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Little known tropical *Chroococcus* species (Cyanoprokaryotes)

Málo známé tropické druhy z rodu *Chroococcus* (*Cyanoprokaryota*)

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Nine little known or new species of the cyanoprokaryotic genus *Chroococcus* from tropical regions are presented. Two of them, *Ch. polyedriformis* Schmidle 1902 and *Ch. mipitanensis* (Wołoszyńska 1912) Geitler 1925, were described as early as in the first decades of this century, but ignored by later authors, probably owing to the authority of Geitler who omitted these taxa in his world monograph from 1932. Both these species occur in tropical freshwater biotopes over the world and were repeatedly published under different incorrect names. Recently, they were found in Central American localities. Five species, differing slightly from the known and described taxa, were found from the metaphyton of stagnant waters in Cuba and in the coastal areas of Mexican Gulf in Mexico (Papaloapan basin); their variability and morphology are discussed. One new species, *Ch. deltoides*, is described. Two planktic species (from the subg. *Limnococcus*) are described from large African lakes, *Ch. catenatus* from L. Edward (E Africa) and *Ch. cronbergae* from the Kariba reservoir.

Introduction

The majority of cyanoprokaryotic (cyanophytic, cyanobacterial) species posses specialized ecological properties, which influence their areas of distribution. The species with world--wide distribution are substantially fewer than supposed up to now by particular authors (and monographic studies or compendia) and usually occur in very distinctly limited ecological environments. The application of "temperate" determination keys for tropical microflora leads to numerous misinterpretations and misidentifications of morphologically similar, simple cyanoprokaryotic species.

However, the diversity of tropical cyanoprokaryotic flora is evidently higher than that of the temperate one which is in coincidence with substantially larger diversity of tropical biotopes. If cyanoprokaryotes from temperate regions are compared precisely with microflora of various tropical biotopes, the species diversity is always higher in the latter, regardless of which tropical country is concerned. Many species occur only in either

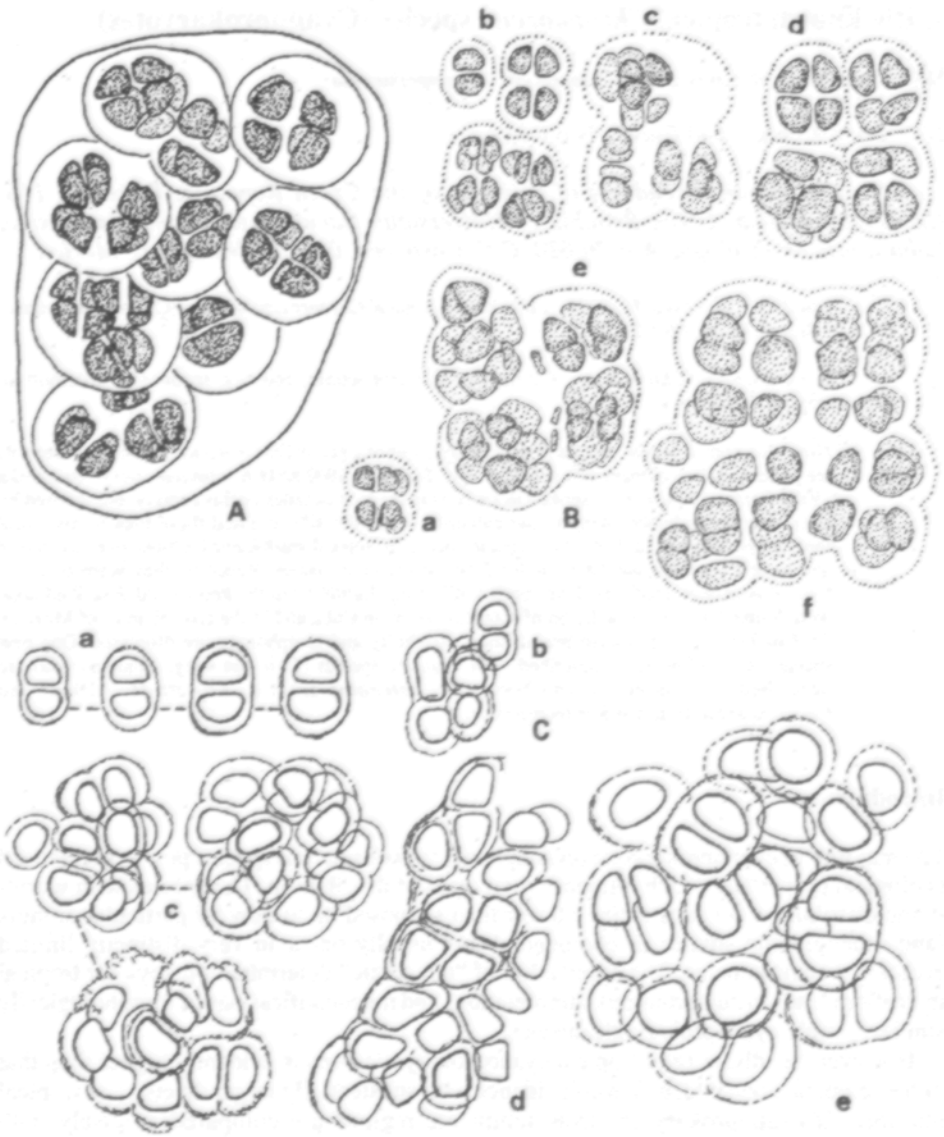


Fig. 1. - *Chroococcus polyedriformis*; A - after Chu (1952, sub *Ch. limneticus* var. *multicellularis*), B - after Desikachary (1959, sub *Myxosarcina spectabilis*), C - orig. from Tehuacan Valley, Mexico.

temperate or tropical regions (or have even more limited distribution areas). Many names of cyanoprokaryotic taxa described from Europe have been used incorrectly for designation of quite different tropical populations. The descriptions of new species are not popular and many authors thus use some of the existing names very arbitrarily. At present, there are many epithets which relate to ecologically and morphologically different organisms.

During our studies of tropical unicellular cyanoprokaryotes, we found several *Chroococcus* species, two of which were already correctly described in the first three decades of this century but ignored by later authors and misinterpreted with other taxa, namely *Chroococcus polyedriformis* Schmidle 1901 and *Chroococcus mipitanensis* (Wołoszyńska) Geitler 1925. In this paper, their morphological descriptions are presented and their correct names are re-established. The morphological variation of two species from Cuban and Mexican biotopes is described. Taxonomic evaluation of five further species from swamps and pools in lowlands of Cuba and Mexico (east coastal areas) is presented. Further, two planktic species from the subg. *Limnococcus* from large African lakes (Lake Edward in E Africa and Kariba reservoir in S Africa - Zimbabwe) are described.

Results and discussion

1. *Chroococcus polyedriformis* Schmidle 1902 (Figs. 1-2)

This species was described by Schmidle (1902b) from subaerophytic localities ("an Gneis-blöcken") near the Lake Nyassa, Tanganyika, but omitted by later authors (Fig. 2f). Geitler (1925, 1932, 1942) did not mention it and neither did Elenkin (1938) and Desikachary (1959) in their monographs. This species is characterized by typical chroococcoid cell division and shape of colonies in the first stages of development but later on, the cells remain in large agglomerations with numerous cells (similarly to various small aerophytic species). The cells in old colonies are irregularly rounded, 10-16 x 8-10 μm (with gelatinous, colourless or yellowish-reddish envelopes) and the chroococcoid type of division is commonly recognizable. Around cells and their groups, the mucilaginous firm, colourless, homogeneous or indistinctly stratified, 2-8 μm wide envelopes are common, which more or less copy the cell shape. This chroococcal character of colonies is more or less recognizable also in old irregular colonies with numerous cells.

