

Review of the cyanoprokaryotic genus *Romeria*

Přehled cyanoprokaryotního rodu *Romeria*

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Abstract

The cyanoprokaryotic genus *Romeria* is traditionally classified as the simplest filamentous cyanobacterium, occurring scarcely in freshwater reservoirs. Three species were described originally, which are known from the temperate zone, and which are usually cited in all identification manuals of this cyanoprokaryotic group. However, other species were found recently, also in other biotopes (benthos, cryoseston, marine plankton), and now the number of registered species increased to 19. The problem is, that they were not yet isolated in culture, and nothing is known about ultrastructure and molecular characters of any *Romeria* species. Recently, two mass developments of two planktic species were found in freshwater reservoirs in Brazil and in Czech Republic, which enabled, at least, the study of their morphological variability and cell structure. It was found, that *Romeria* is evidently very interesting cyanobacterium with close relations to other simple filamentous species, as well as to simple coccoid types living in solitary, rod-like cells. The review of the whole genus, which is included in this article, is necessary for further research of this important cyanobacterial type.

Introduction

The genus *Romeria* KOCZW. ex GEITL. 1932 with the type species *R. leopoliensis* (RACIB.) KOCZW. ex GEITL. 1932 comprises only 3-5 species in traditional identification books (GEITLER 1932, HUBER-PESTALOZZI 1938, HOLLERBACH & al. 1953, STARMACH 1966, KONDRATEVA 1968, BOURRELLY 1985). However, 19 species were described up to now and two of them were found as important components in phytoplankton of eutrophic, man-made reservoirs recently (KOMÁREK & al. 2001, HAUER 2001). The species occurring in Czech Republic and in neighbouring regions respectively, are listed in Table 1.

The taxonomic status of this genus is a little problematic. It was classified by almost all mentioned authors into the order Oscillatoriales in respect to short, irregular “filaments”, which are characteristic to this genus, and in modern manuals into the family Pseudanabaenaceae (ANAGNOSTIDIS & KOMÁREK 1988). Only KOMÁREK (1970, 1976) discussed the very similar cell morphology and cell-division like in the coccoid genera *Synechococcus* and particularly

Rhabdoderma, and described differences in their life cycles (Fig. 1). *Romeria* is not yet in culture and all species are known only from natural populations. Quite recently, the almost identical thylakoid arrangement was found in several *Aphanothece*-types (from the subg. *Anathece*), in several *Synechococcus* species, in *Romeria* and in simple *Pseudanabaenaceae* (Fig 2). The systematic position of *Romeria* should be therefore revised respecting this fact. Of course, the final solution can be derived only after molecular evaluation of all mentioned types.

The ultrastructural generic features of *Romeria* are summarised and discussed in KOMÁREK & SULEK (in press). The connections of cells in pseudofilaments of two studied species are in Fig. 3. The review of all phenotype species of this genus described up to date is presented in this article. Instead of the identification key are included the Tables 2 and 3. In the Table 3 are explicitly designated species, which do not correspond with the generic diagnosis, and which should be revised. In characteristics of taxa the diacritical features are only presented, not the full descriptions. The original illustrations are cited, for comparison see the drawings in Table 3. The description with drawings will be included in the prepared 2nd part of cyanoprokaryotes in the 2nd edition of the compendium Süßwasserflora von Mitteleuropa (ANAGNOSTIDIS & KOMÁREK in prep.).

Taxonomic review

Genus *Romeria* KOCZW. ex GEITL. Kryptog.-Fl. 14: 915, 1932.

Syn: *Raciborskia* KOCZW. Kosmos 53: 107, 1929; *Amalia* DE TONI Noter. nom. algol. 1: 5, 1934; *Campylotropium* HORTOB. et HILLIARD Acta bot. hung. 11: 140, 1965 incl.

Type species: *Romeria leopoliensis* (RACIB.) KOCZW. ex GEITL. Rabenh.'s Krypt./Fl. 14: 916, 1932.

