Contribution to the knowledge of planktic cyanoprokaryotes from central Mexico

Příspěvek k poznání planktonních sinic ze středního Mexika

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The diversity of freshwater and inland saline planktic cyanoprokaryote microflora (cyanobacteria, cyanophytes) in Mexico depends on the wide variation of the biotopes in this country. There are no detailed studies, describing the planktic cyanoprokaryotic species from this region. This paper lists 51 planktic morphospecies, which were found in various water bodies in central Mexico during May 1992 and March-September 1993. Four new species (*Cyanobacterium lineatum, Cyanotetras aerotopa, Anabaena fallax, Cylindrospermopsis taverae*) are described, and important species commented. Various species characteristic for various types of reservoirs (volcanic lakes, lakes and artificial reservoirs with diverse trophic levels, hypertrophic pools, saline coastal lakes) were found. Taxonomic and ecological elaborations of the planktic cyanobacteria of Mexico (from an ecological, geographical as well as sanitary point of view – eutrofication, biomass production, toxicity) are urgently needed.

Keywords: Plankton, cyanobacteria, cyanoprokaryotes, taxonomy, ecology, distribution, phenotypic variability, Mexico, tropical biotopes

Introduction

The cyanoprokaryotic (cyanobacterial) microflora is still poorly known. Particularly in tropical regions and extreme biotopes numerous populations occur that are impossible to identify using traditional phenotypic characters. However, unique types not known from other regions sometimes occur also in common biotopes (plankton of eutrophic freshwater reservoirs, soil species). Diverse unknown morphotypes are found especially in geographically distant tropical regions.

Thus, neither the distribution of species is well known and numerous misinterpretations occur in the literature. Floristic papers describing and documenting the phenotype species from various regions are therefore important. Natural populations of planktic species, which we studied during our stay in central Mexico, are reported in the present paper and remarks on the morphological variation of 51 planktic species found in freshwater, and inland and coastal saline water bodies are presented (see Table 1 for a complete list). Four characteristic morphotypes differ substantially from all described cyanoprokaryotic taxa and are described as new species.

Table 1. – List of planktic cyanoprokaryotic species from central Mexico; ∗ = with comments in text, • = Figure. L. = lake

	Localities
Chroococcales	
Aphanocapsa delicatissima	Catemaco L. (Ver.); L. Tecuitlapa (Puebla)
A. cf. *holsatica*	reservoir Angeles (Hidalgo)
A. incerta	Chapultepec Park (Mex. D. F.)
A. nubilum	L. Tecuitlapa (Puebla)
Aphanothece cf. *bachmannii*	L. Quitzeo (Guanaj.); L. Tecuitlapa (Puebla)
A. comasii	Catemaco L. (Ver.)
Chroococcus cf. *aphanocapsoides*	Catemaco L. (Ver.)
C. cf. *limneticus*	Catemaco L. (Ver.)
Coelomoron minimus	Catemaco L. (Ver.)
Cyanobium sp. (div.) •∗	L. Tecuitlapa (Puebla); L. Alberca (Guanaj.)
Cyanodictyon imperfectum	Catemaco L. (Ver.)
Cyanotetras aerotopa •∗	Catemaco L. (Ver.); eutrophic pond, Valles (S. L. P.)
Cyanobacterium lineatum •∗	eutrophic ponds (S. L. P.)
Gomphosphaeria cf. *salina* •∗	L. Alchichica (Puebla)
Merismopedia punctata	L. Quitzeo (Guanaj.)
M. warmingiana ∗	L. Tecuitlapa (Puebla)
Merismopedia sp. •∗	eutrophic ponds, Valles (S. L. P.)
Microcystis aeruginosa	Chapultepec Park (Mex. D. F.); volcanic lakes (Puebla)
M. panniformis	Chapultepec Park (Mex. D. F.)
M. novacekii	Chapultepec Park (Mex. D. F.)
M. cf. *protocystis* •∗	Chapultepec Park (Mex. D. F.); L. Patzquaro (Mich.); Catemaco L. (Ver.); volcanic lakes (Puebla); reservoir Angeles (Hidalgo)
M. cf. robusta ∗	Oaxaca
Radiocystis geminata	Catemaco L. (Ver.); Tecuitlapa L. (Puebla)
Snowella sp. •∗	reservoir Angeles (Hidalgo)
Synechocystis endophytica ∗	Chapultepec Park (Mex. D. F.)
Woronichinia cf. *fremyi* •∗	small eutrophic lakes (Ver.)
Oscillatoriales	
Arthrospira cf. *indica* •∗	L. Parangueo (Guanaj.)
A. maxima •∗	salty lakes (Puebla, Mex. D. F., Guanaj.)
Geitlerinema unigranulatum •∗	eutrophic ponds (S. L. P.)
Planktolyngbya circumcreta •∗	tropical lakes and reservoirs, common
P. microspira •∗	eutrophic pond, Valles (S. L. P.)
P. regularis •∗	Catemaco L. (Ver.)
P. tallingii •∗	mesotrophic to eutrophic water bodies, common
Planktothrix agardhii ∗	Chapultepec Park, Xochimilco Park (Mex. D. F.); reservoir Angeles (Hidalgo)
Pseudanabaena mucicola ∗	Chapultepec Park (Mex. D. F.); volcanic lakes (Puebla)
Pseudanabaena sp. div. ∗	brackish lake near Alvarado (Ver.)
Trichodesmium cf. *hildebrandtii* ∗	salty lake Laguna Superior (Oaxaca)
Nostocales	
Anabaena fallax •∗	Chapultepec Park (Mex. D. F.)
A. helicoidea •∗	L. Quitzeo (Guanaj.), Chapultepec Park (Mex. D. F.)
A. manguinii •∗	volcanic lakes (Puebla); L. Quitzeo (Guanaj.)
Anabaenopsis cf. *circularis* ∗	L. Quitzeo (Guanaj.)
Anabaenopsis sp.	L. Tecuitlapa (Puebla)
A. tanganyikae ∗	Chapultepec Park (Mex. D. F.)
Aphanizomenon cf. *yezoensis*	L. Tecuitlapa (Puebla); L. Patzquaro (Mich.); reservoir Angeles (Hidalgo)
Cylindrospermopsis catemaco ∗	Catemaco L. (Ver.)
C. cuspis ∗	volcanic lakes (Ver.), rare
C. philippinensis •∗	Catemaco L. (Ver.)

C. raciborskii ∗	L. Asmolapan (Ver.)
C. taverae •∗	eutrophic pond, Valles (S. L. P.)
Nodularia cf. *spumigena* •∗	L. Alchichica, Atexcac (Puebla)
Richelia intracellularis •∗	Pacific coastal waters (Oaxaca)

Methods

The material was collected occasionally from various water bodies in May 1992, and from March to September 1993 in central Mexico, and studied using optical microscopy. The main observations were carried out in the Laboratorio de Ficología (UNAM) in Mexico City, and later checked in the Algological Department of the Institute of Botany of the Czech Academy of Sciences in Třeboň, Czech Republic. The taxonomic and ecological evaluations are summarized in the comments on the species.

Results

Chroococcales

Cyanobium sp. div. (Fig. 1)

We found two large populations of slightly different *Cyanobium* morphotypes, the taxonomic identification and mutual relatedness (species identity) of which are uncertain. Both populations were found in small Maar-type volcanic lakes, which were secondarily heavily eutrophized by human activities: (a) in lake Alberca, Guanajuato state, they gave water a picoplanktic greyish colour (temp. 28 °C, pH 10.4), and were almost the only phytoplankton species (24 July 1993); (b) in lake Tecuitlapa, Puebla state, there was a picoplanktic population with a slight bloom due to two species, *Anabaena* sp., *Aphanizomenon* cf. *yezoensis* (leg. G. Vilaclara, 29 November 1991), together with several other nano- and microplanktic species. In both populations, the presence of photosynthetic pigments was determined by fluorescence microscopy.

Species of the genus *Cyanobium* often make up a large component of the picoplankton in freshwater reservoirs, salty lakes, and seas and oceans. They sometimes are so abundant that they colour the water. However, the infrageneric taxonomy of this genus is difficult and poorly known.

Description: (a) Solitary, free-floating, rod-like cells without mucilage, with an homogeneous greyish blue-green content, 3.5–4 × 0.8–1 μm, division cross-wise into two symmetrical daughter cells. (b) Solitary, free-floating, rod-like cells without mucilaginous envelopes, with an homogeneous pale greyish blue-green content, 0.8–2.5 × 0.4–0.6 μm, division cross-wise. Slight differences of both populations were only in cell size.

Cyanotetras aerotopa Komárek et Komárková-Legnerová **spec. nova** (Fig. 2)

Found in eutrophic water bodies, a member of rich phytoplankton communities, never abundant, but a characteristic species. Studied at two localities: large volcanic lake Catemaco (Veracruz state), where it occurred repeatedly in 1993–1994, and a pond near Valles (San Luis Potosí), at temperatures of 20–32°C, and pH 7.5–9.5.

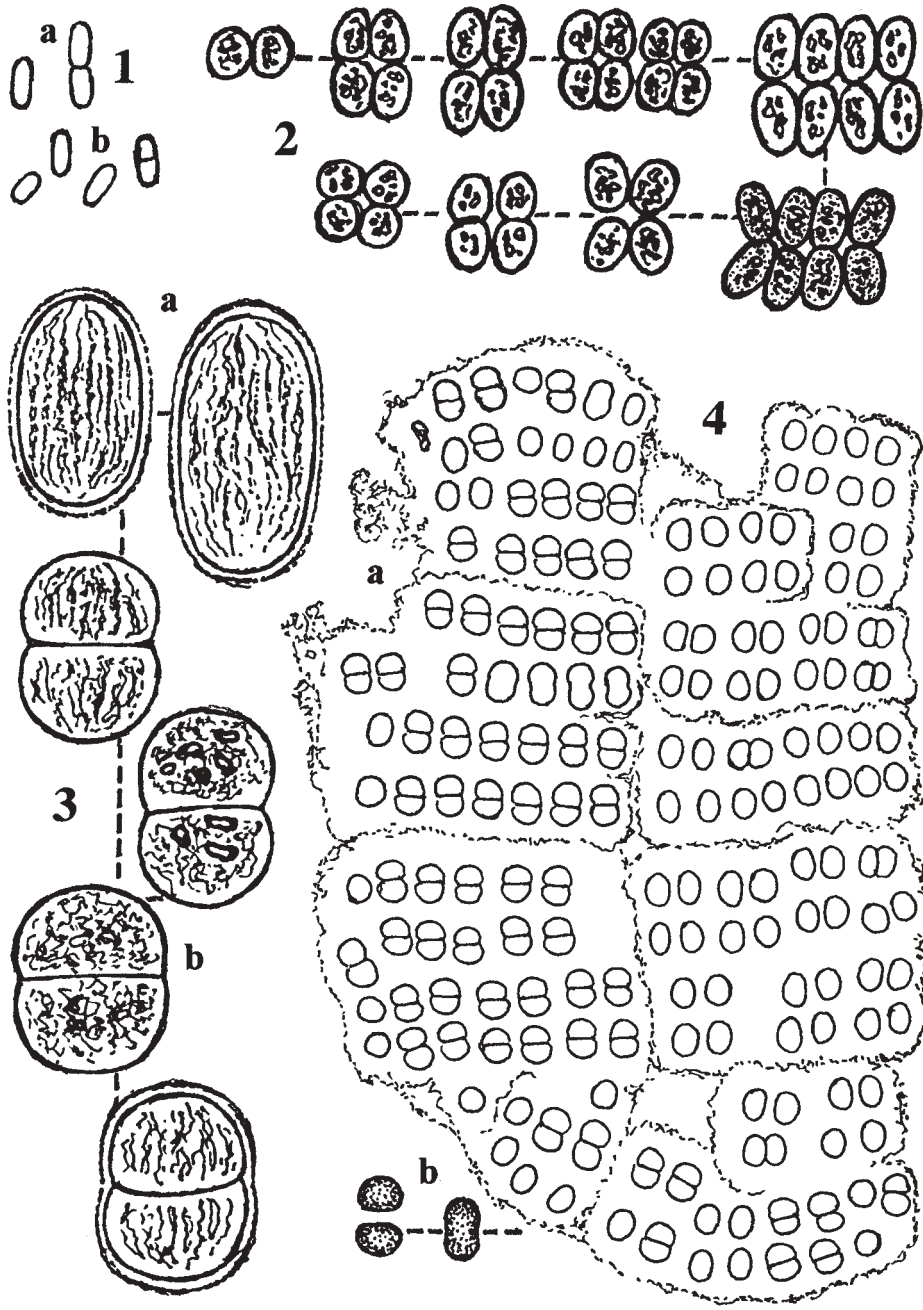

Fig. 1. – *Cyanobium* sp. div.: a – population from lake Alberca, Guanajuato; b – population from lake Tecuitlapa, Puebla.