This species appeared later several times in the literature under different names. It was published by Chu (1952) from South China, who described *Chroococcus limneticus* var. *multicellularis* from a "stony pool at the bank of a rapid stream, Helungkiang ... in Szechwan, ... attached to leaves and stems of hydrophytic macrophytes" (Fig. 1A). Cells of his variety are 5-9 μm in diameter. In his book, Desikachary (1959) presents "*Myxosarcina spectabilis* Geitler" (Fig. 1B) with cells 6.5-10 μm in diameter, which he found on "cement water tubes in laboratory and in cultures of water from Red Hills Lake, Madras" in India. However, Geitler (in Geitler et Ruttner 1935) describes in the original material of *Myxosarcina spectabilis* the nanocytic division ("endospores"), which were not documented in Desikachary's drawings from the Indian material. On the contrary, the mucilaginous envelopes around single cells (cells distinctly distant one from another) are recognizable in Madras specimens. The dimensions of cells and morphology of colonies

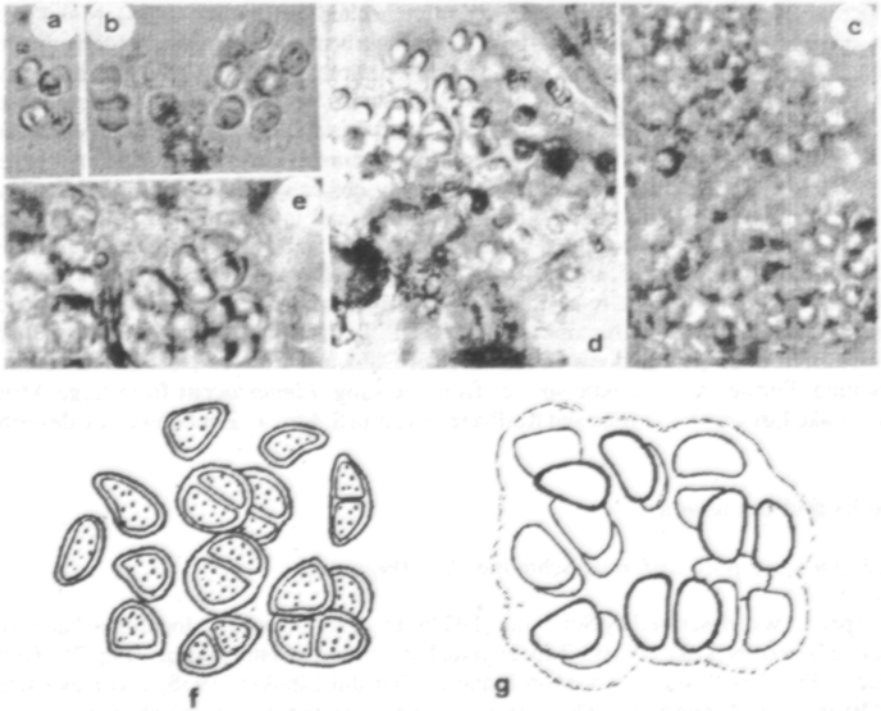


Fig. 2. - *Chroococcus polyedriformis;* a-e, g - from Tehuacan Valley, Mexico, f - iconotype from Schmidle (1902).

of Schmidle's, Chu's and Desikachary's taxa are almost identical and their taxonomic identity is highly probable.

In samples from a temporary pond, connected with irrigation channel near San Lorenzo and in soil cultures from the surrounding area, Tehuacan Valley, state Puebla, Mexico (1600 m a. s. l., temperature over 30°C, pH ± 8.5), rich populations of *Chroococcus* species were found repeatedly in 1979 and 1984; these were evidently identical with *Chroococcus polyedriformis* (Fig. 1C, 2g). *Chroococcus polyedriformis* grows there mainly in metaphyton on submerse leaves and on water plants. Cells in the colonies were rather variable in size (4-11 μm) which is, however, a feature common within this genus. Similar size variation (but not nanocyte formation!) is recognizable also from drawings of Desikachary (1959, Fig. 30:3). The type of division is the same as in other *Chroococcus* species. It differs from *Myxosarcina* in the structure of colonies (with the cells being arranged more freely) and, mainly, in typical nanocytes being completely absent.

From these data, the morphological and taxonomic relatedness of the reported specimens is evident. The form of old cell clusters is transitional between the characteristic shape of *Chroococcus* colonies and of other chroococcacean genera, particularly of *Gloeocapsopsis* and *Cyanosarcina*, respectively. However, because the arrangement of cells in multicellular

agglomerated colonies also corresponds to *Chroococcus*, we classify this species into this genus under the prior name *Chroococcus polyedriformis* Schmidle 1902. The similar cell shape and arrangement of cells in colonies may be also found in *Chroococcus quaternarius* Zalessky 1926, a species described from benthos and metaphyton of clear, oligotrophic lakes in the E and NE Europe (Lake Beloe ozero, Russia, later found by Wojciechowski (1971) in SE Poland near Lublin). This species, which is evidently distributed in clear lakes of the temperate zone, has the cells more than two-times larger.

Revised description of *Chroococcus polyedriformis* Schmidle 1902 (syn.: *Chroococcus limneticus* var. *multicellularis* Chu 1952; *Myxosarcina spectabilis* Geitler sensu Desikachary 1959 (non Geitler 1935); Figs. 1, 2): Initial cells rarely solitary, more or less oval, soon in twice within common envelope, hemispherical, enveloped by limited, distinct, colourless (rarely yellowish or reddish) and hyaline (rarely finely striated) mucilaginous envelopes, which are ± 2-3 (-8) µm wide. Cells divide after repeated binary fission in three perpendicular planes, in more irregular planes and become polygonal-rounded form. In later stages, cells remain agglomerated with their envelopes in irregular colonies of numerous cells, aggregated in up to macroscopically recognizable mucilaginous, pale blue-green clusters. Cells in old colonies polygonal-rounded, (4-) 5-10 (-16) µm in diameter, surrounded by thin, colourless, homogeneous or finely striated enveloping mucilaginous layers. Cell content pale or bright blue-green, olive-green up to slightly reddish. Cell division in three perpendicular planes in initial stages, later in different planes. - Metaphytic species occurring subaerophytic or in shallow ponds and pools in tropical regions, often with stony substrate, freely attached to stones or to water plants; probably with pantropical distribution (S China - Szechwan, India - Madras, E Africa - Nyassa Lake, Mexico - Tehuacan Valley).

2. *Chroococcus mipitanensis* (Wołoszyńska) Geitler 1925 (Figs. 3-4)

This common and well recognizable cyanoprokaryotic species occurs in tropical regions probably all over the world. It lives mainly in metaphyton and periphyton, in detritus of non-polluted tropical ponds, swamps, channels, in littoral of lakes and flat reservoirs with plenty of water plants and in paddy fields; occasionally it also occurs in plankton. It was originally described by Wołoszyńska (1912) from the plankton of the lake Sava in Indonesia (Java - Mipitan) as *Chroococcus turgidus* var. *mipitanensis*. Although its diagnosis is poor, the species is well recognizable according to the simple, but characteristical drawing provided (Fig. 3a).

This species is obviously different from *Chroococcus turgidus*, therefore correctly reclassified by Geitler (1925) at the species level. He himself omitted it, however, completely from his later monograph (Geitler 1932) and the name was forgotten. Only in the later compendia of Elenkin (1938), Hollerbach et al. (1955) and Starmach (1966), the species appears as a form of *Ch. turgidus*.

According to the literature, *Ch. mipitanensis* is obviously pantropically distributed and occurred in different papers under different names. It has been reported e.g. from India (Gonzalves et Kamat 1958 sub *Ch. minutus*, Fig. 2:18; Desikachary 1959 sub *Ch. minutus*, Fig. 26:15, and possibly also sub *Ch. cohaerens*, Fig. 26:9; Venkatesvarlu 1976 sub *Ch. minutus*), Burma (Skuja 1949, Fig. 1:9 sub *Ch. minutus*), Indonesia (original description from Java; Bernard 1908, Figs 1-3, sub *Ch. turgidus*), Philippines (coll. by H. Fernando in 1978 in the artificial pond in the University Campus, Quezon City), and in tropical Africa (our finds; possibly also in the Lake Chad, see Compère 1974, Fig. 1:6 sub *Ch. limneticus*). Identifications of later findings are possible according to the drawings or microphotographs showing very characteristical shape of colonies and special morphology. We also found it several times in Central America in Mexico (1979 and 1984, in metaphyton of pools and

channels in Tehuacan Valley) and Cuba (numerous localities, 1980-1982, e.g. in provinces Ciudad de la Habana: pools with water plants in the Botanical Garden, Av. 27; Habana: small ponds with aquatic plants near Managua; Matanzas: pools on the peninsula Zapata; in several localities in pools and in littoral of shallow reservoirs in Isla de Pinos - Isla de la Juventud, near Nueva Gerona in the artificial reservoir Abra, etc.).

The original description as well as the populations from Philippines, Cuba and Mexico studied by ourselves were used to compile the following description: For *Ch. mipitanensis*, the morphology of colonies is characteristic; these are oval in the typical state, or "duplexoid", i.e. more or less of a "biscuit-like" form, and composed from groups of cells, which divide clearly in three perpendicular planes in following generations. The cells grow after division, but do not obtain the original oval shape before next division. The cells separate soon one from another within colonies. Mucilaginous envelopes are colourless, slightly diffluent or limited, structureless, but sometimes their own narrow gelatinous sheaths appear around single cells. Populations with very diffluent envelopes were also found. Colonies contain maximally 8 (-16) cells within one envelope and disintegrate after the following division. Typical colonies composed of two oval connected parts arise by this process (Fig. 3). Cells are ± spherical or oval, hemispherical after division, and later in a form of rounded sphere-section. Cell content pale or bright blue-green, sometimes olive-green or brownish, finely granular or with few solitary granules, variable in size, (2.5-) 6.5-13.5 (-18) µm; 4-celled colonies 23-36 µm in diameter.