Suprageneric classification: Fam. *Pseudanabaenaceae*, Order *Oscillatoriales*.

Generic phenotype characters:

- Trichomes free-living, solitary, or few in irregular mucilaginous clusters.
- Trichomes short, usually (1)2-12(23)-celled, exceptionally with more (up to >60) cells, frequently fragmentating.
- Trichomes usually irregularly wavy or coiled, rarely almost straight, or irregularly screw-like, 0.6-3 µm wide.
- Trichomes constricted at cross-walls (species without constrictions belong probably to other genera (genotypes); it concerns particularly *R. austriaca* and *R. cryophila*. Characteristical is the occasional shift of neighbouring cells within trichomes.
- Trichomes enveloped by fine, colourless, diffuse mucilaginous envelopes (in all species?). Sheaths are lacking.

- Cell cylindrical, always longer than wide. In few species the Y-shaped cells were found.
- Cell division cross-wise, sometimes asymmetrical. Heterocellular trichomes occur.
- Terminal cells do not differ from other cells, capable to divide.
- Thylakoids arranged parietally in cylindrical cells.
- Cell connected by gelatinous matrix of various width; pores in connecting cross-walls are lacking (always?).
- Gas vesicles lacking.
- Reproduction by trichome fragmentation.

Species review:

Note: Species marked by asterisk do not correspond exactly to generic diagnosis and their taxonomic classification must be revised.

1. ***Romeria minima*** (LEMM.) KOM. comb. nov.

Syn.: *Rhabdoderma minimum* LEMM. Arch. Hydrobiol. Planktonk. 4: 187, 1909; basionym.

Synechococcus minimus (LEMM.) KOM. Arch. Protistenk. 112: 363, 1970.

Trichomes solitary or few in mucilaginous colourless colonies, (1)-4-celled, constricted et cross-walls. Cells 1.5-3 x 0.7-0.8 μm , pale greyish blue-green. – Metaphytic in small clear streams; Czech Republic (Beskydy Mts.), Italy.

2. ***Romeria alascensis*** (HORTOB. et HILLIARD) KOM. comb. nov.

Syn.: *Campylotropium alascense* HORTOB. et HILLIARD Acta Bot. Hung. 11: 140-141, 1965; basionym.

Aphanothece alascense (HORTOB. et HILLIARD) BOURR. Alg. d'eau douce 3: 318, 1985.

Trichomes in small mucilaginous clusters, (1)2-4(8)-celled, clearly constricted et cross-walls, arcuated. Cells 3.7-8.3 x 0.6-0.8 μm , pale blue-green. – Planktic in oxidation pond; USA (Alaska).

3. ***Romeria caruaru*** KOM. et al. Arch. Hydrobiol./Algol. Stud., in press, 2001

Trichomes disintegrating (numerous solitary cells in population), irregularly coiled, solitary in diffuse, indistinct slime, 1-4(12)-celled, constricted et cross-walls. Cells 1-12.8 x 0.7-1 μm , pale greyish blue-green. – Planktic in meso- to eutrophic reservoirs; tropical, Brazil (state Pernambuco).

* 4. ***Romeria chlorina*** BÖCHER Kong. danske Vidensk. Selsk., biol., 21(1): 26, 1949.

Syn.: *Synechococcus chlorinus* (BÖCH.) KOM. Arch. Protistenk. 112: 363, 1970.

Synechococcus sp. 1 sensu KOM. Arch. Protistenk. 118: 137, 1976.

Trichomes solitary, arcuated, very short ("few-celled"), not constricted at cross-walls, but disintegrating and composed from few segments with constrictions, mucilage?. Cells 1.5-2.5 x ± 1 µm, yellow-green. – Benthic, epipelagic in lakes with muddy bottom; Czech Republic, Denmark, northern Germany.

5. *Romeria cylindrocellularis* HIND. Preslia 60: 295, 1988.