Fig. 2. – *Cyanotetras aerotopa* (iconotype): flat, 2–8-celled colonies.

Fig. 3. – *Cyanobacterium lineatum* (iconotype): a – old cells; b – dividing cells.

Fig. 4. – *Merismopedia* sp.: a – plate-like colony; b – detail of cells. – Orig.

The genus *Cyanotetras* is poorly known and the relatedness of various species unclear. To date, there are only two species described (*C. fusca* Hind. and *C. crucigenielloides* Kom.). *C. aerotopa* is the only species, which has gas vesicles in its cells. However, the genus *Cyanotetras* is the only genus (in which the cells are organised into flat colonies), into which our species can be placed.

Description: Rarely solitary cells, usually 2–8-celled, flat colonies, in which the cells are arranged in two parallel rows or indistinctly radially; four-celled colonies are quadratic, rectangular, or with slightly divergent cells. Cells in 8-celled colonies also slightly divergent. Cells almost spherical, shortly oval or widely ovoid, with the longer axis orientated perpendicular to the center or to the long axis of the colony, pale blue-green or yellow-green, 4.0–5.5 μm long, with small aerotopes in protoplast.

Diagnosis: *Cyanotetras aerotopa* spec. nova. – Coloniae microscopicae, planae, 2–4–8-cellulares, cum cellulis in seriebus duobus curtissimis, perpendiculariter ordinatis, rarissime cellulae solitariae vel in quattuor ordinatae. Cellulae subsphaericae vel late ovales, in plano uno plus minusve parallele ordinatae, pallide aerugineae vel luteovirides, contentu aerotopis impletae, 4.0–5.5 μm longae. Divisio cellularum in planis duobus, perpendicularibus, reproductio disintegratione coloniarum. – Holotypus (iconotypus): figura nostra 2. – Habitatio: planktice lacubus piscinisque mesotrophicis; locus classicus: Mexico, lacus Catemaco, Veracruz.

Cyanobacterium lineatum Komárek et Komárková-Legnerová **spec. nova** (Fig. 3)

Found in a small eutrophic, cattle-polluted pond in the agricultural area between Valles and Micos (San Luis Potosí) in May 1992, together with numerous Euglenophytes, diatoms, and solitary cells of *Cosmarium*. Water temperature was high (over 30 °C), pH slightly alkaline. This species belongs to unicellular, solitary living cyanobacteria with elongated cells, dividing crosswise.

According to the ultrastructure (especially the thylakoid arrangement), the various species with solitary oval cells belong to one of three different clusters of cyanobacteria. The *Cyanothece* species (based on the type species *C. aeruginosa*) have numerous radially arranged thylakoids throughout the whole protoplast, which tend to form intrathylakoidal spaces (this thylakoid pattern causes the typical net-like "keritomy" of cell protoplasts). The "small" species, with several parietal thylakoids are classified in the genus *Cyanobium*. The group of species with dense lengthwise arranged thylakoids throughout the whole cell are segregated in the genus *Cyanobacterium* (*C. stanieri, C. dianae, C. cedrorum, C. diachloros*, etc.; Komárek & Cepák 1998, Komárek et al. 1999). The linear structures in the protoplast of *C. lineata* indicate that our species belongs in this group of species and must belong in the genus *Cyanobacterium.*

Description: Solitary cells living in metaphyton and plankton, spherical, widely oval to oval before division, after division more or less hemispherical. Around cells a very thin layer of colourless and structureless mucilage. Cell contents pale blue-green or dark blue-green, with very fine, barely visible lengthwise striation throughout the whole protoplast, sometimes with a few prominent granules. Cell dimensions: 18.5–30.2 × 15.7–20.2 μm. Cell division by transverse cleavage of the cell, the daughter cells soon separate one from another.

Diagnosis: *Cyanobacterium lineatum* spec. nova. – Cellulae solitariae, late ovales vel ovales, aeruginosae, longitudinaliter indistincte irregulariterque lineatae, cum granulis sparsis parvis. Divisio cellularum perpendiculariter in partes aequales. – Holotypus (iconotypus): figura nostra 3. – Habitatio: apicibus rotundatis, plus minusve sine mucilagine, 18.5–30.2 × 15.7–20.2 μm, contentu planktice stagnis piscinisque eutrophicis; locus classicus: Mexico, piscina prope oppido Valles, San Luis Potosí.

Gomphosphaeria cf. *salina* Kom. et Hind. 1988 (Fig. 5)

Solitary colonies were found in the metaphyton and (very rarely) plankton in the volcanic alkaline lake Alchichica, which has an increased salinity of about 10–11‰ (see Tavera & Komárek 1996 for the description of the locality). This species was scarce.

The genus *Gomphosphaeria* is well defined, and the various morphospecies were characterized by Komárek & Hindák (1988). The colonies from Alchichica were similar to *G. salina*, which is known mainly from coastal brackish pools and swamps in temperate and subtropic zones.

Description: Colonies small, irregularly spherical, with most of the cells in the peripheral layer, usually 32–58 μm in diameter. Mucilage barely visible (staining needed!). Cells slightly elongate, more or less obovate or irregularly obovate to slightly cordiform after division, radially arranged with homogeneous, pale blue-green content, ± 10 × 6 μm. Central mucilaginous stalks not visible without staining!

Merismopedia cf. *warmingiana* Lagerh. 1883

A common component of the phytoplanktic community in the small volcanic eutrophic lake Tecuitlapa (Puebla state). This species belongs to the small-celled *Merismopedia* taxa, which are difficult to distinguish. It occurs usually in brackish, or slightly salty and polluted shallow water bodies. It is characterized by very small, spherical, pale blue-green cells and only 16-celled colonies.

Merismopedia sp. (Fig. 4)

Found in small, usually slightly alkaline and warm (about 30 °C) eutrophic ponds, pools and basins in the dairy farm area near Valles, San Luis Potosí, in May 1992.

Several morpho- and ecotypes close to *M. glauca* and *M. convoluta* occur in various tropical biotopes. They differ usually slightly in the structure of the colonies (including number of cells, type of subcolonies, distance of cells one from another, etc.), and their classification is difficult. Our description concerns one type from this group, differing slightly from *M. glauca* and *M. convoluta* in the character of its colonies and the size of its cells.

Description: Colonies microscopic, flat, usually composed of several table-like subcolonies, which are delimited by colourless, diffluent, but recognizable mucilaginous margins; sometimes up to 260 cells in one large colony. Cells more or less spherical or subspherical, after division hemispherical, slightly distant one from another (up to cell diameter apart), pale blue-green, with distinct chromatoplasma, ± 5.0–6.7 μm in diameter.

Microcystis cf. *protocystis* Crow 1923 (Fig. 6)

It is a common member of water blooms in large eutrophic water bodies, and was recorded at sites in Mexico D. F., Veracruz, Puebla, Hidalgo, Michoacan. Its common occurrence in central Mexico corresponds to its pantropical distribution.

The taxonomic delimitation of this species is unclear. However, a *Microcystis* type corresponding to Crow's original description occurs commonly in tropical countries (Komárek et al. 2002). In contrast, it is unlike any well known species from the temperate zone. Its main diacritical features are: colonies irregular in outline, in fine, diffluent slime; cells 3.5–4.5 (6.5) μm in diameter, scarcely (very rarely densely) dispersed within the mucilage.

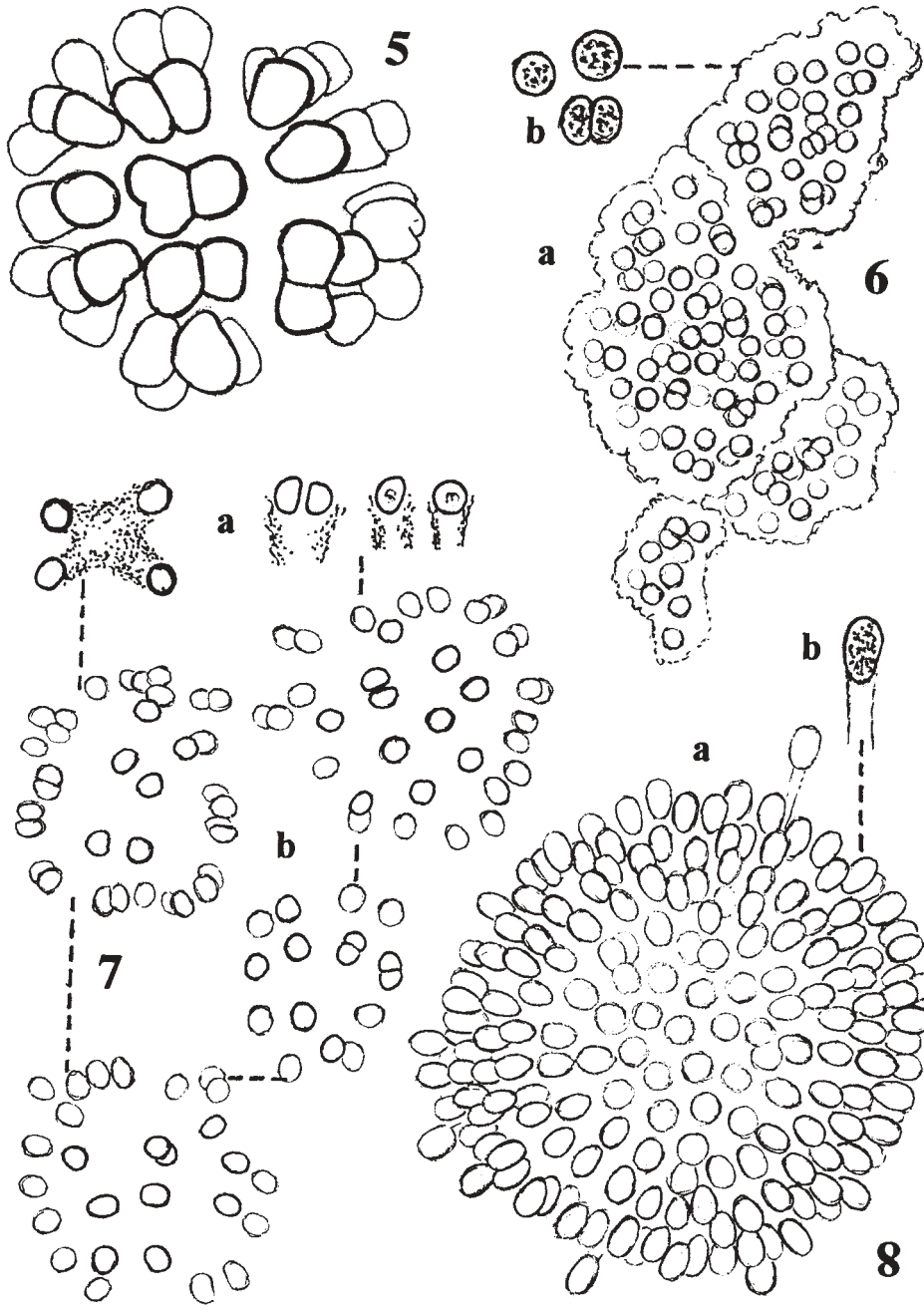

Fig. 5. – *Gomphosphaeria* cf. *salina*: spherical colony.

Fig. 6. – *Microcystis* cf. *protocystis*: a – characteristic colony; b – detail of cells.

Fig. 7. – *Snowella* sp.: a – stained mucilaginous stalks; b – shape of colonies.

Fig. 8. – *Woronichinia* cf. *fremyi*: a – shape of colony; b – detail of a cell. – Orig.

Description: Colonies microscopic to macroscopic, usually larger than 2500 μm in diameter, irregular, without holes. Mucilage indistinct, diffuse, forming margin up to 10 μm wide, colourless. Cells 7.2–8.8 μm in diameter with small aerotopes.