With respect to the wide variation in size, protoplast colour and very wide pantropical distribution, the heterogeneity within this species is possible. The occurrence of different ecomorphoses or separated taxa is possible.

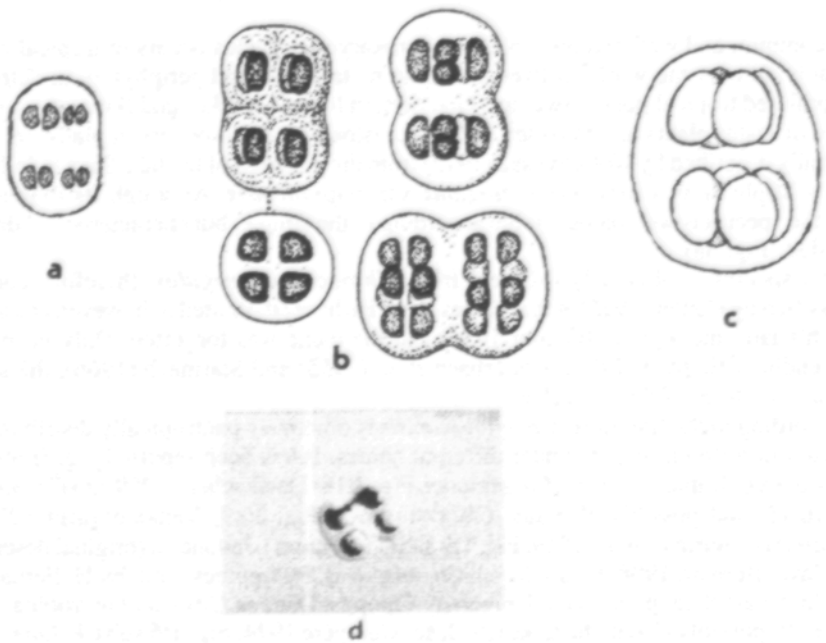


Fig. 3. - *Chroococcus mipitanensis;* a - iconotype after Wołoszyńska (1912, sub *Ch. turgidus* var. *mipitanensis*), b - after Skuja (1949, sub *Ch. minutus*), c - after Compère (1974, sub *Ch. limneticus*), d - orig. photo from Mexico.

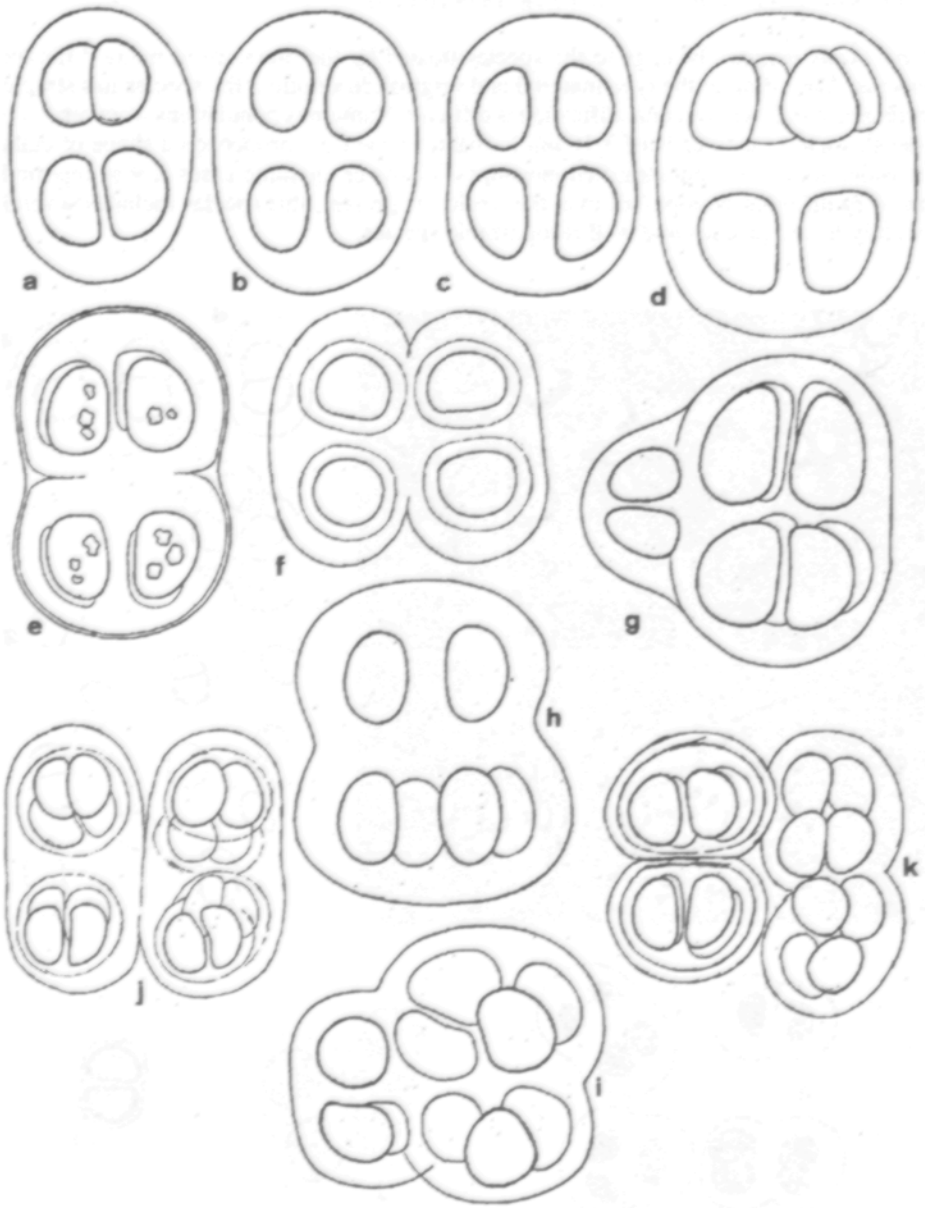


Fig. 4. - *Chroococcus mipitanensis;* orig. from Cuban localities.

3. *Chroococcus* cf. *minutus* (Kütz.) Näg. 1849 (Fig. 5)

Chroococcus minutus belongs to the species treated by the literature in many different concepts. According to the type material and original description, the species has simple morphology and its correct identification is difficult. Numerous populations were reported under this name, with cells of 3-10 μm in diameter, typical chroococcoid shape of cells and wide, colourless, not stratified envelopes. However, in some cases it was reported from very different biotopes all over the world. At present, this species includes several evidently heterogeneous and well recognizable species.