Trichomes irregularly wavy, solitary, with numerous cells, but disintegrating, with wide mucilaginous envelopes, constricted at cross-walls. Cells short, cylindrical, 1-1.5 x ± 1 µm, yellow-green or pale blue-green. – Planktic in eutrophic ponds; Slovakia.

* 6. *Romeria westii* (KUFFER.) ANAGN. Preslia, in press, 2001.

Syn.: *Phormidium westii* KUFFER. Ann. Crypt. Exot. 2(1): 46, 1929.

Trichomes very short, arcuated, 2-3-celled, more in gelatinous mass, constricted at cross-walls. Cells long cylindrical, ± 6 x 1 µm, pale blue-green. – Subaerophytic, epiphytic on wet mosses; tropical species, Costa Rica.

7. *Romeria leopoliensis* (RACIB.) KOCZW. ex GEITL. Rabenh.'s Krypt.-Fl. 14: 916, 1932.

Syn.: *Arthrospira leopoliensis* RACIB. Phycol. polon. 9; Kosmos 35: 82, 1910.

Raciborskia leopoliensis (RACIB.) KOCZW. Kosmos 53: 108, 1929.

Amalia leopoliensis (RACIB.) DE TONI Noter. Nomencl. Algol. 1: 5, 1934.

Synechococcus leopoliensis (RACIB.) KOM. Arch. Protistenk. 112: 362, 1970 p.p.

Trichomes solitary, short, irregularly arcuated, (1)2-4(8)-celled, with very fine and indistinct diffuse slime, slightly constricted at cross-walls. Cells cylindrical, 3-6 x 0.8-1.2 µm, pale blue-green. – Planktic in ponds and lakes; known mainly from central Europe, probably over the whole temperate zones.

8. *Romeria gracilis* (KOCZW.) KOCZW. ex GEITL. Rabenh.'s Krypt.-Fl. 14: 916, 1932.

Syn.: *Raciborskia gracilis* KOCZW. Kosmos 53: 104, 1929.

Amalia gracilis (KOCZW.) DE TONI Noter. Nomencl. Algol. 1: 5, 1934.

Synechococcus gracilis (KOCZW.) KOM. Arch. Protistenk. 112: 363, 1970.

Trichomes solitary, irregularly wavy to coiled, 2-18-celled, with very fine, colourless, mucilaginous envelopes, constricted at cross-walls. Cells short cylindrical to almost barrel-shaped, 3.5-4.6 x 1.2-1.5 µm, pale blue-green. – Planktic in ponds and lakes; cosmopolitan (?).

9. *Romeria hieroglyphica* KOM. et al. Revista bot. brasil., in press, 2001.

Trichomes solitary, very irregularly coiled, 12-24-celled, with mucilaginous, diffuse envelopes, constricted at cross-walls. Cells long cylindrical, 4.5-9.2 x 1-1.3 μm , pale blue-green. – Planktic in small eutrophic ponds and pools; tropical species (?), Brazil (São Paulo state).

* 10. *Romeria cryophila* KOL Ann. hist.-nat. Mus. Nat. Hung., Bot. (Budapest) 58: 161-168, 1966.

Trichomes solitary, almost straight or slightly arcuated, 8-16-celled, with mucilaginous envelopes, not constricted at cross-walls. Cells cylindrical, 1-3 x 1-1.5 μm , pale blue-green. – Kryosestic; Poland (High Tatra Mts.). - Generic identification problematic.

11. *Romeria simplex* (HIND.) HIND. Preslia 60: 299, 1988.

Syn.: *Tubiella simplex* HIND. Arch. Hydrobiol./ Algal. Stud. 13: 338, 1975.

Trichomes solitary, slightly wavy to almost straight, 4-16-celled, constricted at cross-walls. Cells cylindrical, 4-12 x \pm 1.2-1.6 μm , pale blue-green; sometimes Y-formed cells occur. – Planktic in eutrophic village ponds; Slovakia.

12. *Romeria victoriae* KOM. et CRONB. Nova Hedwigia, in press, 2001.