Microcystis cf. *robusta* (Clark) Nygaard 1925

Found in a slightly brackish lake in Oaxaca. It is a species described from tropical countries (Panama) and probably widely distributed, but without well defined features. The absence of aerotopes (see original diagnosis) is a problematic feature. Because the species was described from preserved material, gas vesicles may have been present in the original material. Many authors identify samples with aerotopes as *M. robusta*. Our material corresponds well with the original description, but the cells contain aerotopes (comp., e.g., Huber-Pestalozzi 1938).

Snowella sp. (Fig. 7)

The genus *Snowella* consists of seven species distributed mainly in temperate and northern regions; only one species is known also from the tropics (Komárek & Hindák 1988, Komárek & Komárková-Legnerová 1992). In the artificial reservoir Presa Angeles near Pachuca, state of Hidalgo, a population of *Snowella* was found together with the following species of planktic cyanobacteria: *Planktothrix agardhii, Microcystis* cf. *protocystis, Aphanizomenon* cf. *yezoensis, Aphanocapsa* cf. *holsatica* and fragmented trichomes of *Anabaena* (leg. G. Montejano). The Mexican population is silmilar to the nordic *S. septentrionalis*. The short solitary trichomes of *Pseudanabaena* cf. *mucicola* rarely occur within slime of colonies.

Description: Colonies subspherical, microscopic, usually 20, to 27 μm (rarely up to 32 μm) in diameter, with loosely and radially arranged cells, more or less localised at the periphery, and distant from one another. Wide, but very fine and colourless stalks (visible after staining!) are recognizable only in young colonies with (2) 4–8 cells, in older colonies indistinct. Cells spherical, after division slightly elongated, pale greyish-blue-green, sometimes with one central aerotope, 2.7–3.8 μm in diameter.

Synechocystis endobiotica (Elenk. et Hollerb.) Elenk. et Hollerb. 1938

Endogloeic species, which appeared in the typical form (comp., e.g., Hindák 1996) in the mucilage of *Microcystis protocystis* in one lake in the Chapultepec Park, Mexico D. F., in May 1992. It was not found in colonies of *M. novacekii,* which were common in the same planktic community and its slime was colonised only by the endogloeic *Pseudanabaena* cf. *mucicola.*

Woronichinia cf. *fremyi* (Kom.) Kom. et Hind. 1988 (Fig. 8)

Samples of this species were collected occasionally and not abundant from a few eutrophic ponds in the state of Veracruz (near the coast, southern part). Only two *Woronichinia* species with obligatory aerotopes are known to form water blooms, i.e. the cosmopolitan *W. naegeliana*, and the tropical and subtropical *W. fremyi*. However, there are several morphotypes of both species in distant regions, the taxonomic value of which is uncertain. Our samples conform to *W. fremyi*, but differ slightly from the type material (comp. Komárek 1974).

D e s c r i p t i o n : Colonies simple, subspherical, microscopic, up to 75 (88) μm in diameter, and made up of densely and radially arranged peripheral cells. Stalks thick, just visible without staining, colourless, diffluent. Cells obovate to oval, pale yellow-green, with very small, point-like aerotopes, 6.0–8.8 × 4.0–5.0 μm.

Oscillatoriales

Arthrospira cf. *indica* Jeeji Bai et Desik. 1992 (Fig. 9)

A large bloom of two types of *Arthrospira* occurred in the small volcanic and hypersaline Maar-type lake El Rincon de Parangueo in Guanajuato state, in the absence of other algae and cyanobacteria. In addition to the dominant *A. maxima*, a planktic *Arthrospira*, made up about 5% of the population, which is morphologically very similar to *A. indica*, recently described from India (Jeeji-Bai & Desikachary 1992). For an account of the ecology of this lake see the next species (*A. maxima*).

The population of *A.* cf. *indica* from Parangueo was distinct from the better known *A. maxima*, and no transitional forms were found. The main differences were in the broader trichomes of the former species (13.5–14.5 compared to 10.7–12.0 μm in *A. maxima*) and in the slightly different, but very distinct type of coiling (see Figs. 9–10). In spite of these morphological differences, it is difficult to understand how two genetically diversified but morphologically similar species can co-occur in such an extreme biotope. However, this is an interesting case of cyanoprokaryotic diversity and should be studied further.

D e s c r i p t i o n : Trichomes solitary, free floating, more or less regularly screw-like coiled with some irregularities, indistinctly constricted at cross-walls, 13.5–14.5 μm wide; the width of coils = 64–67 μm, the height of coils = about 40 μm, but the regularity sometimes varies; the trichomes are not attenuated apically. Cells are always shorter than wide, with plenty of small aerotopes (groups of gas vesicles); the end cell is rounded, with a thickened outer cell wall.

Arthrospira maxima Setch. et Gardn. 1917 (Fig. 10–11)

This species is known from the whole of tropical and subtropical America, and from Africa (mainly from western areas). It occurs very rarely (occasionally) in small quantities in summer in warm areas of the temperate zone. It requires specific conditions: inland reservoirs with high salt content, where massive, sometimes almost monospecific populations (large blooms) develop. It is also cultivated in Mexico where it has long been kept artificially in culture ponds in Texcoco (Mexico D. F.) and also occurs naturally in shallow lakes in that region. Moreover, this species was found forming distinct water blooms in two small volcanic lakes of Maar-type in central Mexico: lake Atlacoya (a small shallow lake with muddy bottom) in the crater of Tecuitlapa in Puebla state, and the hypersaline drying lake El Rincon de Parangueo, Guanajuato state. It was always found where the temperatures are high (24-29 °C), pH over 9.5 and the conductivity varied between 1600 and 1800 μS.

The genus *Arthrospira* consists of two groups of species: planktic, living in solitary trichomes and with gas vesicles within cells, and periphytic living in mats made up of cells without gas vesicles and aerotopes. The taxonomy and nomenclature of planktic *Arthrospira* species was in a confused state for many years for two reasons: (1) The genus *Arthrospira* was included into the genus *Spirulina* by scholars, until EM and molecular in-

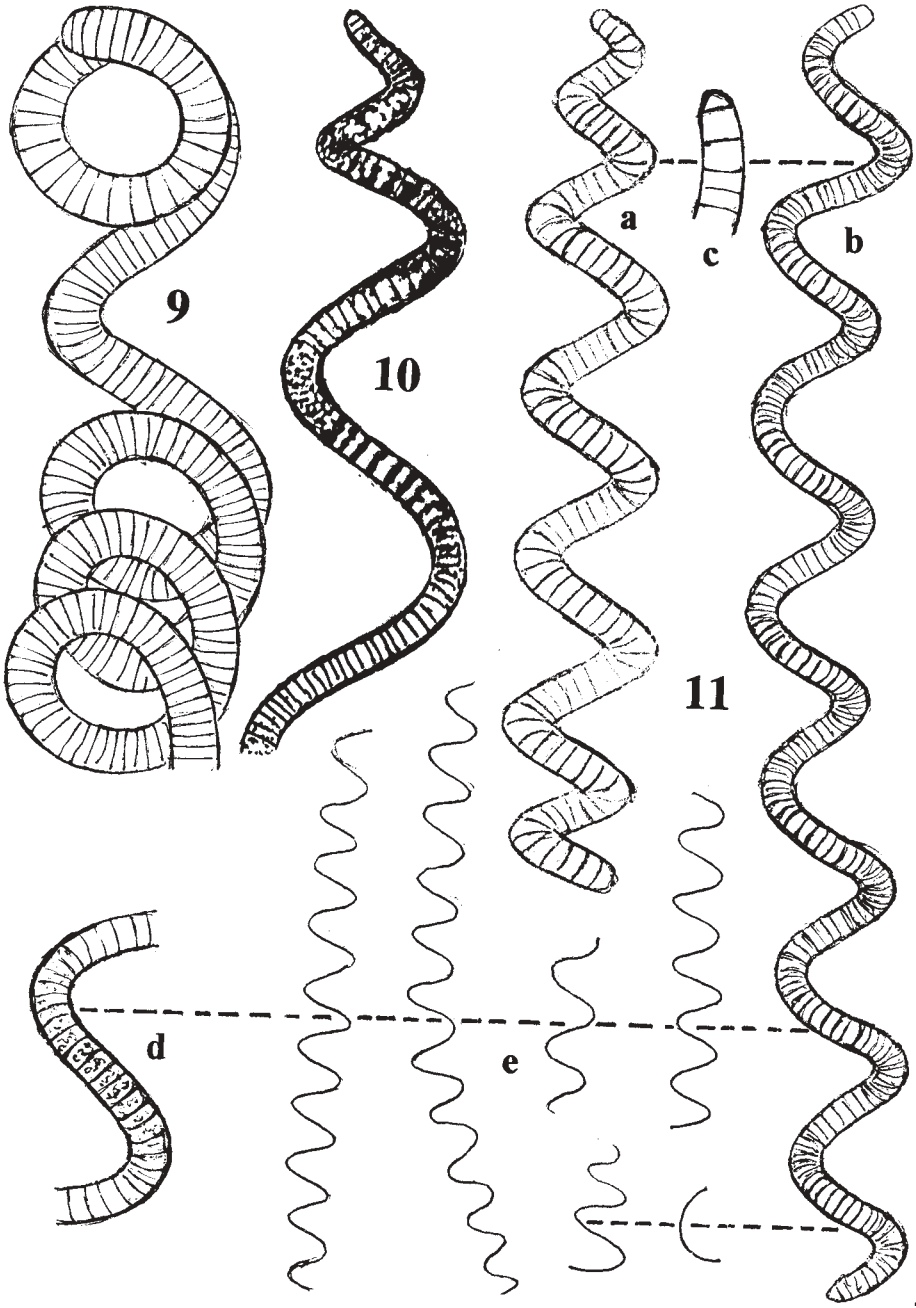

Fig. 9. – *Arthrospira* cf. *indica*: specimen from lake El Rincon de Parangueo, Guanajuato.

Fig. 10. – *Arthrospira maxima*: dominant type from lake El Rincon de Parangueo, Guanajuato.

Fig. 11. – *Arthrospira maxima*, population from lake Atlacoya in the crater of Tecuitlapa, Puebla: a–b – detail of solitary trichomes; c – detail of apical cell; d – detail of a trichome; e – variability in coiling. – Orig.

vestigations showed the substantial differences between these genera (Anagnostidis & Komárek 1988, Nelissen et al. 1994). (2) The planktic African populations of *Arthrospira* (to which *A. maxima* is closely related) were incorrectly designated as the periphytic and in mats living *Arthrospira platensis* (described from Argentina); the name "*Spirulina platensis*" was used for many years for both natural populations and cultured strains, and for commercial use. The taxonomic and nomenclatural clarification took a long time (Fott & Karim 1973, Hindák 1985, Komárek & Lund 1990, Jeeji-Bai & Desikachary 1992, Tomaselli 1996) but currently, the basic taxonomy is resolved. The Mexican populations belong to the species "*A. maxima*", which was originally described from S California; the width of trichomes from Atlacoya varied between 8.0–11.3 μm, those from Parangueo between 10.7–12 μm. The type of coiling typical for *A. fusiformis* was never found in *A. maxima*.

Description: Trichomes solitary, free floating, very regular screw-like coiled, without heterocytes and akinetes, not constricted or very indistinctly constricted at cross walls, 8– (12) μm wide; the width of coils = (34.5) –51 μm, towards the ends the width is narrower (slight "spindle-like" outline of the coiled filament); the coils are regular and their height is more or less equal to their width. Cells usually shorter than wide (rarely up to isodiametric), pale blue-green with numerous small aerotopes; the well developed apical cell with conical calyptra.

Geitlerinema cf. *unigranulatum* (R. N. Singh) Kom. et Azevedo 2000 (Fig. 14)

G. unigranulatum was found recently and is a common planktic species in eutrophic reservoirs in the state of São Paulo, Brazil (Komárek & Azevedo 2000). The Mexican specimens have a similar morphology, but with shorter and straighter trichomes without visible cross-walls and with numerous granules within the cells. They were found in small eutrophic reservoirs, which have slightly alkaline water and high temperatures (often over 30 °C). A population from a pond near the road from Valles to San Luis Potosí, collected in May 1992, was used for the following description.

Description: Fine trichomes are short, to 50 μm long (rarely longer), only few-celled, almost straight, solitary, free floating. Cross-walls almost invisible, not constricted, cell content very pale, with scattered distinct granules. Width of trichomes = 0.8 to 1.2 μm.