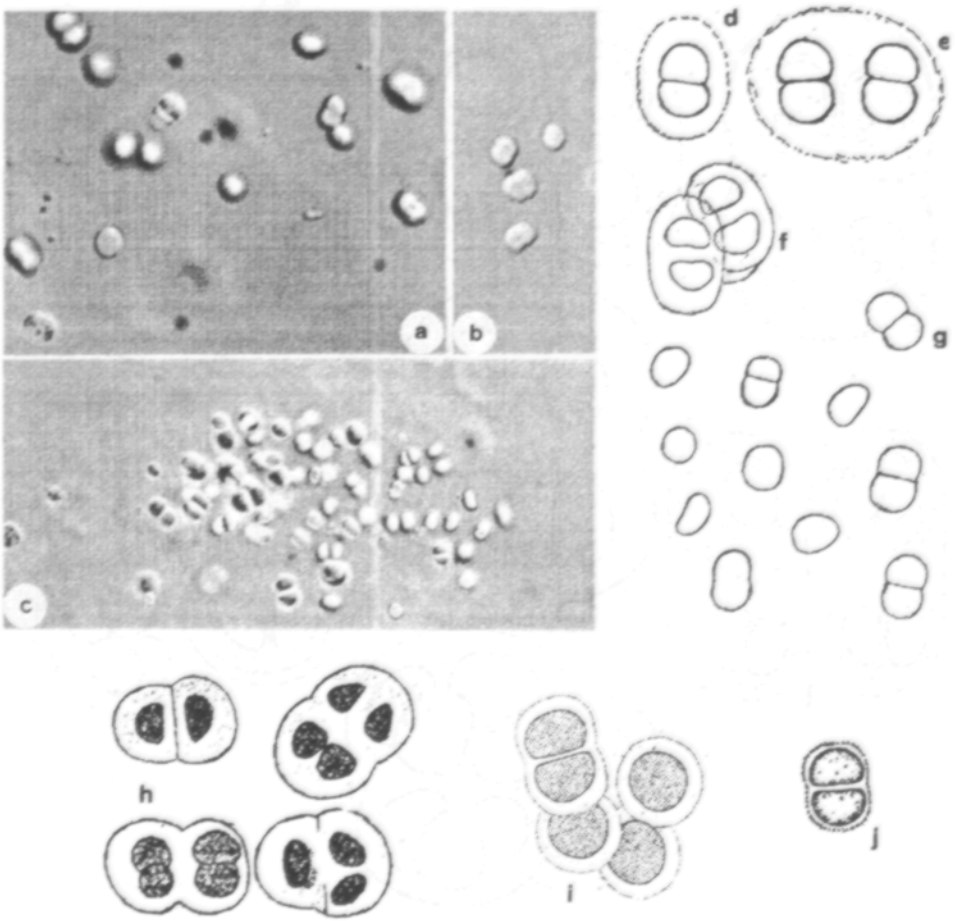


Fig. 5. - *Chroococcus* cf. *minutus;* a-g - from Papaloapan basin, Mexico, h - after Geitler (1932) from the original material of Kützing, i - "planktic form" after G. M. Smith (1920), j - after Růžička from Komárek (1975).

Despite of this, the species has probably more or less cosmopolitan distribution and occurs in several slightly different morphotypes and ecotypes. It was described originally by Kützing (1843) and later by Nägeli (1849) from the metaphyton of pools, ponds and lakes; secondary it occurs also in plankton of mesotrophic stagnant waters, but never in high quantities (Figs. 5h-j). Particularly the findings from extreme biotopes (thermal and salinic waters) and from aerophytic habitats are usually wrong. We present the drawings of Geitler (1932) from the Kützing's original material (Fig. 5h), planktic form of G. M. Smith (1920, Fig. 5i) and one colony from metaphyton of the pond Řežabinec in S. Bohemia, Czech Republic (after Růžička from Komárek 1975, Fig. 5j) which all correspond, both morphologically and ecologically, to the original concept.

Some other populations also correspond morphologically to the original diagnosis, e.g. those from metaphyton of creek pools in Kathmandu Valley in Nepal (Watanabe et Komárek 1994) as a special morphotype, or those repeatedly collected by ourselves in 1979 and 1984 in Mexico, Papaloapan basin, where they grow freely metaphytic/periphytic in irrigation channels in Tehuacan Valley, state Puebla. The temperature was always over 20° C, pH was in alkaline range (usually about 8.6).

The cells of Mexican populations vary between 3.5-7.5 μm in diameter (mostly between 5.1-6.0 μm) and occur solitary or in few-celled colonies. Cell content is blue-green, homogeneous, sometimes regularly and finely granular, but without prominent inclusions. Facultative absence of envelopes is a characteristic feature. Typically, the species (and also numerous cells and small colonies of our specimens) has up to 5 μm wide, homogeneous, not stratified, diffluent or more or less limited, colourless envelopes. Various modifications occur within variation range of one and the same population; numerous cells appear quite without envelopes (Fig. 5a-c, g). However, this phenomenon (total absence of envelopes in *Chroococcus*) appears in well developed populations of numerous, clearly different species. Its explanation is not easy, but it is probably associated with reproduction strategy. It was observed in more species of the typical subgenus *Chroococcus* (comp., e.g. in *Ch. tenax, Ch. turicensis* and *Ch. minutus* in Watanabe et Komárek 1994), and is also known in other species from different biotopes and regions (see also the following species).

4. *Chroococcus* sp. 1 (Fig. 6)

This species was being found commonly in the same localities as *Ch.* cf. *minutus* and the following two species (*Ch. deltoides, Ch.* cf. *turgidus*). However, it differs from all other related species occurring in similar biotopes (*Ch.* cf. *minutus, Ch. mipitanensis, Ch. deltoides*). The cells are well distinguishable from *Ch.* cf. *minutus* by larger size (5.6-8-16.3 μm, dividing stages up to 17 μm long), and by up to 8.5 μm wide, fine, colourless, homogeneous, finely limited envelopes. Because the tropical populations of similar species have not been described properly till now, it is difficult to decide whether this type represents an independent species or only a modification (variety, form?) of another *Chroococcus*. Other similar species (*Ch. helveticus, Ch. turicensis,* etc.) are of a different size and occur under different ecological conditions.

Description of our material (Fig. 6): Cells solitary or in few-celled colonies with cells distant one from another. Cells oval, after division hemispherical or in a form of the sphere-section, with pale blue-green, finely and homogeneously granular content, or with few distinct granules in the protoplast, after division sometimes

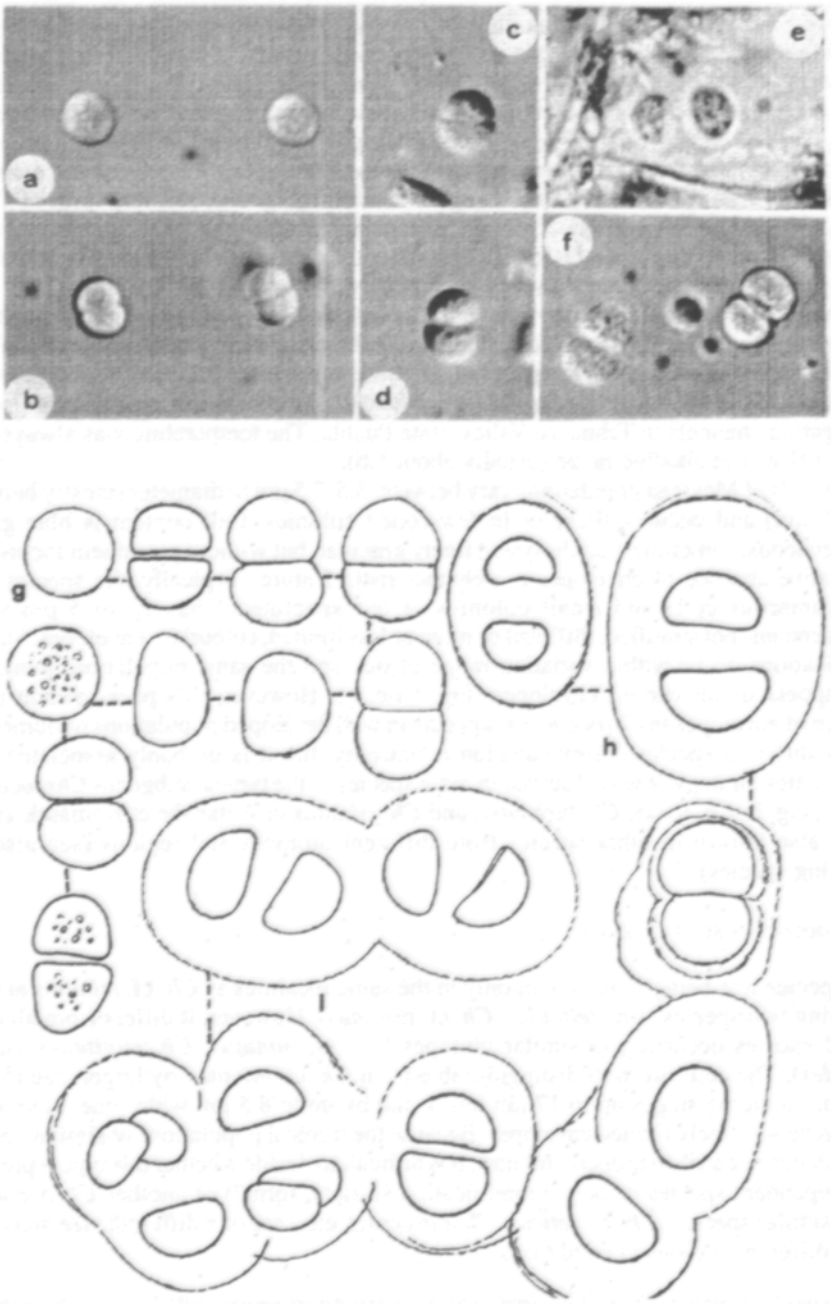
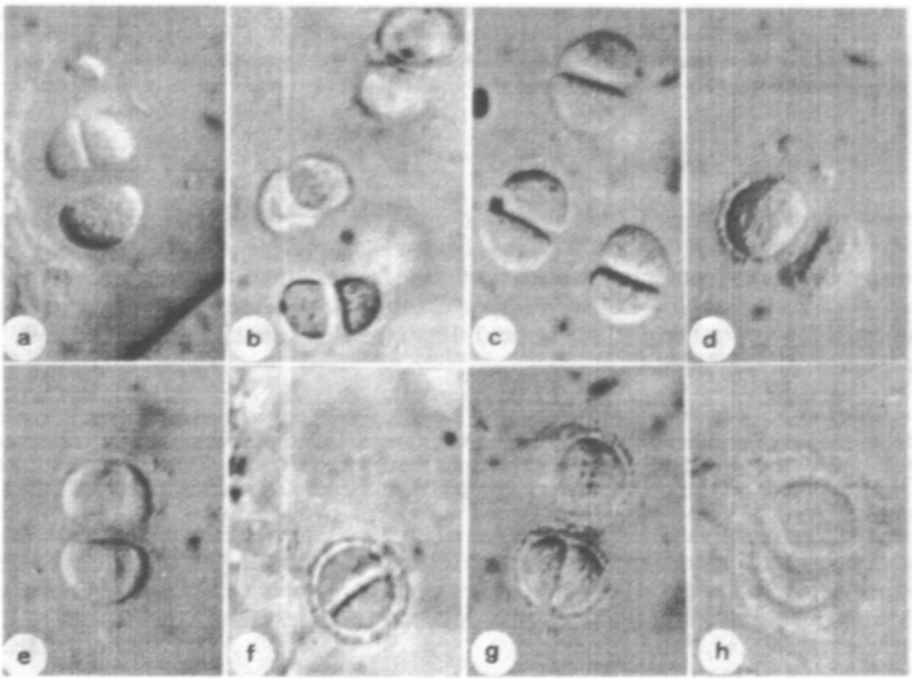


