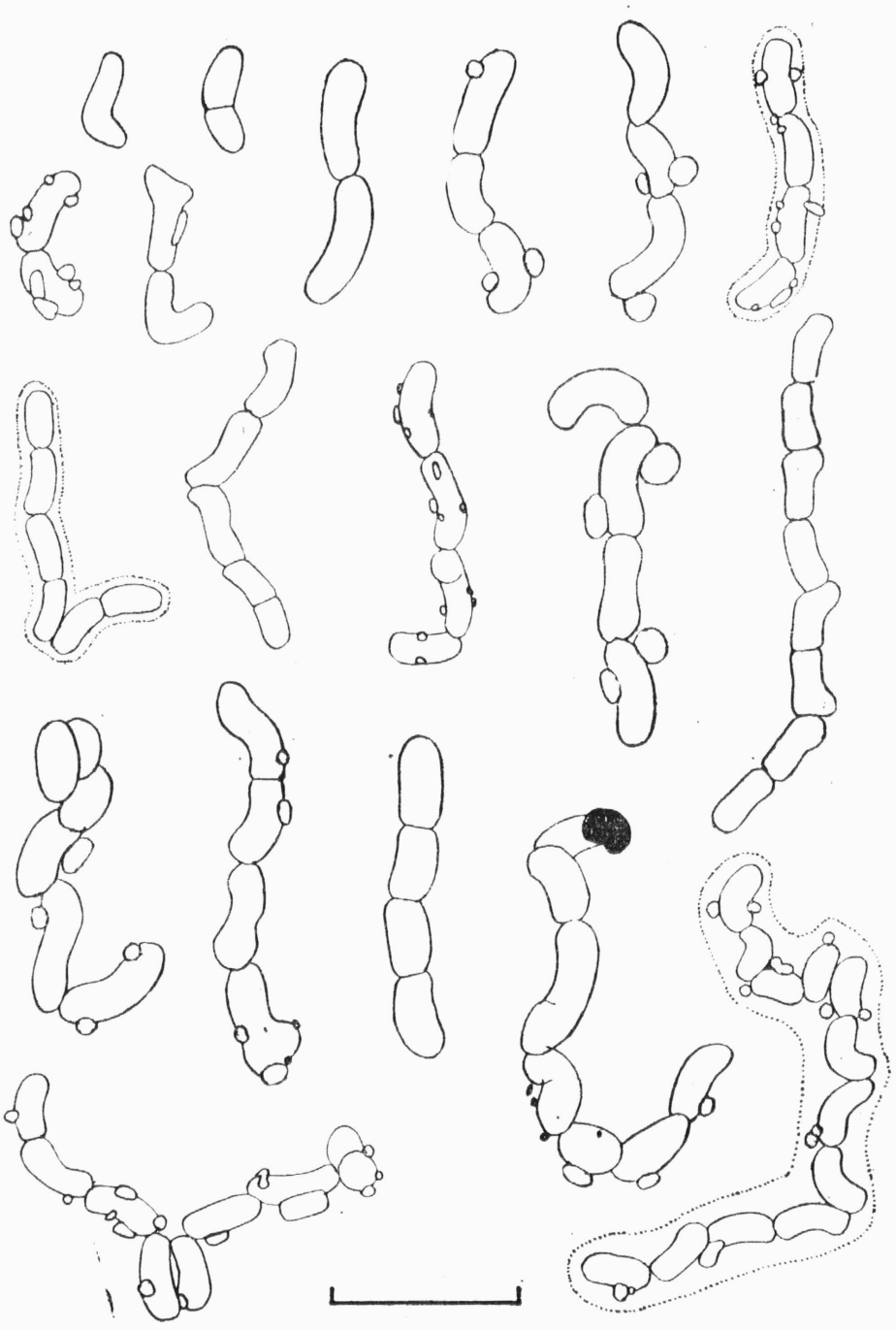

Fig. 5. — *Romeria crassa* HIND., specimens from a fishpond Stávek at Stupava near Bratislava. Scale: 10 μm.

genera, in *Romeria* as well as in *Rhabdoderma*. In the connection with this new species some new evidence of the genus *Romeria* can be illustrated. Thus specimens from plankton of a fishpond at Jakubov near Malacky, W Slovakia (Fig. 3: 2), showed both formation of pseudofilaments and *Rhabdoderma*-stages, i.e. colonies with several short pseudofilaments arranged without any order in spherical to oval colonial mucilage. The same phenomenon was found in specimens collected from a sand pit lake in Bratislava-Devín (Fig. 3: 3). Figured specimens were by the cell size within the range of a certain variation in good agreement with the species but differred from it by the cell shape: cells were broadly oval with rounded ends.

Romeria simplex (HINDÁK) HINDÁK, comb. nova (Fig. 4: 1, 2)

Basionym: *Tubiella simplex* HINDÁK Arch. Hydrobiol./Suppl. 46, Algol. Studies 13 : 338, 1975.