Planktolyngbya circumcreta (G. S.West) Anagn. et Kom. 1988 (Fig. 12)

Common throughout tropical and subtropical areas, in the plankton of large, freshwater eutrophic reservoirs. In Mexico, it was found at several localities, sometimes repeatedly and in high quantity (volcanic lakes Tecuitlapa – Puebla, Catemaco – Veracruz, etc.) throughout the year.

It is morphologically a well defined and distinct species with more or less regular spiral coiling (low and wide coils). The type of coiling and dimensions are the only features distinguishing this species from others.

Description: Filaments solitary, free floating, ± regularly spirally coiled with wide circular coils. Trichomes cylindrical, without constrictions at cross walls, pale yellow-green or greyish blue-green, 2.5–3.0 μm wide. Sheaths thin, firm, colourless, usually overpassing the trichomes and coiled in the same way as the trichomes. Cells ± isodiametrical, sometimes very short (after division), without aerotopes, with ± homogeneous content; apical cell rounded.

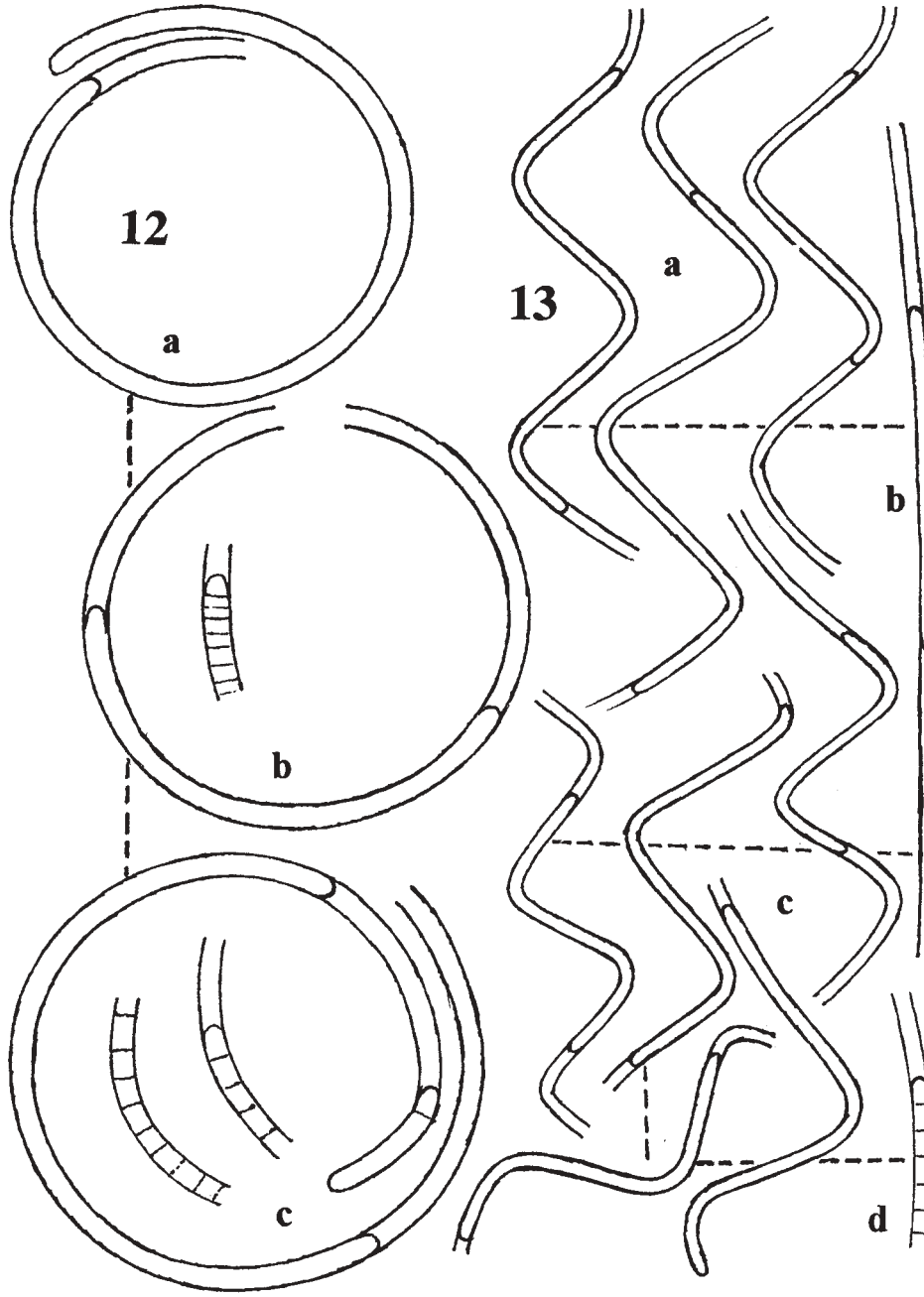

Fig. 12. – *Planktolyngbya circumcreta*: a–c – typically coiled filaments with details of trichomes and filament ends, in c hormogonium formation.

Fig. 13. – *Planktolyngbya microspira*: a–c – variability of filaments; b – exceptionally occurring straight filament from a large population; d – detail of filament end. – Orig.

Planktolyngbya microspira Kom. et Cronb. 2001 (Fig. 13)

This fine species was described from South Africa, growing in solitary trichomes in freshwater eutrophic reservoirs, usually as a part of rich nano- and microplankton. In Mexico, it was found at several localities. The material used for the description presented below was collected from a population in an eutrophic pond near Valles (San Luis Potosí; pH 7.5, temp. ±32 °C). It differs from other *Planktolyngbya* species in its regular screw-like coiling and small size.

D e s c r i p t i o n : Filaments solitary, free floating, regular screw-like coiling with 1 to maximally 2.5 coils. Trichomes cylindrical, without constrictions at cross walls, pale grey-bluish, 0.8–1.2 μm wide. Sheaths very fine, colourless, thin, usually overpassing the trichomes and distinguishable at the ends of filaments. Cross walls almost invisible without staining; cells slightly longer than wide, without aerotopes or any granules, homogeneous; apical cell rounded.

Planktolyngbya regularis Kom.-Legn. et Tavera 1996 (Fig. 15)

Described from the large Mexican volcanic and eutrophic lake Catemaco (Ver., SE part of Mexico), where it is always present but an uncommon component of the phytoplanktic community (it was studied from 1993–1995).

This *Planktolyngbya* species is characterized by its very regular screw-like coiled filaments, which is the main feature distinguishing it from all other *Planktolyngbya* species except *P. microspira* (which is, however, distinctly smaller).

D e s c r i p t i o n : Filaments solitary, free-floating, very regular screw-like coiled, up to 200 μm long, with (2) 4–6 (8) coils, which are 14.4–16.0 μm wide. Trichomes cylindrical, without constrictions at cross walls, pale blue-green or greyish blue, 1.8–2.5 μm wide; cross walls only slightly visible, but distinct after staining. Sheaths thin, firm, colourless, usually overpassing the trichomes at both ends, with the same type of coiling as in the sections with trichomes. Cells ± isodiametric, or longer (up to 3-times) than wide, (2.2) 2.5–6.0 μm long, with homogeneous contents without aerotopes and granulations; apical cell rounded.

Planktolyngbya tallingii Kom. et Kling 1991 (Fig. 17)

This species was originally described from the large lake Victoria in E Africa, but is probably widely distributed, with a pantropical distribution. It is possibly confused with other species, especially *P. contorta* from the temperate zone. In Mexico, it was found in the plankton of various freshwater eutrophic water bodies, e.g., in the volcanic lakes Catemaco (Ver.), La Preciosa (Puebla) and Tecuitlapa (Puebla), where it probably grows all year round. It was found in all the samples collected from these lakes in 1991–1993 (leg. Tavera, Vilaclara, our samples).

P. tallingii is a species with irregularly coiled filaments, however, the coiling is characteristic. Other distinguishing features are the morphology and dimensions of the trichomes.

D e s c r i p t i o n : Filaments solitary, free-floating, irregularly coiled; coils mainly 13–16 μm high. Trichomes cylindrical, not constricted or slightly constricted at cross walls; with pale grey, homogeneous content, 0.7–1.0 μm wide; cross walls almost invisible, or distinct (constrictions!). Sheaths thin, colourless, hyaline, often overpassing the ends of the trichome. Cells ± isodiametric up to twice (rarely up to 3-times) as long as wide.

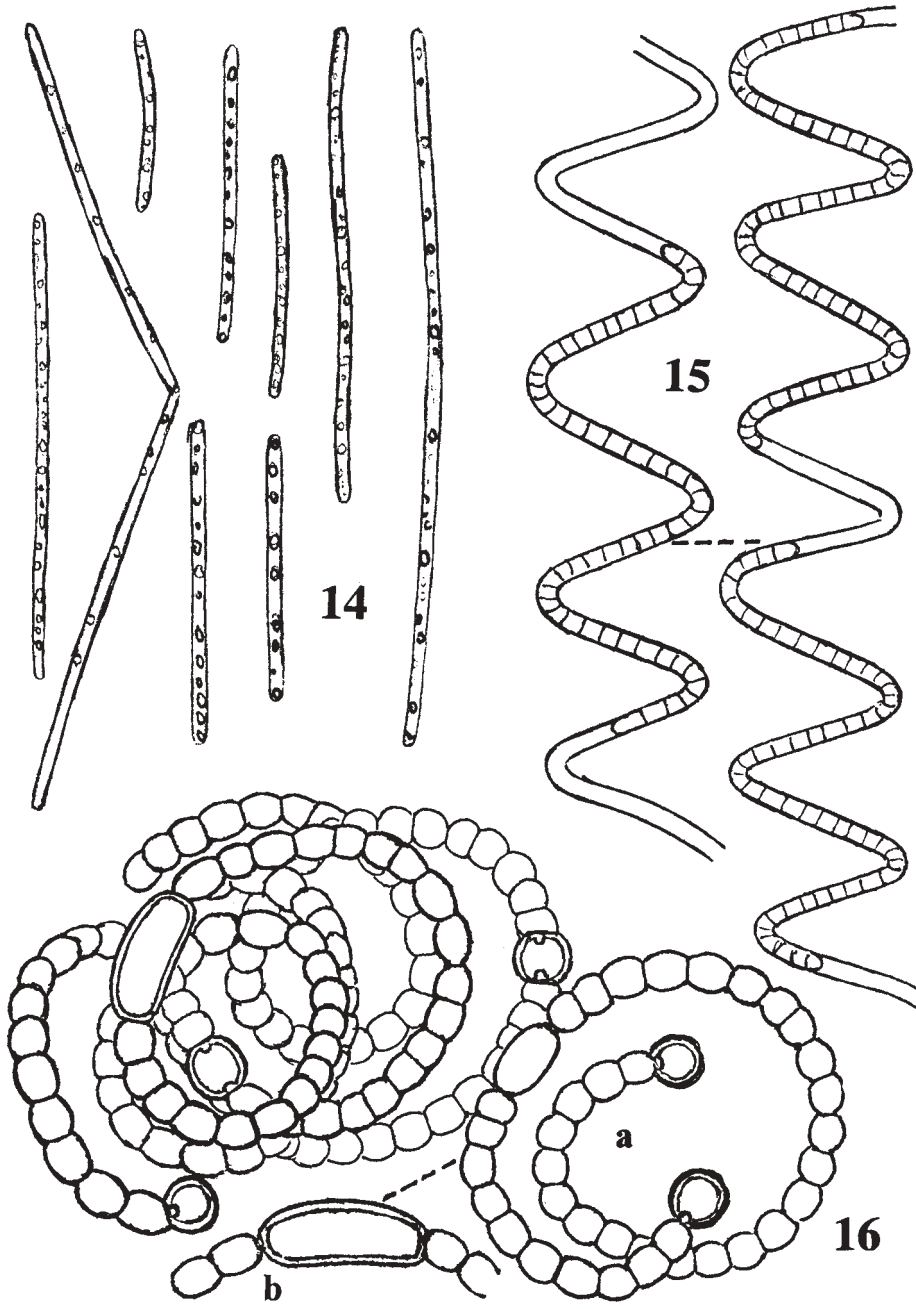

Fig. 14. – *Geitlerinema* cf. *unigranulatum*: variability of free floating, short trichomes with granules in the cells.

Fig. 15. – *Planktolyngbya regularis*: two filaments.