Fig. 6. - *Chroococcus* sp. 1; from Papaloapan basin, Mexico.



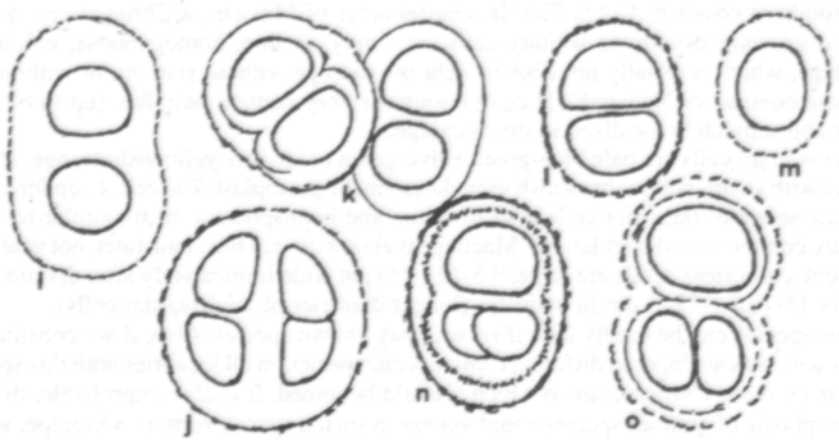


Fig. 7. - *Chroococcus* sp. 2; from Papaloapan basin, Mexico.

only 5.6 µm wide, but usually 8-13.5 (-16.3) µm in diameter; the dividing stages up to 17 µm long. Mucilaginous envelopes usually wide, homogeneous, colourless, slightly visible (staining!), diffluent, but cells with narrow, finely stratified and disintegrating envelopes were also found, probably as special stages before division. In all populations studied, cells without envelopes were also common.

5. *Chroococcus* sp. 2 (Fig. 7)

Similar to previous species, from which it differs only by distinctly granular envelopes. Both types occurred in different localities, but we were not able to decide, whether they were only ecomorphoses or taxa with characteristic features. In the literature, only a single *Chroococcus* species with granular envelopes (*Ch. verrucosus* Krieger 1931) was described, also from the tropical region (Cameroon). However, this species with smaller cells is morphologically different.

Description of our material (Fig. 7): Cells rarely solitary, usually in few-celled colonies, in typical "chroococcoid" configuration, enveloped by colourless envelopes. Cells oval, hemispherical or in a form of rounded sphere-section, with blue-green, finely granular protoplast with scattered prominent granules, 6.6-11.1 µm in diameter. Mucilaginous envelopes copy the cell form, homogeneous, limited, colourless, up to 1.6 µm wide.

Our populations were collected repeatedly in different seasons of 1984 and 1993 in wells and irrigation channels (pH about 7, water temperature about 18° C) near Francisco I. Madero among other algae (*Spirogyra*), in Tehuacan Valley (1180 m a. s. l.).

6. *Chroococcus deltoides* spec. nova (Fig. 8)

In swamps and waters with submerse vegetation in coastal regions of Caribbean district (flat southern coasts of Cuba, Florida, coastal areas of Mexico), a *Chroococcus* species occurs, growing usually in solitary cells, or, rarely, in fine, homogeneous, colourless mucilage, which is usually invisible in light microscope without staining or without use of phase contrast or Nomarski. If colonies appear, they contain only few (up to 6) cells, freely and separately localized in the mucilage.

The solitary cells are pale blue-green, olive-green or slightly yellowish-orange, almost always with small, yellow-brownish granulation in the protoplast. The cells keep for a long time the shape of daughter cells after division, and hemispherical or triangular-rounded cells are common in all populations. Mucilage is absent or very fine, indistinct, not stratified, diffluent, colourless. Cells are large, 9.3-12 (-15) µm wide immediately after division, but usually 15-19.8 (-23.5) µm in diameter (longer diameter of the irregular cells).

This species can be hardly identified with any known species. Also, if we consider the stages without envelopes in different *Chroococcus* species, in all localities with this species there is no other *Chroococcus* to which it could be joined. It is also improbable, that the ecomorphosis of another species could appear in such a special form in a biotope, which is, particularly in tropical countries, very common. Hence we consider it as a new species.

For our study, we used one population from Florida (Everglades, coll. by J. Vymazal), three populations from Cuba (coll. in 1980-1982) and 17 samples from the southern part of the state Puebla, Mexico (municipalities Tehuacán, Zapotitlán, Ajalpan and Tepanco de López), collected in the period 1977-1984. The ecology of all these populations was