Because of twisted S-shape cells embedded in mucilage, the species was originally placed into the genus *Tubiella* GOLLERB. 1934. However, the type species of the genus, *T. elenkinii* GOLLERB. 1934, differs by having another type of mucilage which could be considered as a simple type of sheath: tubular mucilage may be widened according to diameter of helices of pseudotrichomes, so mucilage layers are not formed regularly around cells of pseudotrichomes but as a tube-like sheaths.

The species has been found several times in the classical locality at Kľúčovec as well as in similar gravel pit lakes in SW Slovakia. Illustrated specimens (Fig. 4: 1, 2) coming from autumn plankton of a highly eutrophic gravel pit lake at Medveďov differ from our original drawings by irregularly coiled pseudotrichomes. While in plankton at Kľúčovec pseudotrichomes formed mostly ± straight rows, in material from Medveďov they exhibited clearly coiled arrangements of cells. Futhermore, the cells were not so markedly S-shaped but sausage-like bent and slightly twisted, 6—8.5 × 1.3—1.6 μm. Cells were connected by their ends directly or slightly subterminally thus forming irregular and easily disintegrating rows. No *Rhabdoderma*-like colonies have been found.

Romeria ***crassa*** HINDÁK, sp. nova (Fig. 5)

Diagnosis: Pseudofilamenta libere natantia, solitaria, ordine uno, irregulariter flexuosa vel raro recta, usque 30 μm longa, plerumque curta, composita e 2-4-(8-12) cellulis catenarie post se coniunctis. Tegumentum gelatinosum hyalinum, subtile, 0,5—1 μm circa cellulas. Cellulae breviter cylindricae, irregulariter arcuatae, sigmoideae, interdum in forma litterae T, L usque Y, rare ± rectae, apicibus late rotundatis, 3-5-(7) × (2)-2,5-2,8 μm, apicibus vel partibus apicalibus tangentes. Protoplastum cellularum homogeneum, pallide coeruleo-viride vel griseum, sine pseudovacuolis. Multiplicatio cellularum in partes duas et fragmentatione pseudofilamentorum.
Habitatio: In plancto piscinae Stávek in Stupava apud Bratislava, Slovacia occidentalis.
Iconotypus: Figura nostra 5.

Pseudofilaments free floating, solitary, uniseriate, irregularly bent or rarely straight, to 30 μm long but mostly short, consisting of 2-4-(8-12) cells. Mucilaginous envelopes very thin, diffluent, only 0.5—1 μm around cells. Cells shortly cylindrical, rarely straight, usually irregularly bent or slightly twisted, sometimes T-, L- to Y-like, with broadly rounded ends, 3-5-(7) × (2)-2.5-2.8 μm, connected by their terminal or subterminal parts. Cell contents homogeneous, pale blue-green to grey, without gas vesicles. Cell division by binary fission into two equal parts; multiplication of pseudofilaments by fragmentation.

Occurrence: In summer plankton of the fishpond Stávek at Stupava near Bratislava, W Slovakia.

In July through August 1979 the species appeared abundantly and represented one of dominant species of the present phytoplankton communities. Judging from outward appearance of slightly arcuated to twisted cells and formation of irregular cells roughly resembling letters L, T or Y, the new species stands closely to *R. simplex*. It differs from it namely by shorter and wider cells and very thin mucilaginous envelopes. Cells were not so long and not so regularly S-shaped as in the previous species, and besides, cells forming pseudofilaments were mostly arranged without any order, only rarely resembling coiling. Other distinguishing feature is the presence of small oblong, spherical to irregular transparent bodies to 2.5 μm long attached directly on cell surface. However, there were also cells or the whole pseudofilaments without them.

Romeria okensis (Meyer) Hindák (Fig. 4: 3)

Among the representatives of the genus *Romeria*, this species is unique by its regularly and densely coiled pseudofilaments. Apparently for this reason the species was originally described as *Arthrospira okensis* Meyer 1924. In our preceding papers (Hindák 1975, 1985), the essential features differring *Romeria* from *Spirulina*/*Arthrospira* were emphasized: they are mainly the absence of both motility and formation of hormogonia. For these reasons *Spirulina*/*Arthrospira okensis* was transferred into the genus *Romeria* Hindák 1975).

Since 1974 *Romeria okensis* has been a commonly occurring member of phytoplankton of a highly eutrophic village gravel pit lake at Kľúčovec, W Slovakia. The river Danube is the second locality of this species on the territory of Slovakia. The depicted specimen (Fig. 4: 3) shows regularly coiled pseudofilament with distances between helices of 5—6 μm and diameter of coils 8—10 μm. Cells were cylindrical, slightly constricted at the ends, 5—6 × 1.2—1.5 μm, with homogeneous blue-green contents and without gas vesicles. Mucilaginous envelopes were somewhat wider than the diameter of cells, i.e. ca 2 μm around cells.