Fig. 16. – *Anabaena helicoidea*: a – typically coiled filaments with heterocytes, akinetes and barrel-shaped cells; b – detail of an akinete. – Orig.

Fig. 17. – *Planktolyngbya tallingii*: a – details of filament ends; b–d – variability in coiling of trichomes. – Orig.

Planktothrix agardhii (Gom.) Anagn. et Kom. 1988

Probably has a cosmopolitan distribution in mesotrophic to eutrophic waters, with the exception of subpolar regions. It regularly occurs as a member of rich phytoplanktic communities and sometimes forms water-blooms. In spite of its occurrence in eutrophic waters, it does not occur everywhere and its ecological requirements are poorly known (for important data see e.g. Skulberg & Skulberg 1985, sub *Oscillatoria agardhii*). It is taxonomically distinct from similar species (comp. Anagnostidis & Komárek 1988, Suda et al. 2002).

Pseudanabaena mucicola (Naum. et Hub.-Pest.) Schwabe 1964

Morphologically and taxonomically well known species with an almost cosmopolitan distribution (comp. Huber-Pestalozzi 1938 sub *Phormidium mucicola,* Bourrelly 1970, Anagnostidis & Komárek 1988, and many others), which lives in the mucilage of other planktic cyanobacteria and rarely that of other algae. However, it does not always occur in all planktic cyanophytes, and the data on other algae need to be revised. Its reported presence in the envelopes of other nonplanktic species is probably because it was confused with other types of fine, filamentous, endogloeic cyanoprokaryotes. In Mexico, *P. mucicola* was found in e.g. the volcanic eutrophic lake Quechulac (state Puebla), commonly in colonies of *Microcystis aeruginosa*, but not *M. protocystis*, common in the same planktic community. A similar situation was observed at Chapultepec Park (Mexico D. F.), where it was very common in colonies of *Microcystis novacekii*, but not *M. protocystis* (the slime of which was inhabited by *Synechocystis endophytica*). The relation of endogloeic species to the host species is unknown but must have numerous ecophysiological consequences the resolution of which depends on future research.

Pseudanabaena sp. div.

Several *Pseudanabaena* types, which were practically unidentifiable using keys and the literature, were found in planktic material from central Mexico. They were uncommon, and it was difficult to evaluate them taxonomically. However, we mention them because their morphological and ecological variation needs to be studied.

Trichodesmium cf. *hildebrandtii* Gom. 1892

One of the cyanoprokaryotic species, occasionally forming distinct populations in oceanic plankton throughout the world. The genus *Trichodesmium* was studied several times; we use mainly the review of Golubić (1977; see also Anagnostidis & Komárek 1988). Our material was collected by G. Figueroa (UNAM, Mexico D. F.) from the saline lake Laguna Superior, which is connected to the Pacific ocean. It grows in a community of typical marine diatoms. *T. hildebrandtii* differs from other species mainly in its characteristic fasciculate colonies, morphology of end cells, and pale blue-green colour of cell protoplasts.

Nostocales

Anabaena fallax Komárek et Komárková-Legnerová **spec. nova** (Fig. 18)

Water-bloom forming cyanoprokaryote, abundant in the largest eutrophic lake in Chapultepec Park, Mexico City (coll. 12 April 1993). It belongs to the planktic *Anabaena* species, which have solitary floating trichomes and aerotopated cells (subg. *Dolichospermum*), but has several curious features which resemble those of the genus *Anabaenopsis*: heterocytes sometimes develop intercalary in pairs, and sometimes occur in a terminal position after the trichome disintegrates.

However, it must be classified as an *Anabaena* species for the following reasons: (i) solitary heterocytes sometimes occur in a terminal position in disintegrated trichomes, but more commonly in an intercalar position; (ii) heterocytes develop intercalarly, are usually solitary, only rarely in pairs, but never after mirror image asymmetrical division of two neighbouring cells (i.e., from two vegetative cells); (iii) heterocytes usually have two pores; (iv) trichomes disintergate usually between two vegetative cells (Fig. 18d, arrows), or at heterocytes; after this second mode, terminal heterocytes appear (sometimes at both ends of a trichome), but the division between two intercalar heterocytes was never observed (in several cases the trichome disintegration in two heterocytes was found, which both remained at the end of one divided trichome – Fig. 18e).

Akinetes were not found, but the morphology of the trichomes is so specific that it defines this new species.

D e s c r i p t i o n (Fig. 18): Trichomes solitary, free floating, more or less regularly coiled in very wide (48–76 μm) and low spirals, rarely slightly irregular; trichomes have cylindrical appearance, at cross walls slightly, but distinctly constricted, 5.2–6.0 μm wide, apical cells more or less cylindrical and widely rounded, or slightly narrowed and rounded. Cells cylindrical to barrel-shaped, more or less isodiametric or slightly longer than wide, with many small aerotopes. Heterocytes oval, uni– or bipored, hyaline, develop from intercalar or (rarely) apical cells, solitary or (rarely) in pairs, 7.2–8.4 × 6.0–7.0 μm. Akinetes not observed. Trichomes commonly disintegrate between two vegetative cells, rarely at heterocytes.

D i a g n o s i s : *Anabaena fallax* spec. nova. – Trichoma solitaria, libere natantia, plus minusve regulariter, rare irregulariter contorta, spirales 48–76 μm latae, ad dissepimenta paucim sed clare constricta, sine vaginibus, isopolares, 5.2–6.0 μm latae, cellulae apicales plus minusve cylindricae, late rotundatae. Cellulae cylindricae vel barriliformes, plus minusve isodiametricae vel paucim longior quam latae, aerotopis impletae. Heterocytae ovales, uni- vel biporae, hyalinae, intercalares vel apicales, solitariae vel in duobus, 7.2–8.4 × 6.0–7.0 μm. Akinetes not observatur. – Holotypus (iconotypus): figura nostra 18. – Habitatio: planktice in lacubus eutrophicis; locus classicus: Mexico, lacus artificialis in Chapultepec, Mexico D.F.

Anabaena helicoidea Bernard 1908 (Fig. 16)

Planktic species, forming blooms in eutrophic reservoirs. It was described from Indonesia in 1908, but has been overlooked. It is probably a common species with a pantropical and subtropical distribution. In Mexico, it was collected from the rich phytoplankton in the lake Quitzeo, state Guanajuato (25 July 1993), and in several lakes in the Chapultepec park, Mexico D. F. (16 May 1992). At both localities, the pH exceeded 10 and water temperature ranged from 28 to 36 °C.

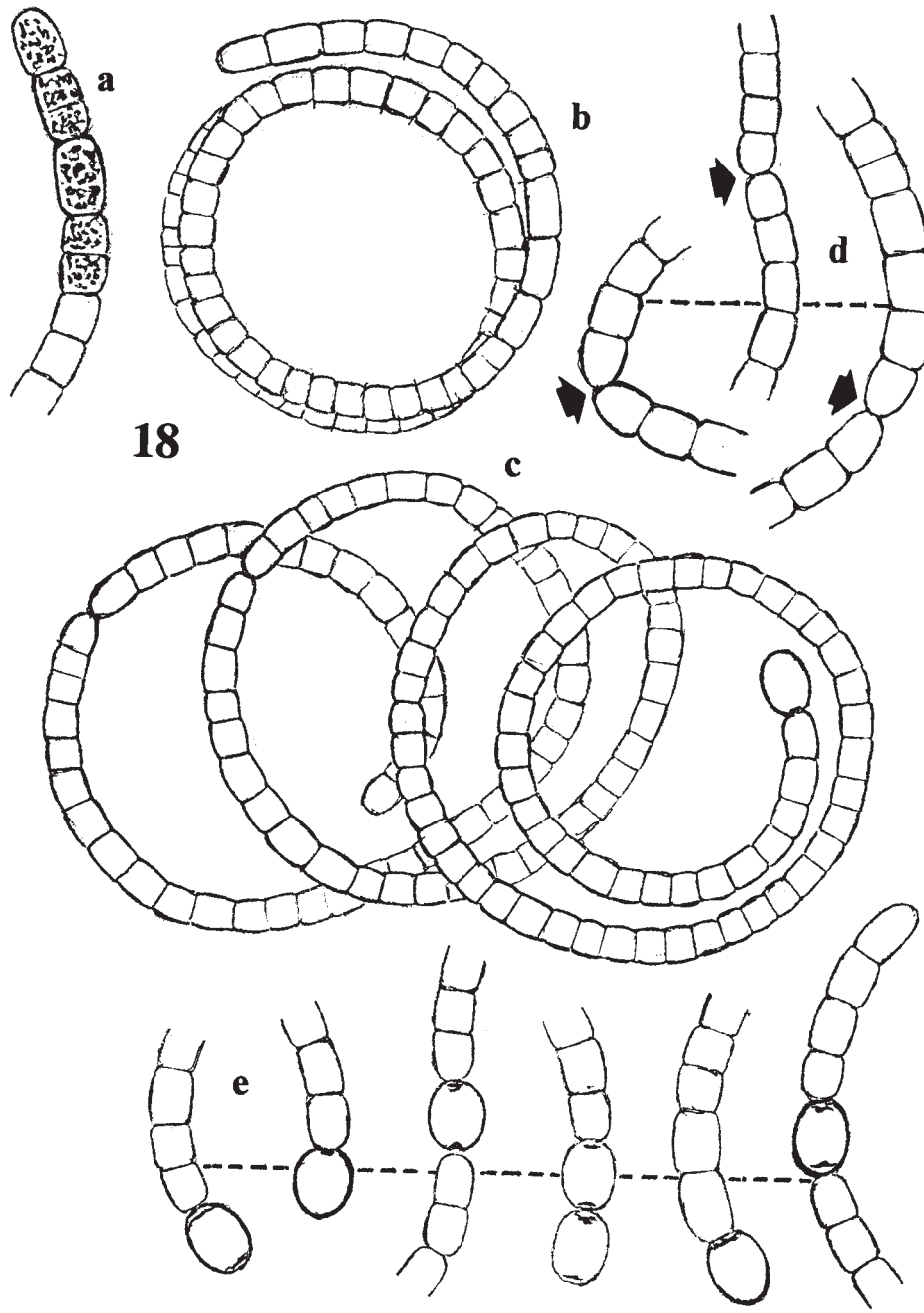

Fig. 18. – *Anabaena fallax* (iconotype): a – detail of filament end; b–c – typically coiled filaments; d – site of disintergation of trichomes between the vegetative cells; e – variability in form and position of uni- or bipored heterocytes. – Orig.

This species is characterized by irregularly coiled trichomes, lives solitarily or in small clusters, barrel-shaped cells with aerotopes, and cylindrical-oval akinetes, which develop distant from heterocytes.

Description: Trichomes solitary or in clusters, free floating, irregularly coiled, distinctly constricted at cross walls, 5.0–5.5 μm wide; terminal cells do not differ from the intercalar ones. Cells barrel-shaped, ± spherical or slightly elongated (longer than wide), with aerotopes. Heterocytes spherical or widely oval, hyaline, solitary, develop intercalarly, or from apical cells (unipored), 7.0 × 5.2–7.0 μm. Akinetes distant from heterocytes, usually develop solitarily, when ripe they are cylindrical to elongate-oval with rounded-truncate ends, usually ± 25 × 8 μm; akinetes were rare in our material.

Anabaena manguinii (Bourr.) Kom. 1974 (Fig. 19)

Member of rich phytoplanktic communities in freshwater, mesotrophic lakes, in solitary trichomes, rarely forming small blooms. Known from the Caribbean (Cuba, Guadeloupe), Brazil, and now Mexico, where there is a perennial population in the non-salty, alkaline, volcanic lake La Preciosa, Puebla state, central Mexico. Collected twice; on 24 April 1993 (without akinetes) and on 18 June1993 (with akinetes). It also occurred, but was uncommon in another volcanic lake, Tecuitlapa in Puebla state (18 June 1993).

Originally described by Bourrelly (Bourrelly & Manguin 1952) as *Aphanizomenon manguinii*, because of its narrow trichome ends, and slightly elongated and often hyaline terminal cells. Komárek (1974) transferred this species to the genus *Anabaena,* because the trichome development is metameric with numerous heterocytes. The final taxonomic position of the group of planktic "*Anabaenas* with straight trichomes and narrowed ends" (comp. Komárek & Kováčik 1989) has yet to be resolved.