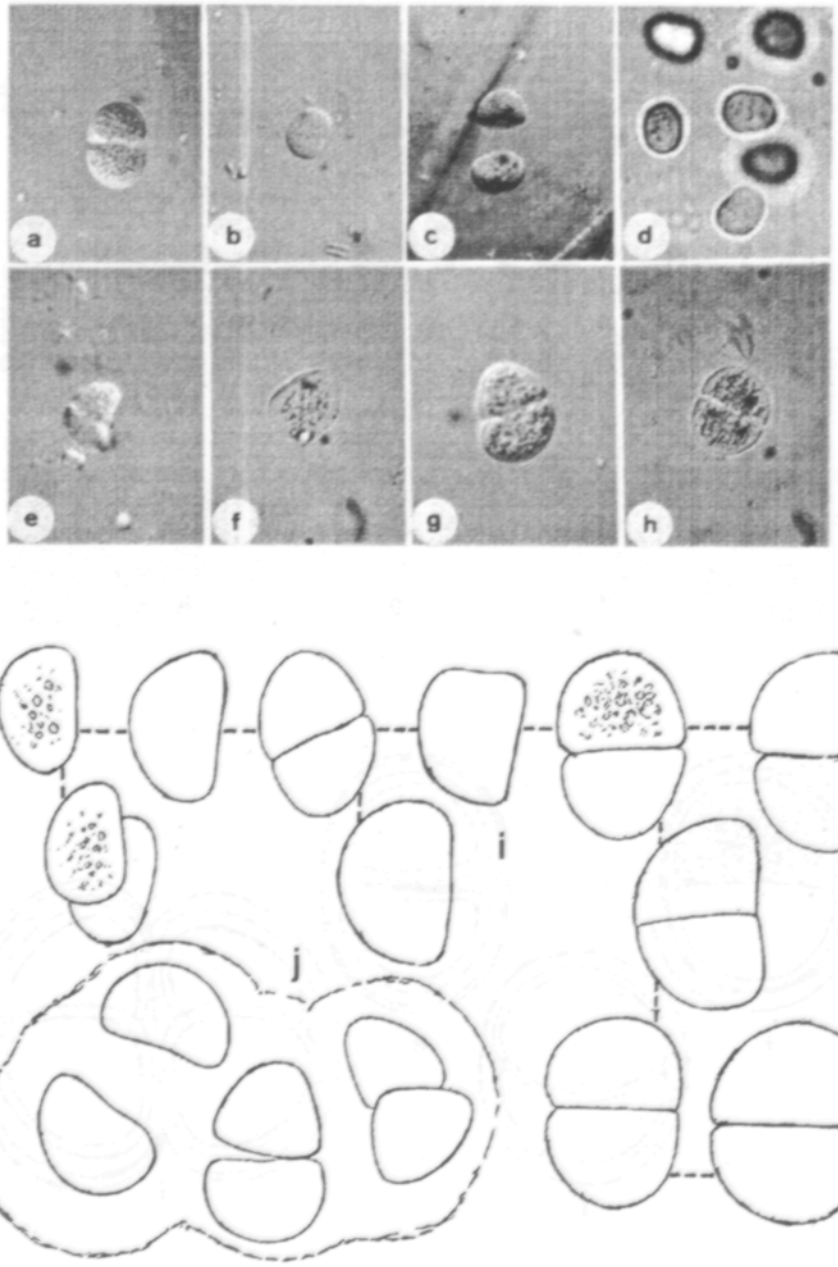
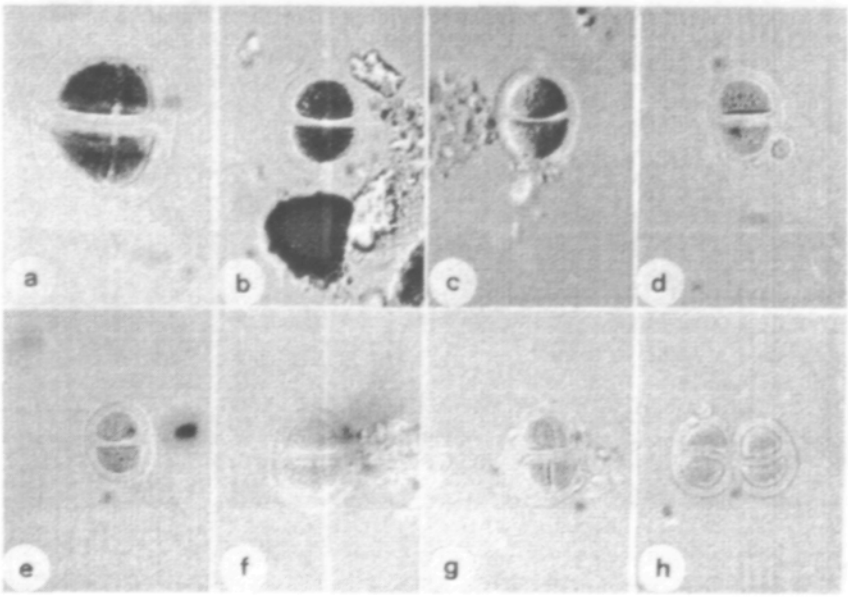


Fig. 8. - *Chroococcus deltoides* spec. nova; from Tehuacan valley, Mexico, (iconotype).



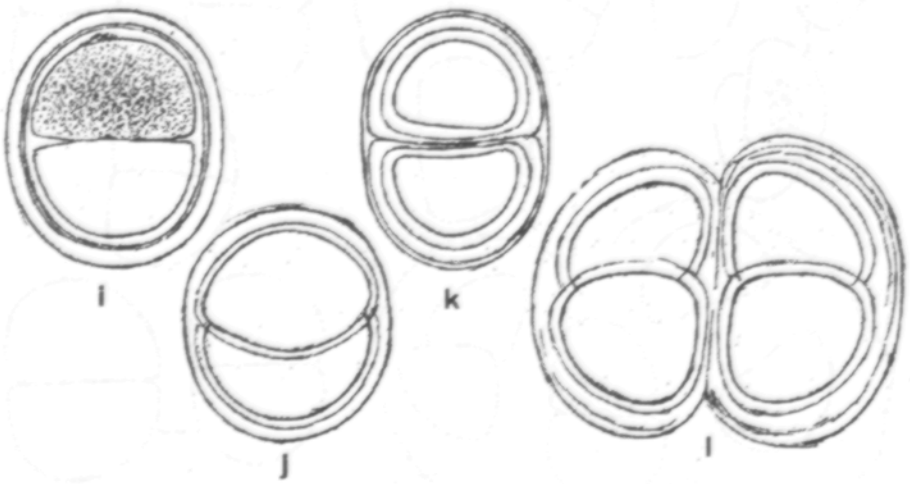


Fig. 9. - *Chroococcus* cf. *turgidus;* from Papaloapan basin, Mexico.

analogous: the species grows metaphytic or periphytic among submerse plants, or on submerse stones, two samples were collected from the shore from wet soils. Water temperature was always above 20° C, usually between 24° to 26° C, pH about neutral values (6.5-7.5).

Diagnosis: Cellulae cyanoprocaryoticae, praecipue solitariae, sine mucilagine, libere inter algas et plantas vasculares (metaphytice) natantes, rare in gregibus paucicellularibus (ad 6-cellularibus) irregulariter consociatae, inter se distantes, cum mucilagine tenui, incolori, sine structura, homogeneo, ad marginem diffluenti et paucim visibili. Cellulae plus minusve ovales, hemisphaericae, subsphaericae vel in forma sectionis sphaericae, vel deltoidiformes, inter se separantur, 9.3-23.5 µm in diametro, contentu homogeneo vel tenui granuloso, pallescente aeruginoso vel olivaceo-viridi. - Typus (iconotypus): figura nostra 8. - Habitatio (locus classicus): Metaphytice in paludibus cum plantis aquaticis, San Lorenzo, Tehuacán, Puebla meridionalis, Mexico (coll. Eberto Novelo, 24. 4. 1984).

7. *Chroococcus* cf. *turgidus* (Kütz.) Näg. 1849 (Fig. 9)

Chroococcus turgidus is one of the most known cyanoprokaryotic species whose occurrence has been reported all over the world. The original description concerns populations from cold moors and acidic swamps in Central Europe. This species grows in metaphyton and occurs also in all microbiotopes corresponding more or less to the same conditions: temperature usually below 15° C, pH less than 7; i.e., in non-polluted water with submersed vegetation, in littorals (rarely secondary in plankton) of clear ponds and lakes, on wet rocks in mountains (with "dropping" water), but also in similar localities in lowlands (in moors and swamps).

However, this cyanoprokaryotic type is polymorphic and many varieties, forms or only ecoforms or morphotypes were recorded from various biotopes. Several such varieties were already separated as different species (*Ch. submarinus, Ch. westii, Ch. subnudus* etc.), but morphologically very similar populations still occur in other biotopes. There are records of this species from salinic waters (incl. mangroves), from aerophytic habitats from trunks of trees, from thermal springs, etc. (comp. Geitler 1932, Desikachary 1959, etc.). Similar populations do occur particularly in tropical countries but sometimes under very different ecological conditions. We had an opportunity to study similar ecotype and morphotype, morphologically corresponding to *Ch. turgidus*, growing metaphytically in warm, slightly alkaline tropical swamps, springs and creeks in Cuba (Ciudad de la Habana: Bot. Garden; Habana: reservoir Niña Bonita; Matanzas: Zapata; Pinar del Rio: reservoir San Juan; Isla de Pinos/Isla de la Juventud: Presa de Abra, etc.) and in two areas in Mexico: creeks of the basin of the Xicatacotla River in the southern part of the state Morelos, and channels and springs near Media Luna in a limestone area of the state San Luis Potosí. The ecology of all these populations was approximately the same: clear water bodies with plenty of vegetation (filamentous algae, vascular plants), temperature over 25° C (usually about 30° C), pH > 7 (7.2-8.2). *Chroococcus pulcherrimus* Welsh 1965 is probably identical with tropical populations of "*Chroococcus turgidus*".

Description of our specimens: Colonies small, microscopic, 2-4-celled, very rarely with up to 8 cells. Cells hemispherical or in form of a sphere-section, bright blue-green, with finely granular protoplast, (9-) 11-19 (-25) µm in diameter (without envelopes). Gelatinous envelopes distinct, limited, striated, colourless, (2.7-) 3-5 (-5.5) µm wide. Similar tropical populations were described, e.g., by Schmidle (1902b) from E Africa, Desikachary (1959) from India, Compère (1974) from Chad Lake, etc.