Arthronema africanum (Schwabe et Simonsen) Komárek et Lukavský 1988 (Fig. 6)

The genus *Arthronema* with the only species *A. africanum* (syn.: *Pseudanabaena africana* Schwabe et Simonsen) was established quite recently by Komárek and Lukavský (1988). The studied culture strain Lukavský 1981/1 was isolated from a material collected in Kuwait by Dr. I. Šetlík, Třeboň; the culture is stored in the Collection (SAO) of the Institute of Botany, Czechoslovak Academy of Sciences, Třeboň. The results of our observation of morphological variation of trichomes were included in this article because of some peculiarities bearing resemblance to studied cyanophytes namely to the genus *Romeria*.

Trichomes were attracted by their irregular shape and conspicuously unequal cells (Fig. 6). Straight trichomes were formed mostly in young cultures when cells divided intensively. But later on they were cranked in irregular way, without any order. Trichomes breaked very easily and short

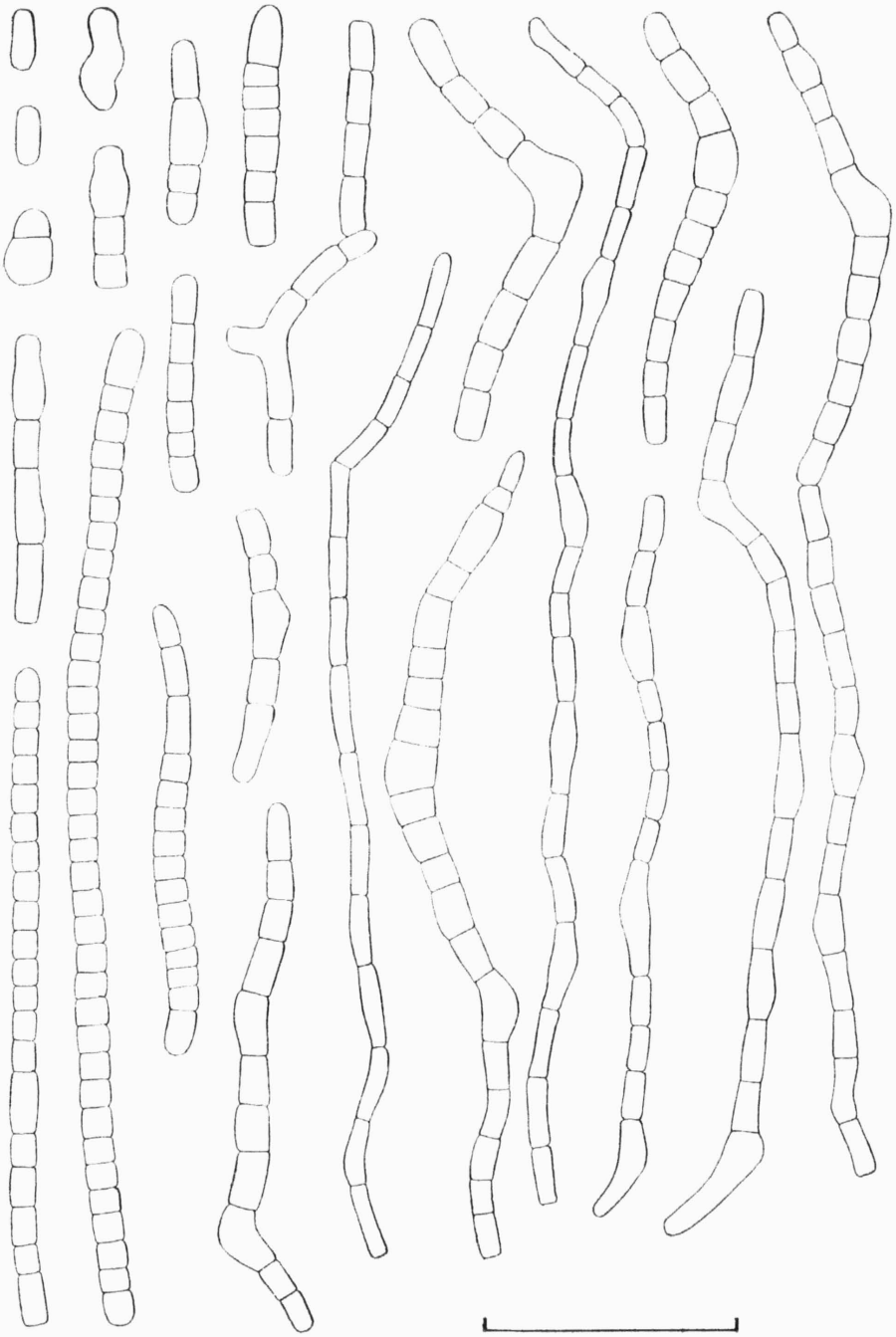

Fig. 6. — *Arthronema africanum* (Schwabe et Simons.) Kom. et Luk., a laboratory culture studied strain Lukavský 1981/1. Scale: 10 μm.