Description: Trichomes straight, isopolar, slightly curved or irregularly waved, with up to 4 (5) heterocytes localized at more or less regular intervals in the trichome, cylindrical, distinctly constricted at cross walls, gradually and slightly attenuated toward both ends, 3.5–4.0 μm wide; terminal cells are narrow in well developed trichomes, elongated, rounded at the apex, and sometimes hyaline. Cells barrel-shaped to almost cylindrical, ± isodiametric or slightly longer than wide, with aerotopes. Heterocytes always intercalar, solitary, spherical to widely oval, sometimes slightly barrel-shaped, with hyaline content when ripe, 6.0–6.5 μm in diameter. Akinetes develop solitarily, distant from heterocytes; they are spherical with granular content, with hyaline exospore and smooth surface, 14–17 μm in diameter.

Anabaenopsis cf. *circularis* (G. S.West) Mill. 1923

Commonly distributed species, mainly in tropical and subtropical regions. Individuals from the Mexican population in lake Quitzeo (state Guanajuato) did not differ substantially from the original description.

Anabaenopsis tanganyikae (G. S. West) Mill. 1923

Solitary trichomes, corresponding to the original description, were found in central Mexico in lakes in Chapultepec Park (Mexico D. F.).

Cylindrospermopsis catemaco Kom.-Legn. et Tavera 1996

This species was recently described from the large volcanic eutrophic lake Catemaco (state Veracruz), where it is a dominant species in the phytoplankton, but is not known

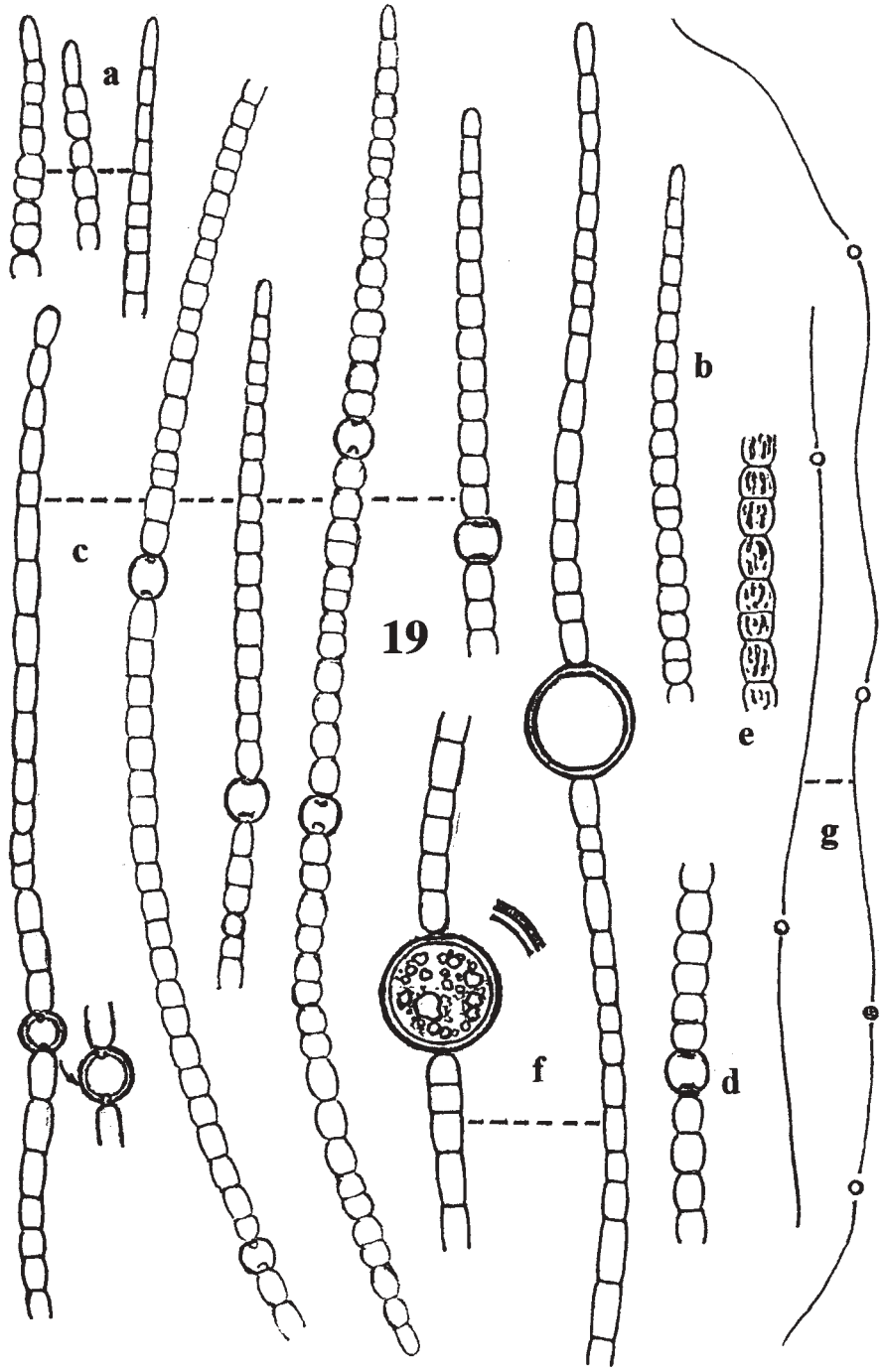

Fig. 19. – *Anabaena manguini*: a–b – detail of trichome ends; c–d – parts of trichomes with heterocytes; e – detail of vegetative cells with aerotopes; f – parts of trichomes with spherical akinetes; g – form of filaments. – Orig.

from other Mexican localities. Details of its ecology can be found in Komárková-Legnerová & Tavera (1996). It is possibly widely distributed, but certainly not a common species. It was found in an artificial reservoir in S California (USA).

Three of the four *Cylindrospermopsis* species with predominantly coiled trichomes, and two of the three with straight trichomes are found in Mexican waters; two coiled species (incl. *C. catemaco*) are recorded only from Mexico. This genus consists almost exclusively of tropical freshwater species, and it is probably very diverse. *C. catemaco* has a distinct trichome morphology and size, but akinetes were not yet found.

D e s c r i p t i o n : Trichomes solitary, free floating, composed of 2 to 4 (10) long cells, without mucilaginous envelopes, more or less regularly screw-like coiled with one to two coils, cylindrical, without envelopes, with long cells (5–30-times longer than wide), attenuated and pointed at both ends, without constrictions at the slightly visible cross walls, 0.8–1.6 μm wide; coils 7–11 μm wide and 5–14 μm high. Cells pale blue-green, heterocytes develop at one end, very rarely were they found at both ends of trichomes, elongate and narrow, sometimes slightly arcuated, pointed, or bluntly pointed apically. Aerotopes occur in cells occasionally, scattered in the protoplast; within cells there are sometimes solitary granules.

Cylindrospermopsis cf. *philippinensis* (Taylor) Kom. 1984 (Fig. 20)

Probably a pantropical species, known mainly from SE Asia (Indonesia, Philippines) and central America (Cuba, Mexico). The identity of all known populations is unclear, several of them are morphologically near to *C. raciborskii*. However, the Mexican specimens differ distinctly from *C. raciborskii*, with which it occur and which may also develop coiled trichomes. This means that coiling is not a main distinguishing feature between *C. philippinensis* and *C. raciborskii* (particularly morphology of cells is different).

Specimens we believe to be *C. philippinensis* were found in Mexico in lakes with a special ecology, in large reservoirs of volcanic origin. A distinct population occurs in lake Catemaco (Veracruz; compare with Komárková-Legnerová & Tavera 1996). It is the first time that akinete formation is reported in this species; the type of akinete formation and its morphology justified the phenotype segregation of this species from other *Cylindrospermopsis* members.

D e s c r i p t i o n : Trichomes solitary, free floating, 30–120 μm long, without mucilaginous envelopes, circularly coiled with 0.5–3 coils, 20–25 μm in diameter and 5–10 μm high, isodiametric with both apical cells narrow, or with heterocytes at one or (rarely) both ends, not constricted at cross walls, 1.9–3.0 (5.0) μm wide. Cells cylindrical, 10–18 (22) μm long, with only a few aerotopes present occasionally. Heterocytes cylindrical to oval, sometimes slightly bent, pointed or blunt. Akinetes solitary or in pairs beside heterocytes. They are elongate, more or less cylindrical with rounded ends, slightly curved, with an homogeneous content with several granules.

Cylindrospermopsis cuspis Kom. et Kling 1991

C. cuspis was found in Mexico for the first time since its original description based on material from Africa. A few specimens were found in a small volcanic lakes in the Los Tuxtlas region (Veracruz). As in Africa the trichomes were always without akinetes.

Cylindrospermopsis raciborskii (Wolosz.) Seenayya et Subba Raju 1972

The typical form of trichomes without akinetes (although the populations were not well developed) was found in small lakes in Los Tuxtlas region (Veracruz), and in large lakes in

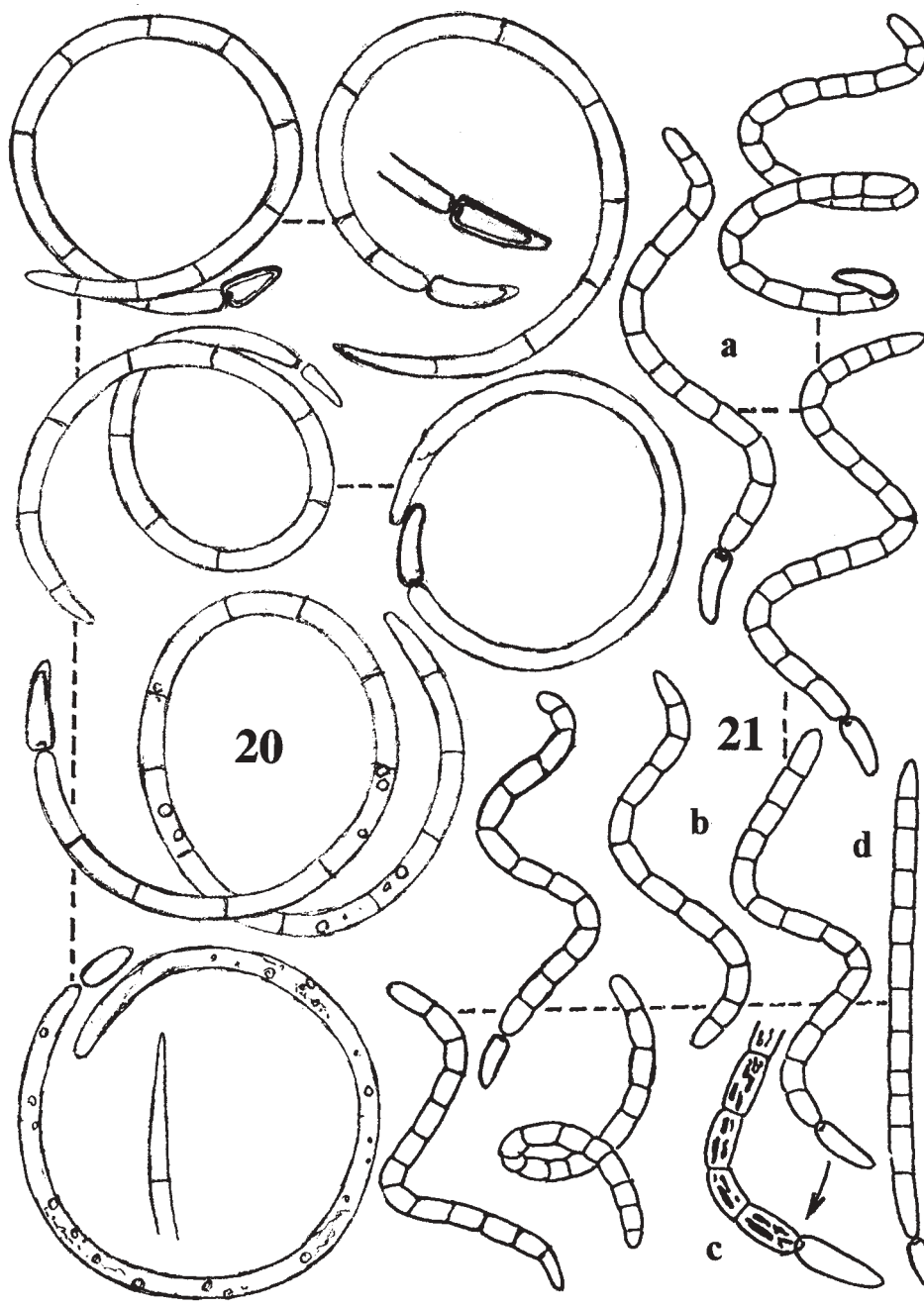

Fig. 20. – *Cylindrospermopsis* cf. *philippinensis*: variability in coiling of trichomes with details of trichome ends and heterocytes.