The explanation of the different habitats of *Ch. turgidus* can be (i) the ubiquitous character of this species, or (ii) the existence of different, morphologically analogous, but ecologically (and also ecophysiologically, biochemically and structurally) various types. We consider the latter explanation more probable: e.g. the typical populations from cold temperate moors, from warm alkaline tropical swamps, thermal waters and coastal hypersaline swamps could be hardly the ecotypes of the same species. However, this difference must be proved by using more exact procedures, inevitably including the isolation of corresponding strains and experimental studies on the molecular level.

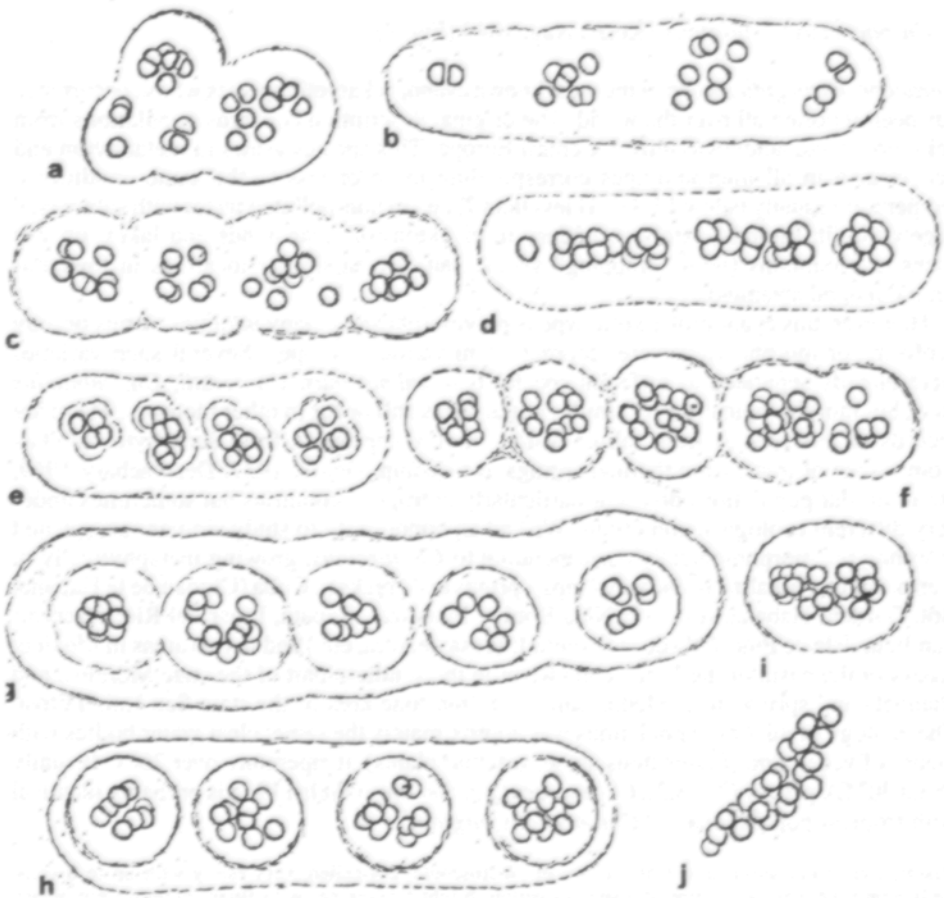


Fig. 10. - *Chroococcus catenatus* spec. nova; from the plankton of Lake Edward, E Africa (iconotype).

8. *Chroococcus catenatus* spec. nova (Figs. 10, 12a-h)

This planktic species belongs evidently to the subgenus *Limnococcus*, but resembles also the genus *Eucapsis* by the arrangement of cells in the colony. The cells divide irregularly in one, two or three different planes, and, according to the prevailing division type, they form characteristic colonies (Figs. 10, 12). However, irregular division in different planes was recognized in the same colony (Figs. 10a, c, d, f, h; 12b-c). This species must be therefore classified rather as a planktic *Chroococcus* species without distinct envelopes around single cells. The most common type of colonies are short rows of cells and small clusters of cells, enveloped by colourless, mucilaginous and sometimes slightly diffluent envelopes. Old colonies have cells sometimes agglomerated in irregular clusters.

Our material was collected by Dr. Hedy Kling from the plankton of Lake Edward, E Africa, in the period of 1988-1990. Cells are spherical or hemispherical after division, pale olive-green or (mostly) yellowish and slightly reddish, 2.6-3.2 μm in diameter. They are irregularly clustered, but rows of several clusters of cells are repeatedly enveloped by common mucilage. This species was common in the lake plankton. It can be hardly misinterpreted with any other species, but is a little bit similar to the next *Chroococcus cronbergae.*

Diagnosis: Coloniae microscopicae, libere natantes, cum cellulis solitariis in seriebus brevissimis, 2-4-cellularibus, vel quadratice ordinatis, postea irregulariter aggregatis, paucim distantibus, cum tegumentis irregularibus, incoloribus, diffluentibus circumdatae; coloniae solitariae plus minusve globosae, vel seriatim consociatae et cum tegumento originali diffluenti circumdatae. Cellulae sphaericae vel subsphaericae post divisionem, 2.6-3.2 μm in diametro, contentu plus minusve homogeneo, olivaceo-viridi vel lutescenti et rosaceo. - Typus: figura nostra 10. - Habitatio: In plancto lacus Edward, Africa orientalis, collecta (Dr. Hedy Kling, Winnipeg).

9. *Chroococcus cronbergae* spec. nova (Figs. 11, 12i-n)

Another planktic *Chroococcus* (subg. *Limnococcus*) species from the Okawango region, Botswana, South Africa, was collected by Dr. Gertrud Cronberg (Lund) in pools near Nkomo Bridge in April 1992. This species is a little bit similar to *Ch. catenatus,* from which it differs in the form of colonies (it never forms the typical composed "catenate" rows of microcolonies) and also slightly in cell size and colour. *Coelosphaerium goetzei* Schmidle is also a similar species, described from plankton of the river Siwa in E Africa (Tanganyika); it posseses larger cells and "verrucose" slime.

The cells of *Ch. cronbergae* are irregularly arranged in limited and often two- (rarely three-) layered mucilaginous envelopes with slightly refractive slime margin. It is interesting, that the lamellation and delimitation of colonies is developed mainly in those of "middle" age, while in young, or, on the contrary, old colonies is the colonial slime diffluent. Colonies are never elongated, usually keep the more or less spherical shape during almost the whole life cycle. The structure of mucilaginous colonies should be recognizable in phase contrast after staining.

Cells are slightly and widely oval up to spherical, after division hemispherical, irregularly situated (sometimes situated at "one side" of a colony), in oldest colonies agglomerated, 3.5-4.5 μm in diameter, with pale grey-blue content, sometimes very slightly reddish; rarely (in old colonies) fine, point-like aerotopes were observed, irregularly distributed within the cell content. Old colonies are multicellular.

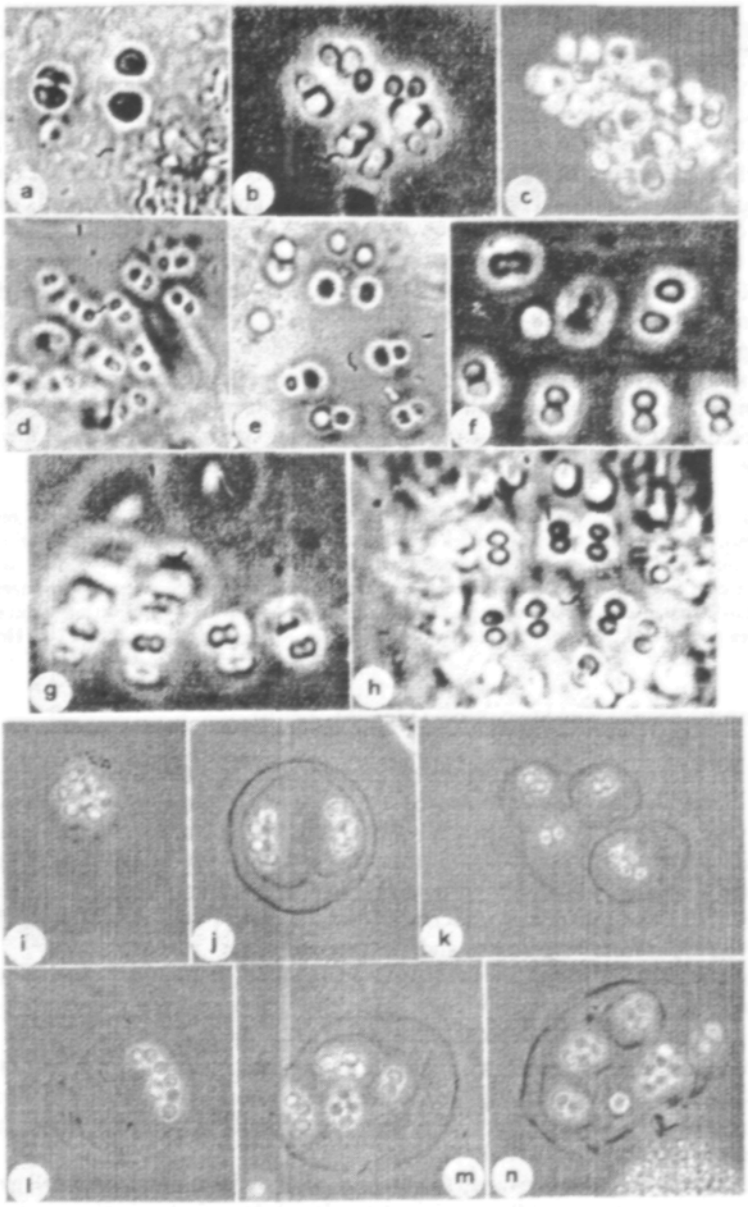


Fig. 12. - a-h - *Chroococcus catenatus* spec. nova from Lake Edward, E Africa; i-n - *Chroococcus cronbergae* spec. nova from Botswana, S Africa.