pieces of trichomes or even unicells commonly occurred in cultures. Another important features of the species consisted of different shape and size of cells. In young cultures trichomes were composed of regular, shortly cylindrical to barrel-shaped cells, sometimes quadratic in outline and shorter than long. In old cultures cells in trichomes differed from each other by shape and dimensions; they were basically cylindrical; only rarely regularly cylindrical, mostly slightly S-shaped, irregularly bent to knee-like swollen or L- to Y-like. By the formation of L- or Y-like cells, *A. africanum* resembles *Romeria crassa* (Fig. 5) and *R. simplex* (HINDÁK 1975). On the other hand, trichomes having unequal cells (namely in breadth) are typical of *Trichodesmium lacustre* KLEB. f. (Fig. 7) in which mucilaginous envelopes are missing, too. Variation in cell dimensions is clearly evident from our measurements: (1)-1.5-3-(5.5) × (0.8)-1.2-(2) μm. Cell contents were pale to bright blue-green; no conspicuous inclusions, gas vesicles nor motion have been observed. Cells divided by binary fission in two equal parts; no involution forms arose (more data see KOMÁREK and LUKAVSKÝ 1988).

Trichodesmium lacustre KLEBAHN f. 1895 (Fig. 7)

This peculiar filamentous cyanophyte was found in plankton of Lake Volvi, located ca 40 km NE of Thessaloniki, Greece. As filaments occurred very rarely, the species was not noticed in previous studies on phytoplankton communities of the lake (MOUSTAKA 1987, HINDÁK and MOUSTAKA 1988). Studied plankton samples were collected in August 26, 1986. Because of exhibition of some differences in diagnostic features, our findings are not in univocal agreement with the literary data of *Trichodesmium* (*Oscillatoria*) *lacustre*. Our hesitation was based on the occurrence of solitary trichomes in both fresh and preserved samples, markedly unequal cells in one and the same trichome, and occasional formation of long cylindrical cells or short series of cells at one end of trichomes. Besides, gas vesicles mentioned in literature have not been observed by LM either in discoid or in cylindrical cells.

Trichomes from Lake Volvi were always straight, solitary, not in bundles, without mucilaginous envelopes and motion; isopolar, with hemispherical to subspherical terminal cells; only seldomly heteropolar, with one end having terminal cells subspherical and the other cylindrical (up to 8 in number), sometimes markedly prolongated. Length of trichomes varied from 14 μm (4-celled trichomes) to 550 μm but majority of found trichomes were ca 200 μm long. Trichomes only rarely consisted of morphologically equal cells, i.e. cells of the same shape and size. Intercalary cells were barrel-shaped but not of equal breadth what is clearly evident from the range of cell dimensions: 1.5—4 × 4—7.5 μm having been found even in one and the same trichomes. Heteropolar trichomes arose rather seldom. At one end the terminal cell became longer and thinner; this cell was able to divide into two equal parts, and thus quite morphologically different part of trichomes has been formed. Dimensions of such cylindrical cells varied relatively less than those of barrel-shape: 5—10 × 3—5 μm. Trichomes with both ends consisting of cylindrical cells have not been observed. Cell contents were full of small spherical globules. Cells divided by binary fission in two equal parts, and in such way pairs of equal cells arose in trichomes. Breakage of trichomes passed through simple separation: two neighbouring cells in trichomes became