Trichomes solitary, wavy to coiled, (1)2-18-celled, but sometimes with numerous cells (up to > 60), slightly constricted at cross-walls. Cells cylindrical, 4.5-9(13) x \pm 1.5 μm , pale greyish blue-green. – Planktic in lakes and large reservoirs; tropical species – central, east and southern Africa.

13. *Romeria elegans* (WOŁOSZ. in KOCZW.) WOŁOSZ. et KOCZW. ex GEITL. Rabenh.'s Krypt.-Fl. 14: 916, 1932.

Syn.: *Raciborskia elegans* WOŁOSZ. in KOCZW. Kosmos 53: 108, 1929.

Amalia elegans (WOŁOSZ. in KOCZW.) DE TONI Noter. Nomencl. Algal. 1: 5, 1934.

Synechococcus elegans (WOŁOSZ. in KOCZW.) KOM. Arch. Protistenk. 112: 363, 1970.

Trichomes solitary, always irregularly wavy, 2-12-celled, with diffuse, colourless mucilaginous envelopes, slightly constricted at cross-walls. Cells cylindrical, (2.5?)3-9 x (1?)1.3-2 μm , pale glue-green. – Planktic in ponds, lakes and rivers; known mainly from temperate Eurasia, but recorded also from India; cosmopolitan (?).

14. *Romeria nivicola* (KOL) KOM. O. et KOM. Proc. symp. “Algae in extreme environments”, Třeboň, in press, 2001.

Syn.: *Romeria elegans* var. *nivicola* KOL Amer. J. Bot. 28: 190, 1941.

Trichomes solitary, irregularly wavy to coiled, facultatively with very diffuse and indistinct slime, usually with up to 12, rarely with numerous cells, constricted at cross-walls, usually heterocellular. Cells cylindrical, (3.5)4-14 x \pm

2 µm, pale greyish blue-green. – Kryosestic; coastal Antarctica, Japan, USA (mountains).

15. *Romeria heterocellularis* KOM. et al. Revista bot. brasil., in press, 2001.

Trichomes solitary, almost straight to slightly wavy, with indistinct mucilaginous envelopes, 2-23-celled, constricted at cross-walls, heterocellular. Cells cylindrical, 2.6-8.2 x (1.4)2.2-2.8 µm, pale blue-green. – Planktic and metaphytic in large reservoirs; tropical species, Brazil (São Paulo state).

* 16. *Romeria austriaca* CLAUS Int. Rev. ges. Hydrobiol. 46(4): 520, 1961.

Syn.: *Borzia austriaca* (CLAUS) ANAGN. et KOM. Arch. Hydrobiol./Algol. Stud. 50-53: 370, 1988.

Trichomes solitary, short, almost straight or arcuated, usually 6-celled, not constricted at cross-walls, cylindrical, to 10 µm long, with diffuse slime envelopes. Cells ± isodiametric or shorter (!) than wide, ± 2.3 µm wide, pale blue-green. – Benthic in shallow lakes; eastern Austria. – Generic identification is problematic (cell morphology, not constricted trichomes).

17. *Romeria crassa* HIND. Preslia 60: 299, 1988.

Trichomes solitary, slightly wavy, with narrow, indistinct mucilaginous envelopes, 2-4(12)-celled, constricted at cross-walls. Cells cylindrical to sausage-shaped, 3-5(7) x (2)2.5-2.8 µm, greyish to pale blue-green; Y-shaped cells occur. – In summer plankton of fishponds; Slovakia.

18. *Romeria okensis* (MEYER) HIND. Arch. Hydrobiol./Algol. Stud. 13: 340, 1975.

Syn.: *Arthrospira okensis* MEYER Arb. Oka Biol. Stat. 3,1: 40, 1926.

Spirulina okensis (MEYER) GEITL. Rabenh.'s Krypt.-Fl. 14: 924, 1932.