D i a g n o s i s : Coloniae microscopicae, libere natantes, irregulariter sphaericae vel subglobosae, cum mucilagine incolori, rarissime diffluenti, postea cum tegumento limitato, interdum bi- vel tri- strato, cum cellulis irregulariter dispositis; coloniae adultae multicellulares, cum cellulis agglomeratis, cum mucilagine diffluenti. Cellulae ovales vel globosae, hemisphaericae post divisionem, 3.5-4.5 µm in diametro, contentu pallescente griseo-aeruginoso vel rubescenti, rare cum aerotopis parvis, irregulariter in cellulis dispositis. - Typus: figura nostra 11. - Habitatio: In plancto stagnorum Okawango, Africa meridionalis, collecta (Dr. Gertrud Cronberg, Lund).

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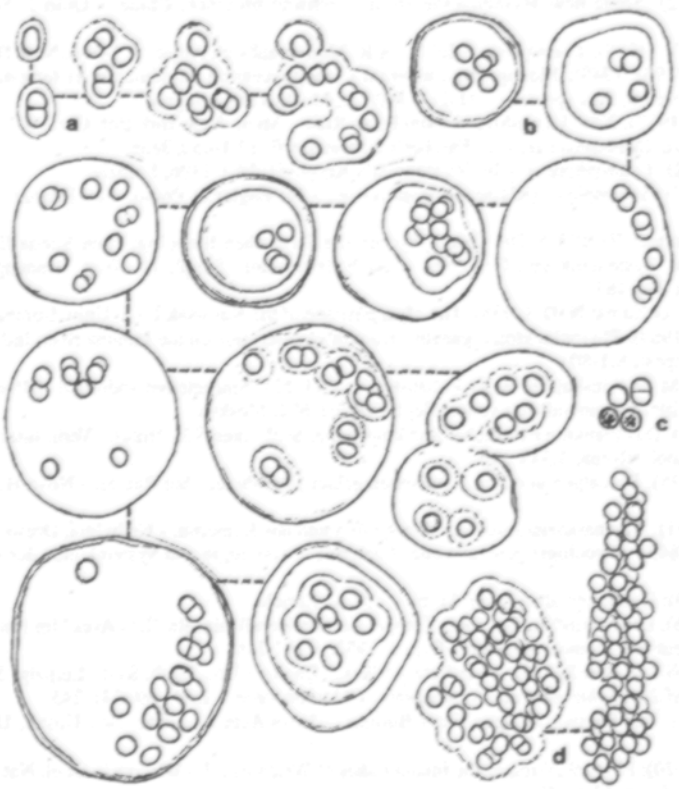

Fig. 11. - *Chroococcus cronbergae* spec. nova; from Okawango, Botswana, S Africa (iconotype).

Souhrn

Článek přináší údaje o devíti málo známých nebo nově popsaných druzích sinic rodu *Chroococcus* žijících v tropických oblastech. Dva z nich, *Ch. polyedriformis* Schmidle 1902 a *Ch. mipitanensis* (Wołoszyńska 1912) Geitler 1925, se nacházejí ve sladkovodních ekosystémech tropů celého světa a byly popsány již začátkem století, ale pozdější autoři popisy nerespektovali a opakovaně je uváděli pod různými jmény jiných druhů. V současnosti byly ověřeny na několika lokalitách v tropických oblastech. Pět druhů, které se nepatrně liší od známých a již popsaných taxonů, bylo nalezeno ve stojatých vodách na Kubě a na pobřeží Mexického zálivu; odtud je popsán nový druh *Ch. deltoides*. Dva planktonní druhy z podrodu *Limnococcus* jsou popsány z velkých afrických jezer - *Ch. catenatus* z Edwardova jezera a *Ch. cronbergae* z nádrže Kariba.

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Florenatlas der Moose und Gefässpflanzen des Thüringer Waldes, der Rhön und angrenzender Gebiete

Haussknechtia Beiheft 3/1, Jena 1992, Textteil 423 str., Kartenteil 1672 map, cena neuvedena. [Kniha je v knihovně ČBS.]

Tři desítky atlasů a velkých mapových souborů s rozšířením cévnatých rostlin v rámci střední Evropy bylo rozhojněno o další, zabývající se tentokrát nejen cévnatými rostlinami, ale též mechorosty. Území, které pokrývá, tj. jihozápad bývalé NDR (většina Durynska) s přilehlými částmi Bavorska a Hesenska, nebylo dosud takto souborně a podrobně zmapováno. Atlas bývalé NSR (1988), zahrnující zmíněné části Bavorska a Hesenska, je konstruován v síti základních polí (64 × hrubších než rastr recenzované práce), Atlas Bavorska (1990) v síti kvadrantů (16× hrubších). Meinungerův Atlas vydala Durynská botanická společnost a Durynský zemský ústav pro životní prostředí. Těžiště mapovaného území bývá označováno jako „zelené srdce Německa".

Autor Dr. L. Meinunger pracoval intenzívně po 30 let, většinou ve svém volném čase, na shromažďování údajů. Základem byl terénní výzkum, zhodnocení literatury a u vybraných druhů herbáře University v Jeně. Teprve otevření hranice mezi NDR a NSR v listopadu 1989 mu umožnilo doplnit terénní výzkum i v přilehlých územích bývalé NSR; tyto údaje do map ještě doplnil, ale do ukončeného textu už jen v nejdůležitějších případech. Vydaný atlas zahrnuje území mezi 50°12′ a 51°00′ s. š. a 9°50′ a 12°00′ v. d., zaujímá 104 základní pole středoevropské mapovací sítě 10′ × 6′, ovšem finální mapovací jednotkou je 1/64 tohoto základního pole, což znamená postupné trojí dělení základního pole, vždy na čtvrtiny. Ve stejné síti 1/64 základního pole čili 1/16 kvadrantu vyšla zatím jediná práce, týkající se cévnatých rostlin, „Flora von Coburg" (Scheller H., Jahrb. Coburger Landesstift., Sonderband 5:1-392, 1989). Kromě rastru 1/64 základního pole s finální mapovací jednotkou 1,25′ × 0,75′ však existuje velmi podobný rastr 1/60 základního pole, jehož finální mapovací jednotkou je minutové pole (1′ × 1′). V tomto minutovém rastru byly v Německu zpracovány zatím tři mapové soubory pro následující území: Saarland (Sauer 1993), Saar-Mosel-Raum (Haffner 1990) a základní pole Kürten (Wauer 1986). Mezi mapovými atlasy mechorostů je recenzovaný atlas v rámci Německa první prací s tak jemným rastrem na tak rozsáhlém území.

Mapované území zaujímá středohory a pahorkatinu. Hlavní osou této části Německé vysočiny je Durynský les (Thüringer Wald), příkré a málo členěné pohoří, převážně z paleozoických hornin, s nejvyšší horou Grosse Beerberg 982 m. Dále tam zasahuje severní část břidličnatého Franckého lesa (Frankenwald) a západní část vrchoviny Vogtland, která tvoří na jihozápadě přechod k Halštrovským horám a Smrčinám, tedy i k našemu Ašskému výběžku. Velmi odlišný je na jihozápadě mapovaného území terciérní eruptivní Rhön, připomínající svými čedičovými a znělcovými kupami naše České středohoří. Ostatní bohatě členěná pahorkatina, místy i s vápnitými horninami, má nejnižší výšku 130 m v údolí řeky Saale u Dornburgu.