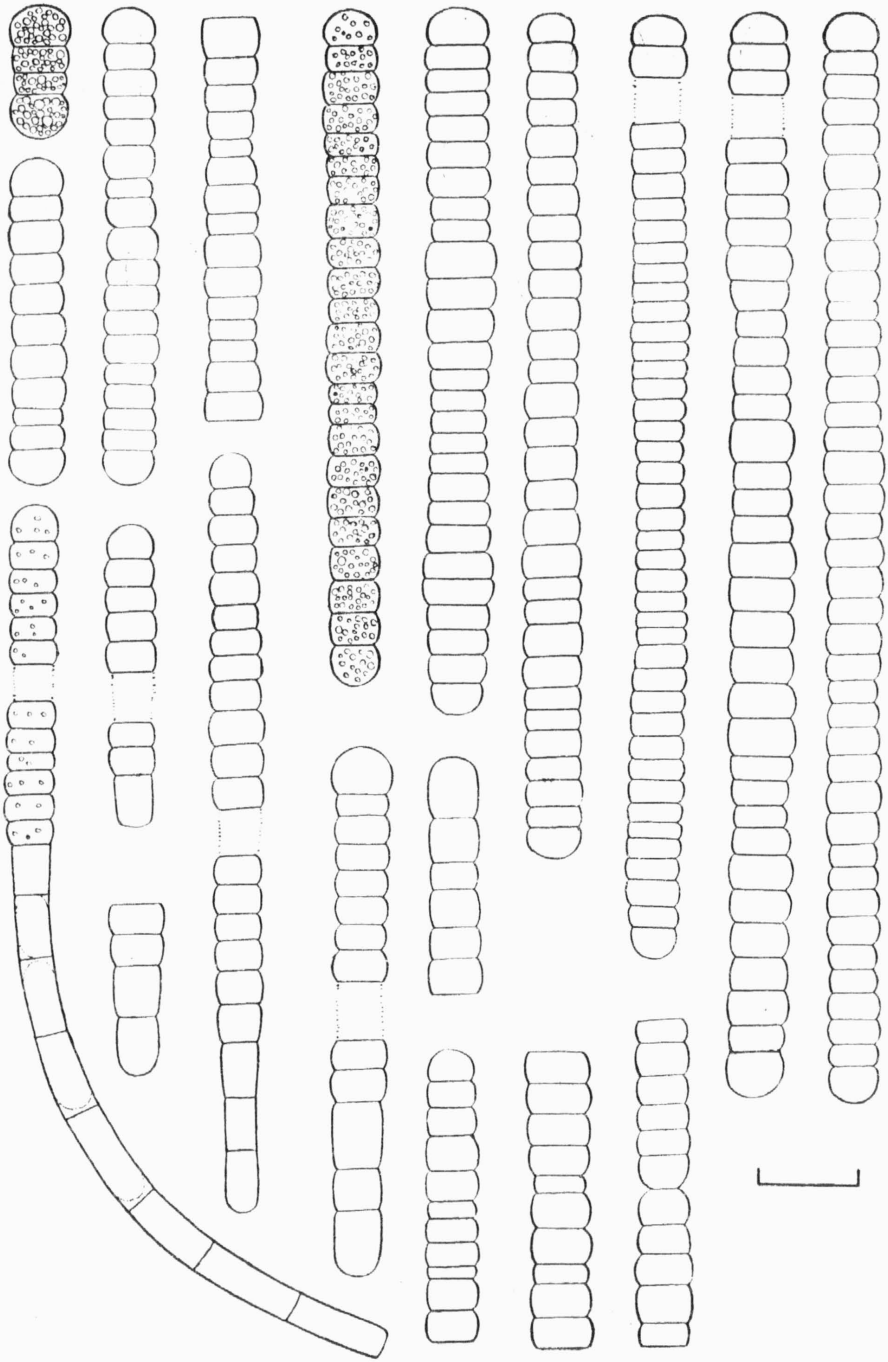

Fig. 7. — *Trichodesmium lacustre* KLEB. f., trichomes from Lake Volvi, Greece. Scale: 10 μm.