Fig. 21. – *Cylindrospermopsis taverae* (iconotype): a–b – typically coiled trichomes with terminal heterocytes; c – detail of terminal part of a trichome with vegetative cells with aerotopes and an apical heterocyte; d – exceptionally occurring straight trichome from an abundant population. – Orig.

central Mexico (Michoacán). The largest population was found in the small Lake Asmolapan in the Los Tuxtlas mountains.

Cylindrospermopsis taverae Komárek et Komárková-Legnerová **spec. nova** (Fig. 21)

This small species with mostly coiled trichomes, which gives a water green colour, but does not form distinct blooms, was found in May 1992 in small freshwater eutrophic ponds near road no. 85 from Valles to St. Luis Potosí, which had a neutral to slightly alkaline pH (about 7.5), and a high water temperature (30–32 °C).

Of the seven *Cylindrospermopsis* species, three have mainly straight trichomes, and four coiled trichomes. However, almost in all species individuals with straight or coiled trichomes can occur (with the exception of the always straight *C. cuspis*, and always coiled *C. catemaco* and *C. curvispora*). The population with coiled trichomes we studied differed from all other species in being smaller. The shape of its cells is similar to that in the larger *C. raciborskii* (which sometimes has coiled trichomes), and to the spirally coiled *C. curvispora*. Straight trichomes would appear to be very rare. Akinetes were not found, but the different morphology justifies the definition of a new species.

Description: Trichomes solitary, free floating, more or less regularly screw-like coiled with one to two coils, cylindrical, constricted at cross walls, 2.7–3.2 (3.5) μm wide, very rarely nearly straight. Cells cylindrical to slightly barrel-shaped, rarely almost isodiametric, usually 1.5 (–2) × longer than wide, with slightly elongated heterocytes; apical cells of the same width as the other cells, or slightly narrower and rounded. Heterocytes were present at only one end of the trichome; they are elongate, slightly conical, curved, and rounded at the apex, 4.2–5.5 μm long. Akinetes not known.

Diagnosis: *Cylindrospermopsis taverae* spec. nova. – Trichoma solitaria, libere natantia, plus minusve regulariter spiraliter contorta, cum una vel duas spiras, cylindrica, ad dissepimenta constricta, 2.7–3.2 (3.5) μm lata, rarissime recta. Cellulae cylindricae vel paucim barriliformes, rare isodiametricae ad 1.5 (–2) × longior quam latae, cum heterocytarum numeris paucim elongatibus; cellulae apicales apice rotundatae. Heterocytae solitariae, apicales, elongatae, conicae, paucim arcuatae, apice rotundatae, 4.2–5.5 μm longae. Akinetes not observatur. – Holotypus (iconotypus): figura nostra 21. – Habitatio: Mexico, planktice in piscinas eutrophicis prope Valles, San Luis Potosí. – The species is named after Rosaluz Tavera PhD., a scientist at the Laboratorio de Ficología, UNAM, Mexico City.

Nodularia cf. *spumigena* Mert. ex Born. et Flah. 1886 (Fig. 22)

We found two *Nodularia* populations in plankton in two volcanic lakes of Maar-type situated close to each other in Puebla state, central Mexico (Alchichica, Atexcac), where they periodically form slight but remarkable water-blooms. Both lakes are small, deep and characterized by a high pH 9.2–10.7, temperature of 16-22 °C at the surface, a high conductivity (over 300 μS) and usually an increased salinity (10–12%). The samples were collected repeatedly on 23 April 1993 and 18 June 1993, and this species was always present at these localities (Vilaclara et al. 1993). The ecology of both these lakes was described in detail also by Tavera & Komárek (1996).

The genus *Nodularia* consists of two groups of species, benthic without aerotopes and planktic with aerotopes. The Mexican planktic populations mainly correspond in their dimensions and cell and heterocyte morphology to the species *N. spumigena* with few exceptions: they lacked coiled trichomes contrary to the descriptions in Huber-Pestalozzi (1938) and Komárek et al. (1993); they are extremely straight and "stiff" and only if they disintegrate (usu-

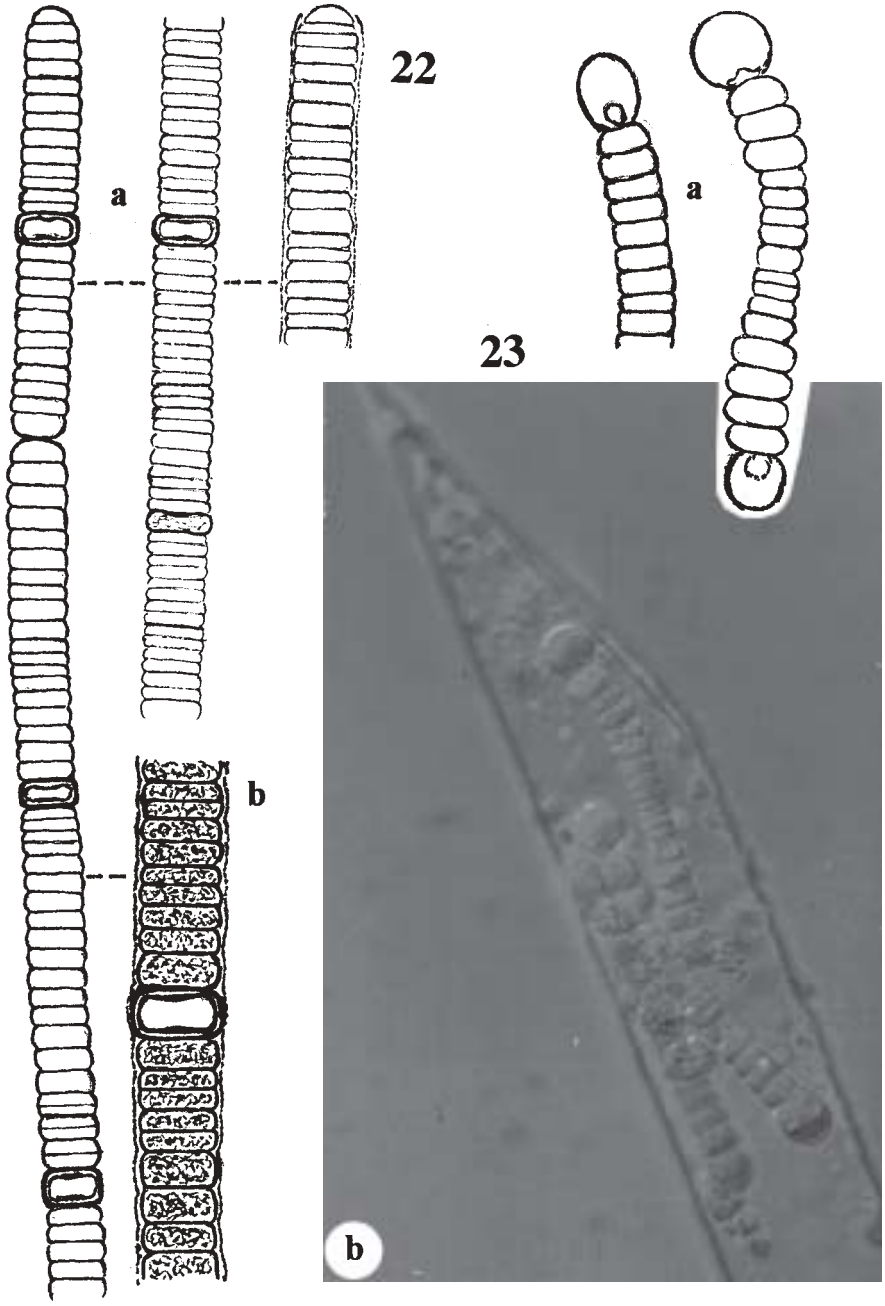

Fig. 22. – *Nodularia* cf. *spumigena*: a – parts of straight trichomes with heterocytes; b – detail of vegetative cells with small aerotopes and detail of a heterocyte.

Fig. 23. – *Richelia intracellularis*: a – detail of trichomes with heterocytes and subpolar akinetes; b – filaments inside scale of *Rhizosolenia*. – Orig.

ally at heterocytes), are their segments likely to join at an angle. Other differences are the very fine sheaths and strong constrictions at cross-walls. The populations from both lakes were morphologically very uniform and identical. Morphologically similar material was collected by DeLeón et al. (1996) from a coastal brackish lagoon in Uruguay (see also Pérez et al. 1997), but with very long filaments. The heterogeneity and taxonomic identity of the various planktic *Nodularia* populations require further study using more precise methods.

Description: Trichomes straight or very slightly arcuated, distinctly constricted at cross walls, with regularly spaced heterocytes. Sheaths very fine, thin, colourless, sometimes quite indistinct, not overlapping the trichomes, 11.4–12.2 μm wide. Cells short barrel-shaped, always distinctly shorter than wide, 2.0–4.8 μm long, with fine granular, yellow-green content; aerotopes are not delimited, indistinct, but always present. Heterocytes short (always shorter than wide), hyaline, as wide as or (usually) slightly wider than the vegetative cells, 5.2–7.0 × 12.0–13.0 μm. Akinetes were never found in Mexican populations.

Richelia intracellularis Johns. Schmidt 1901 (Fig. 23)

Our specimens were collected by G. Figueroa (UAM, Mexico D. F.) in the in-shore plankton off the Mexican coast of the Pacific ocean near Oaxaca. This species lives endobiotically within the scales of marine diatoms, in our samples mainly in *Rhizosolenia.* The genus *Richelia* was monotypic, but Hindák (2000) recently transferred *Anabaena* (= *Richelia*) *siamensis* into this genus and described its special strategy for heterocyte development. Unfortunately, heterocyte development was not observed in the Mexican populations of *R. intracellularis.* As far as we know, we are the first to find akinetes. Their shape and type of formation places *Richelia* near the genus *Nodularia* (e.g., compare our description of *Richelia*-trichomes with that given by Peréz et al. 1997).

Description: Trichomes solitary or few in free clusters, inside *Rhizosolenia* scales, short, maximally with 24 cells. Cells always shorter than wide, 6–8 μm broad. Heterocytes develop succesively at both ends of trichomes. Akinetes are similar to the vegetative cells, but distinctly larger; they develop in rows (up to 6 in our specimens), aside of heterocytes.

Acknowledgements

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Souhrn

Planktonní mikroflóra sinic ve vnitrozemských sladkovodních a salinních nádržích centrálního Mexika je dosti diverzifikovaná vzhledem k různým ekologickým podmínkám těchto biotopů. Dosud neexistují žádné studie popisující detailně planktonní společenstva četných nádrží tohoto regionu. V letech 1992 a 1993 jsme měli možnost navštívit řadu lokalit v rámci řešení jiných úkolů Fykologické Laboratoře univerzity UNAM v Mexico City. V našem článku podáváme soupis 51 významných planktonních druhů, mezi kterými byly rozeznány 4 nové druhy pro vědu (*Cyanobacterium lineatum, Cyanotetras aerotopa, Anabaena fallax* a *Cylindrospermopsis taverae*). U všech druhů jsou poznámky o ekologii a rozšíření; v případě, že se jednalo o morfologické odchylky od běžně známých populací některých druhů, zařazujeme popis mexických populací. Studium této mikroflóry je velice urgentní z hlediska ekologie jednotlivých druhů i z důvodů fytogeografických a vodohospodářských.

References

Anagnostidis K. & Komárek J. (1988): Modern approach to the classification system of cyanophytes 3 – *Oscillatoriales*. – Arch. Hydrobiol./Algolog. Stud. 50–53: 327–472.

Bernard C. (1908): Protococcacées et desmidiées d'eau douce, récoltées a Java. – Batavia. [230 pp.]

Bourrelly P. (1970): Les algues d'eau douce. III. – N. Boubée & Cie., Paris. [512 pp.]

Bourrelly P. & Manguin E. (1952): Algues d'eau douce de la Guadeloupe et dépendances. – Paris. [282 pp.]