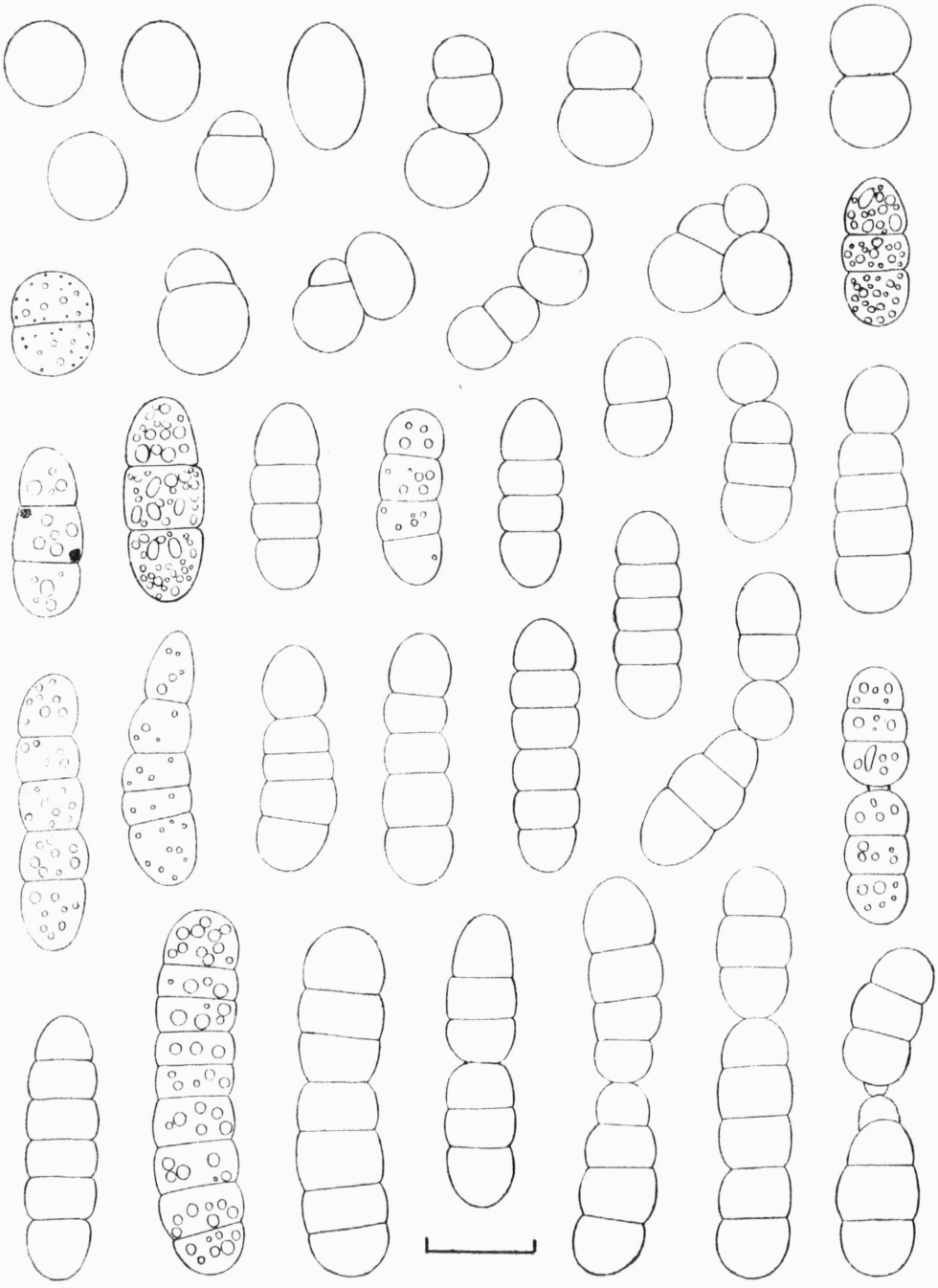

Fig. 8. — *Borzia trilocularis* COHN, specimens from a peat-bog lake of Gerzensee near Luzern, Switzerland. Scale: 10 μm.

spherical and than lost mutual contact; no necroidal cells have been observed (in contrast to the genus *Katagnymene*, see later).

Concerning the taxonomic position of the genus we are of the opinion of its fully independence within *Oscillatoriales*. Apart from the formation of colonies (*Aphanizomenon*-like bundles) which need not be always manifested (the very case of Lake Volvi), following significant features are of generic importance: (i) trichomes consisting of unequally wide cells, (ii) absence of motility; (ii) occasional formation of heteropolar trichomes having one end with subspherical cell and the other one with cylindrical cell/cells. By such heteropolar trichomes *Trichodesmium lacustre* is unique till now within the group of simple filamentous cyanophytes with free floating uniseriate, unbranched trichomes lacking motility, sheaths, akinetes and heterocysts.

Borzia trilocularis COHN 1882 (Fig. 8)

The genus *Borzia* COHN has typical simple, uniseriate, short and motile trichomes without sheaths, mucilaginous envelopes, akinetes and heterocysts. Trichomes control their length, and usually 6- or 8-celled trichomes are breaking into two portions.

In the material sampled from a small peat-bog lake of Gerzensee near Luzern, Kt. Obwalden, Switzerland, summer 1978, some interesting chroococcal and filamentous cyanophytes were found (HINDÁK 1983). *Borzia trilocularis* COHN belonged to them. Under laboratory conditions it grew well for several years but our attemps to isolate it in pure culture failed.

Trichomes in laboratory subcultures were short, 2-8-celled, only rarely more celled, mostly 3-4-celled. When the number of cells in trichomes reached 6 or 8, trichomes separated in two equal parts. Unicells or pairs of cells occurred sporadically. Unicells divided in two equal or sometimes unequal portions. Trichomes in general appearance resembled to a certain degree trichomes of foregoing species, however, their length was strictly limited and trichomes possessed a peculiar movement of a gliding type. Intercalary cells were barrel-shaped, 2.5—5 × 5.5—8 μm; terminal cells subspherical to broadly conical, sometimes markedly bigger or smaller than intercalary cells, 4—7 × 5—7.5 μm. 3- or 4-celled trichomes measured 11—20 × 5.5—8 μm, trichomes before breaking 27—35 μm in length. Unicells were spherical to broadly oval, 5-7-(12) × 4-7-(8) μm. Cell contents were bright blue-green in colour, with many tiny spherical globules and shortly oval bodies, without gas vesicles. No mucilaginous envelopes or sheaths were formed, only very rarely a small bridge between two separating trichomes were observed.

Judging from our long-term observations of the species under laboratory conditions, the genus *Borzia* with the type species *B. trilocularis* can be considered as well defined cyanophyte genus. However, *Borzia*-like hormogonia may be temporarily formed in some genera of filamentous cyanophytes, e.g. in *Stigonema* AG. or *Tolypothrix* KÜTZ. (see BOURRELLY 1970).

Katagnymene accurata GEITLER 1982 (Fig. 9)

In dystrophic littoral parts of the mountain lake Obersee near Lunz am See, Austria, GEITLER (1982) found a new species of *Katagnymene* LEMM., *K. accurata* GEITL., which controlled the length of filaments by bipartition as a certain length had been reached. Breakage of filaments was caused by con-

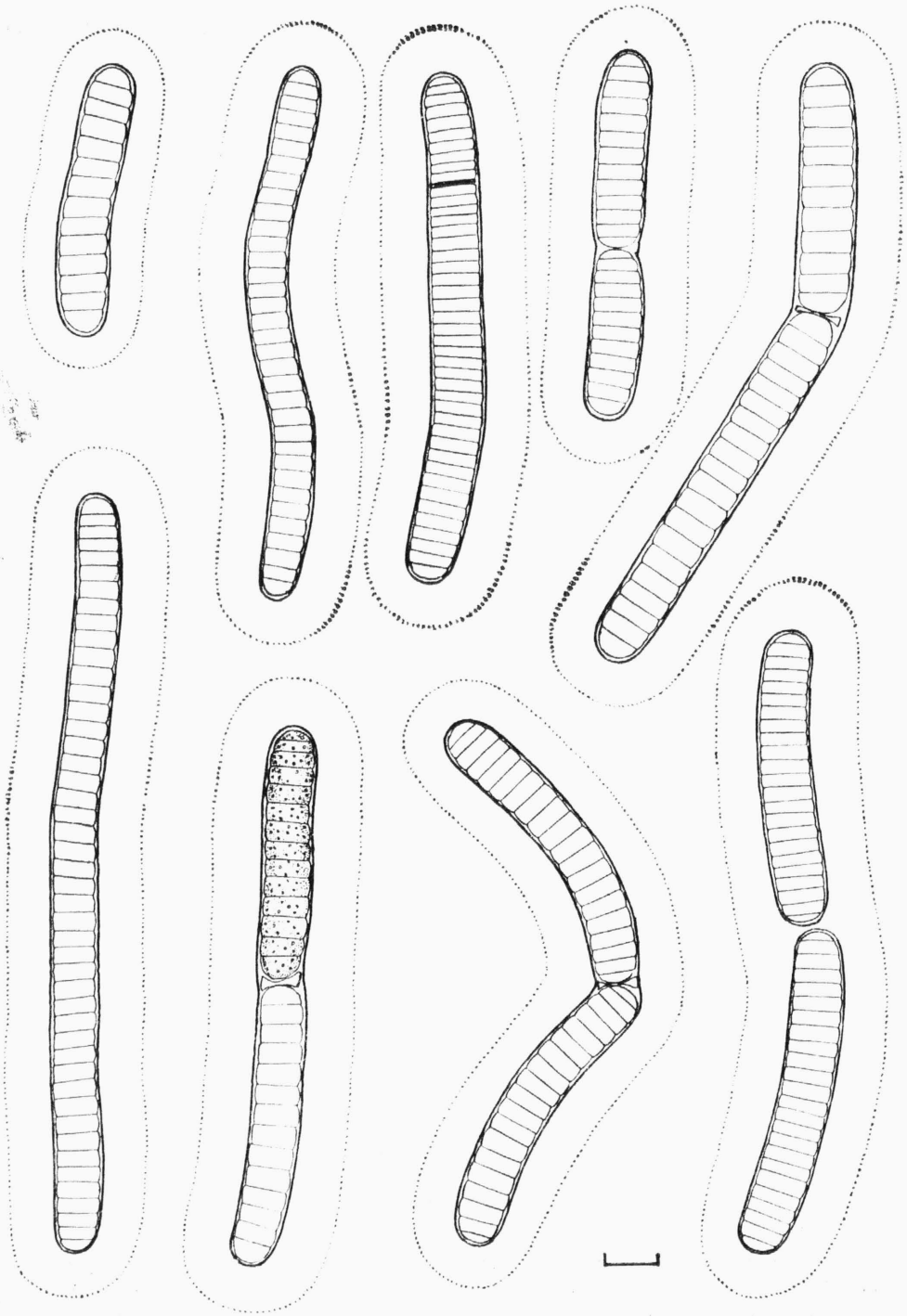

Fig. 9. — *Katagnymene accurata* GEITL., filaments from *Sphagnum* littoral parts of Lake Zollnersee, Austria. Scale: 10 µm.

sequence of the formation of one separation-disc near the middle of filaments. Trichomes were enclosed in a thin but firm sheath and embedded in mucilaginous envelopes; they sometimes showed locomotion by gliding in the direction of their long axis.

On September 3, 1987 we had an opportunity to collect this species in *Sphagnum* littoral part of Lake Zollnersee, Carinthia, S Austria. The lake is small and shallow, located in the Karnische Alps near Italian boundary at 1766 m above see level, pH 5.8—6.0 (detailed chemical and biological data of the lake see TURNOWSKY 1954). Diagnostic features of filaments from this second Austrian locality are in good agreement with GEITLER's diagnosis but some minor differences have been found.