Crow W. B. (1923): The taxonomy and variation of the genus *Microcystis* in Ceylon. – New Phytol. 22: 59–68.

De León L., Bonilla S. & Pérez M. C. (1996): Floracion de *Nodularia spumigena* Mert. (*Cyanobacteria*) en una laguna costera, Uruguay. – Progr. Abstr. IV. Congr. Lat. Amer., Caxambu, 78: 91.

Desikachary T.V. & Jeeji Bai N. (1992): Taxonomic studies in *Spirulina*. – In: Seshadri C. V. & Jeeji Bai N. (eds.), *Spirulina,* ETTA Nat. Symp., Madras.

Fott B. & Karim A. G. A. (1973): *Spirulina* plankton community in a lake in Zebel Marra, Sudan. – Arch. Protistenk. 15: 408–418.

Geitler L. (1932): *Cyanophyceae*. – In: Rabenhorst's Kryptogamenflora von Deutschland, Österreich und Schweiz 14: 1–1196, Akad. Verl., Leipzig.

Golubić S. (1977): Speciation in *Trichodesmium*: occupation of an oceanic pelagic niche. – Schweiz. J. Hydrol. 39: 141–143.

Hindák F. (1985): Morphology of trichomes in *Spirulina fusiformis* Voronichin from lake Bogoria, Kenya. – Arch. Hydrobiol./Algolog. Stud. 38–39: 201–218.

Hindák F. (1996): Cyanophytes colonizing mucilage of chroococcal water blooms. – Nova Hedwigia 112: 69–82.

Hindák F. (2000): A contribution to the taxonomy of the nostocalean genus *Richelia* (*Cyanophyta/ Cyanobacteria*). – Biológia 55: 1–6.

Huber-Pestalozzi G. (1938): Das Phytoplankton des Süsswassers. Systematik und Biologie. 1. – Die Binnengewässer 16: 1–342.

Komárek J. (1974): Sobre las cianofíceas de Cuba. 3. Especies planctónicas que forman florecimentos de las aguas. – Acta Bot. Cubana 19: 1–33.

Komárek J. (1995): Studies on the cyanophytes (cyanoprokaryotes) of Cuba 10. New and little known chroococcalean species. – Folia Geobot. Phytotax. 30: 81–90.

Komárek J. & Azevedo M. T. P. (2000): *Geitlerinema unigranulatum,* a common tropical cyanoprokaryote from freshwater reservoirs in Brazil. – Arch. Hydrobiol./ Algolog. Stud. 99 (Papers Cyanobact. Res 1): 39–52.

Komárek J. & Cepák V. (1998): Cytomorphological characters supporting the taxonomic validity of *Cyanothece* (*Cyanoprokaryota*). – Plant Syst. Evolut. 210: 25–39.

Komárek J. & Cronberg G. (2001): Some chroococcalean and oscillatorialean cyanoprokaryotes from southern African lakes, ponds and pools. – Nova Hedwigia 73: 129–160.

Komárek J. & Hindák F. (1988): Taxonomic review of natural populations of the cyanophytes from the *Gomphosphaeria*-complex. – Arch. Hydrobiol./Algolog. Stud. 50–53: 109–129.

Komárek J., Hübel M., Hübel H. & Šmarda J. (1993): The *Nodularia* studies 2. Taxonomy. – Arch. Hydrobiol./Algolog. Stud. 68: 1–25.

Komárek J. & Kling H. (1991): Variation in six planktic cyanophyte genera in Lake Viktoria (East Africa). – Arch. Hydrobiol./Algolog. Stud. 61: 24–45.

Komárek J. & Komárková-Legnerová J. (1992): Variability of some planktic gomphosphaerioid cyanoprokaryotes in northern lakes. – Nordic J. Bot. 12: 513–524.

Komárek J., Komárková-Legnerová J., Sant'Anna C. L., Azevedo M. T. P. & Senna P. A. C. (2002): Two common *Microcystis* species (*Chroococcales*, *Cyanobacteria*) from tropical America, including *M. panniformis* spec. nova. – Cryptogamie/Algologie (in press).

Komárek J., Kopecký J. & Cepák V. (1999): Generic characters of the simplest cyanoprokaryotes *Cyanobium, Cyanobacterium* and *Synechococcus.* – Cryptogamie/Algologie 20: 209–222.

Komárek J. & Kováčik L. (1989): Trichome structure of four *Aphanizomenon* taxa (*Cyanophyceae*) from Czechoslovakia, with notes on the taxonomy and delimitation of the genus. – Plant Syst. Evol. 164: 47–64.

Komárek J. & Lund J. W. G. (1990): What is "*Spirulina platensis*" in fact? – Arch. Hydrobiol./Algolog. Stud. 58: 1–13.

Komárková-Legnerová J. & Tavera R. (1996): *Cyanoprokaryota* (*Cyanobacteria*) in the phytoplankton of Lake Catemaco (Veracruz, Mexico). – Arch. Hydrobiol./ Algolog. Stud. 83: 403–422.

Nelissen B., Wilmotte A., Neefs J.-M. & De Wachter R. (1994): Phylogenetic relationships among filamentous helical cyanobacteria investigated on the basis of 16S ribosomal RNA gene sequence analysis. – System. Appl. Microbiol. 17: 206–210.

Pérez M. C., Bonilla S., de León L., Šmarda J. & Komárek J. (1999): A bloom of *Nodularia baltica/spumigena* group (*Cyanobacteria*) in a shallow coastal lagoon of Uruguay, South America. – Arch. Hydrobiol./Algolog. Studies 93: 91–101.

Skuja H. (1948): Taxonomie des Phytoplanktons einiger Seen in Uppland, Schweden. – Symb. Bot. Upsal. 9: 1–399.

Skulberg O. M. & Skulberg R. (1985): Planktic species of *Oscillatoria* (*Cyanophyceae*) from Norway. Characterization and classification. – Arch. Hydrobiol./ Algolog. Stud. 38–39: 157–174.

Sládeček V. & Vilaclara G. (1993): A water-bloom in Lake Patzcuaro (Michoacan, Mexico). – Verh. Internat. Verein. Limnol. 25: 431–434.

Suárez Morales E. (1983): Estudios de la variación estacional del plancton en la Laguna de Catemaco, Ver. – Tesis Universidad Nacional Autónoma de Mexico, Biologia, Mexico. [72 pp.]

Suda S., Watanabe M. M., Otsuka S., Mahakahant A., Yongmanitchai W., Nopartnaraporn N., Liu Y. & Day J. G. (2002): Taxonomic revision of water bloom-forming species of oscillatorioid cyanobacteria. – Int. J. Syst. Evol. Microbiol. (in press).

Tomaselli L., Palandri M. R. & Tredici M. R.(1996): On the correct use of the *Spirulina* designation. – Arch. Hydrobiol./Algolog. Stud. 83: 539–548.

Tavera R. & Komárek J. (1996): Cyanoprokaryotes in the volcanic lake of Alchichica, Puebla State, Mexico. – Arch. Hydrobiol./Algolog. Studies 83: 511–539.

Vilaclara G., Chávez M., Lugo A., González H. & Gaytán M. (1993): Comparative description of crater-lakes basic chemistry in Puebla State, Mexico. – Verh. Internat. Verein. Limnol. 25: 435–440.

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Profesor na Universitě J. W. Goetha ve Frankfurtu nad Mohanem Rüdiger Wittig tímto svazkem navázal na svůj předchozí titul „Ökologie der Grossstadtflora“, vydaný v roce 1991 nakladatelstvím Gustav Fischer. Kniha vychází jako svazek řady „Ökosysteme Mitteleuropas aus geobotanischer Sicht“, redigované R. Pottem. Hned na úvod je třeba říci, že se nejedná o zakuklené druhé vydání, jež by se odlišným titulem snažilo nalákat zájemce k opětovné koupi. Třebaže jsou obě knihy strukturovány obdobně – pochopitelně, zabývají se stejným oborem a jsou dílem stejného autora – ta nová je přepracovaná, reflektuje vývoj v oboru v poslední dekádě a (což je důležitá změna) na rozdíl od své předchůdkyně se zabývá nejen flórou a vegetatcí měst, ale též venkovských sídlišť.

Dvěstěpadesátistránkový vázaný svazek je koncipován jako učebnice ruderální geobotaniky ve středoevropské tradici. S příslovečnou německou důkladností jsou zde probírány jednotlivé okruhy témat, počínaje vymezením pojmů, shrnutím dostupných informací, jejich utříděním a vyvozením příslušných závěrů. Takto je čtenář seznámen s historií výzkumu sídlišť, jejich klimatem, půdami, ekologickými faktory a tím co znamenají pro život rostlin. Kniha pokračuje rozborem metodických problémů spojených se studiem ruderální vegetace sídlišť, nechybí kapitola o zavlečených druzích (hezký je přehled 111 archeofytů na str. 42–43 s uvedenou předpokládanou dobou zavlečení či na str. 52–53 přehled 37 neofytů, u nichž bylo doloženo zplanění ze zahrad a parků). Základ knihy pak tvoří popis složení flóry a vegetace sídel, probíraného s ohledem na taxonomickou příslušnost, ekologické skupiny (např. hemerobie), ale samozřejmě starou dobrou fytocenologii. Nutno vyzdvihnout, že ta je zde pojednána poměrně neškolometsky, vkusně a kapitolky o jednotlivých typech společenstev mají ekologický náboj. Užitečná je kapitola o pěstovaných druzích. Knihu uzavírá kapitola aplikovaná – bioindikace znečištění ovzduší, kontaminace půd, ochrana přírody ve městech a ohrožení specifické vegetace sídlišť.

Určitě je třeba velmi vyzdvihnout dokumentaci. Více než 130 fotografií, v naprosté většině barevných a zdařilých (jen výjimečně nikoli, např. str. 36, kde evidentně selhala tiskárna), a množství velmi instruktivních schémat a tabulek, vždy s pečlivou citací pramenů, text velmi příjemně oživuje. Tabulky přitom shrnují informace nejen věcné, ale i bibliografické. Jedna kupříkladu nabízí srovnání prozkoumanosti jednotlivých středoevropských zemí. Dokládá, že fytocenologické snímky jsou k dispozici z 25 německých měst; za Německem následuje Česká republika s 9 městy a Polsko se 6. Dále už je množství dat podstatně skromnější: Slovensko 2, Rakousko a Švýcarsko po 1. Perličkou budiž v této souvislosti, že mezi středoevropská města proklouzlo i švédské Malmö. Inu, stane se.

Opravdu zajímavý a přínosný je přehled literatury. Čítá odhadem 800 položek a zejména německá literatura týkající se ruderální flóry a vegetace je pokryta velmi důkladně; nejsou ovšem opominuty ani práce z okolních zemí a odlišného jazykového prostoru. Jak z tohoto „srovnání významu“ vyšla česká ruderální škola, resp. jak jsou vnímáni její jednotliví představitelé? Nutno říci, že vyšla se ctí a vnímáni jsou důstojně. Po samotném prof. Wittigovi, jehož práce v seznamu zabírají téměř dvě tiskové strany, je jedním z nejčastěji citovaných autorů vůbec Antonín Pyšek – je uvedeno celkem 24 jeho prací a často jsou využity přímo v textu prostřednictvím tabulek s prezentovanými kvantitativními údaji z plzeňské, resp. západočeské ruderální vegetace. Důkladně je zohledněno též významné pražské dílo K. Kopeckého (12 prací), několikrát jsou citováni též např. F. Grüll, E. Hadač, S. Hejný či V. Jehlík, ze slovenských autorů T. Krippelová a P. Eliáš. Je vidět, že práce silné a pracovité generace, jež od 70. let minulého století vytvářela zázemí tohoto oboru u nás, je velmi zřetelně vnímána i na mezinárodní scéně.

Kniha R. Wittiga je užitečnou sumarizací toho, co je známo o sídlištní vegetaci. Nic více, ale hlavně nic méně, protože to je samo o sobě dost. Každému zájemci o tento obor ušetří spoustu práce, protože autor tu pro něho vyhledal a do úsporné formy přetavil, co by měl vědět, než si začne sám klást otázky. Ani obligátní poznámka „škoda, že to není v angličtině“ v tomto případě neobstojí, protože kdo chce studovat ruderální vegetaci, německy umět musí – tato kniha o tom svědčí více než výmluvně.

Petr Pyšek