Filaments occurred freely among other algae mentioned mostly by GEITLER in Lake Obersee, e.g. cyanophytes *Synechococcus aeruginosus* NÄG., *Chroococcus turgidus* (KÜTZ.) NÄG., from *Dinophyceae Glocodinium montanum* KLEBS and many acidophilic desmids. Futhermore, these species were accompanied by some other interesting cyanophytes [e.g. *Rhabdogloea linearis* (GEITL.) KOM. — see HINDÁK 1984], chlorococcal algae [e.g. *Scenedesmus asymmetricus* (SCHRÖD.) CHOD., *S. subspicatus* var. *brevicauda* (G. M. SMITH) CHOD., *S. pluricostatus* BOURR.] and ulotrichal algae (e.g. *Closteriospira lemanensis* REVERD.).

Filaments were only rarely straight, usually slightly S-shaped or undulated, 30—150 μm long and 8—11 μm wide. Hyaline sheath of filaments was thin but firm and distinct. Mucilaginous envelopes were 7—10 μm around cells, wider than in classical locality. Cells measured 2—4.5 × 7—10 μ, i.e. they were longer and somewhat thinner than those in the original diagnosis. Also terminal cells of filaments in our findings differed from the previous one: they were usually shorter and smaller than intercalary cells. Filaments fragmentated mostly in two equal parts but unequal bipartition occasionally occurred, as well. Separation-disc (a necroidal cell?) was visible but it disappeared completely as soon as new fragment of filaments separated. New terminal cells in the neighbourhood of the separation-disc exhibited the same shape as other terminal cells (no conspicuous globules were accumulated as in the case of Geitler's findings).

Katagnymene accurata belongs to a small group of freshwater species of the genus; the first species in a group, *K. palustris* G. S. WEST, was found in a lake in Egypt, and its trichomes were 28 μm wide. Marine species, *K. spiralis* LEMM. (a type species) and *K. pelagica* LEMM., are distinguished from two mentioned freshwater ones not only by the habitat but also by width of mucilaginous envelopes (100—168 μm) and long trichomes (filaments?) (GEITLER 1932). More data are needed to judge the question if *K. accurata* with firm sheaths and strictly controlled length of filaments really belongs to the genus *Katagnymene* sensu LEMMERMANN 1899 or represents a member of an independent genus.

SÚHRN

Pri niektorých nových alebo ojedinele sa vyskytujúcich siniciach sa študovala a taxonomicky vyhodnotila morfologická variabilita buniek, kolónií, vláknitých útvarov a vlákien. *Cyanotetras fusca*, gen. et sp. nov., pripomína zástupcov rodu *Merismopedia* MEYEN, ale má hnedé guľovité slizové obaly a zvyčajne 4-bunkové kolónie typu *Crucigeniella*. *Johannesbaptistia pellucida* (DICKIE) TAYLOR et DROUET s vláknitými útvarmi podobnými rodu *Radiofilum* sa hromadne rozmnožila v brakických lagúnach v jz. Kube. Do rodu *Romeria* KOCZW. in GEITL. sa navrhujú

ďalšie tri druhy vyskytujúce sa v eutrófnych štrkoviskových jazerách na záp. Slovensku: jeden druh sa prevádza z rodu *Tubiella* Gollerb. [*R. simplex* (Hind.) comb. nova] a dva sú nové druhy (*R. cylindrocellularis*, *R. crassa*). Vlákna s rozlične širokými a dlhými bunkami sú charakteristické pre *Arthronema africana* (Schwabe et Simons.) Kom. et Luk., ktorá sa študovala v laboratórnej kultúre. V severogréckom jazere Volvi sa našla vláknitá sinica *Trichodesmium lacustre* Kleb. f., ktorá na rozdiel od doterajších pozorovaní netvorila zväzky, ale vyskytovala sa v jednotlivých vláknach, ktoré niekedy v dôsledku tvorby jednej dlhšej a užšej valcovitej bunky (prípadne až 8 buniek) boli heteropolárne. Rody *Borzia* Cohn a *Katagnymene* Geitl. majú limitovanú dĺžku vlákien. *Borzia trilocularis* Cohn nájdená v malom rašeliniskovom jazere Gerzensee vo Švajčiarsku sa niekoľko rokov sledovala v laboratórnych podmienkach; vlákna aj v kultivovanom materiáli boli krátke a ak dosiahli 6—8 buniek, rozdelili sa na dve rovnaké časti. Naproti tomu pri *Katagnymene accurata* Geitl., ktorá sa pozorovala v rašelinovom litoráli horského jazera Zollersee v južnom Rakúsku, vlákna dosahovali dĺžku až 150 μm a v dôsledku tvorby nekroidnej bunky sa rozdelili na dve rovnaké alebo nerovnaké časti.

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