Trichomes solitary, irregularly to almost regularly screw-like coiled, with diffuse mucilaginous envelopes, up to 27-celled, constricted at cross-walls. Cells cylindrical, arcuated, 5.2-12 x 2-3 µm, pale blue-green. – Planktic in eutrophic ponds, reservoirs and large rivers; Czech Republic, Hungary, Russia, Slovakia, Ukraine.

19. *Romeria mexicana* (ROUCHIJ.) KOM. comb. nova

Syn.: *Oscillatoria mexicana* ROUCHIJ. Novit. syst. Plant. non Vasc. 1968: 6, 1968; basionym.

Trichomes solitary, slightly wavy, 2-8-celled (sometimes with more cells?), constricted at cross-walls, heterocellular, sometimes attached by one end to floating microscopic particles. Cells long cylindrical, 8-48(80!) x 2-3 µm, pale greyish blue-green. – Marine, planktic; Mexico gulf.

Discussion

The following main questions remain open in the genus *Romeria*:

1. The proof of genotype separation of this genus and its homogeneity (monophyly) by molecular methods.
2. The proof of presence or absence of pores between cells (taxonomic classification in coccoid or filamentous cyanobacteria).
3. The examination of relations of *Romeria* to coccoid *Aphanothece*-types and filamentous *Pseudanabaena*-types, as representants of one evolutionary line.
4. The taxonomic revision of species conspect (mainly if all described *Romeria* species belong to one and the same genotype – genus).
5. Toxicity of various strains and species.
6. The distribution of various species (eko- and morphotypes).

Acknowledgement

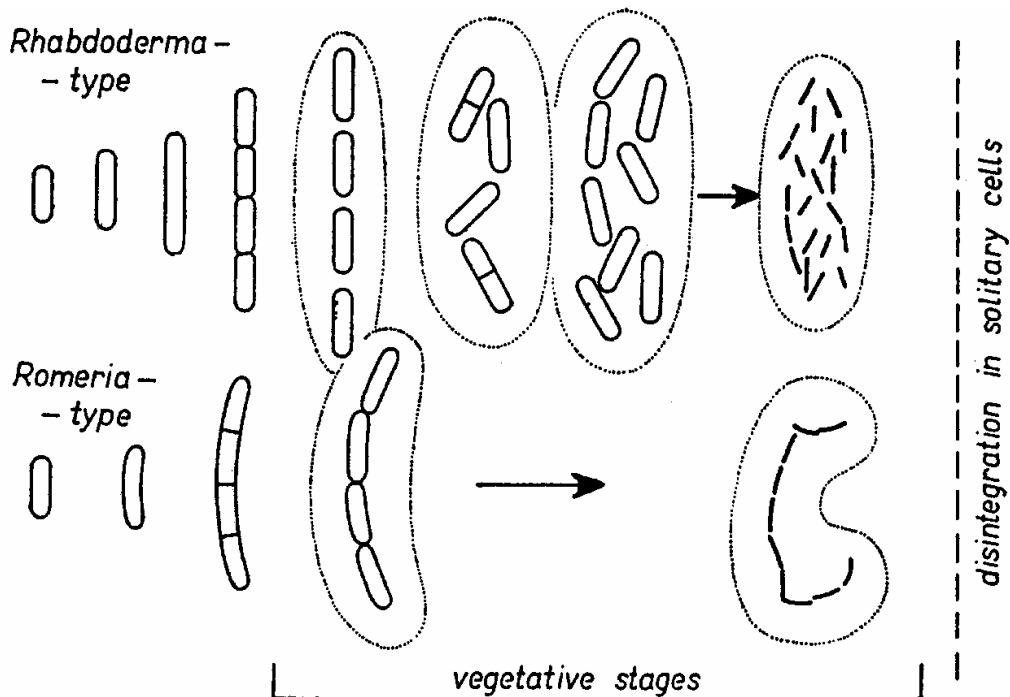
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Fig. 1. Comparison of life-cycles in genera *Rhabdoderma* (Chroococcales, Synechococcaceae), and *Romeria* (Oscillatoriales, Pseudanabaenaceae). – (From KOMÁREK 1970).



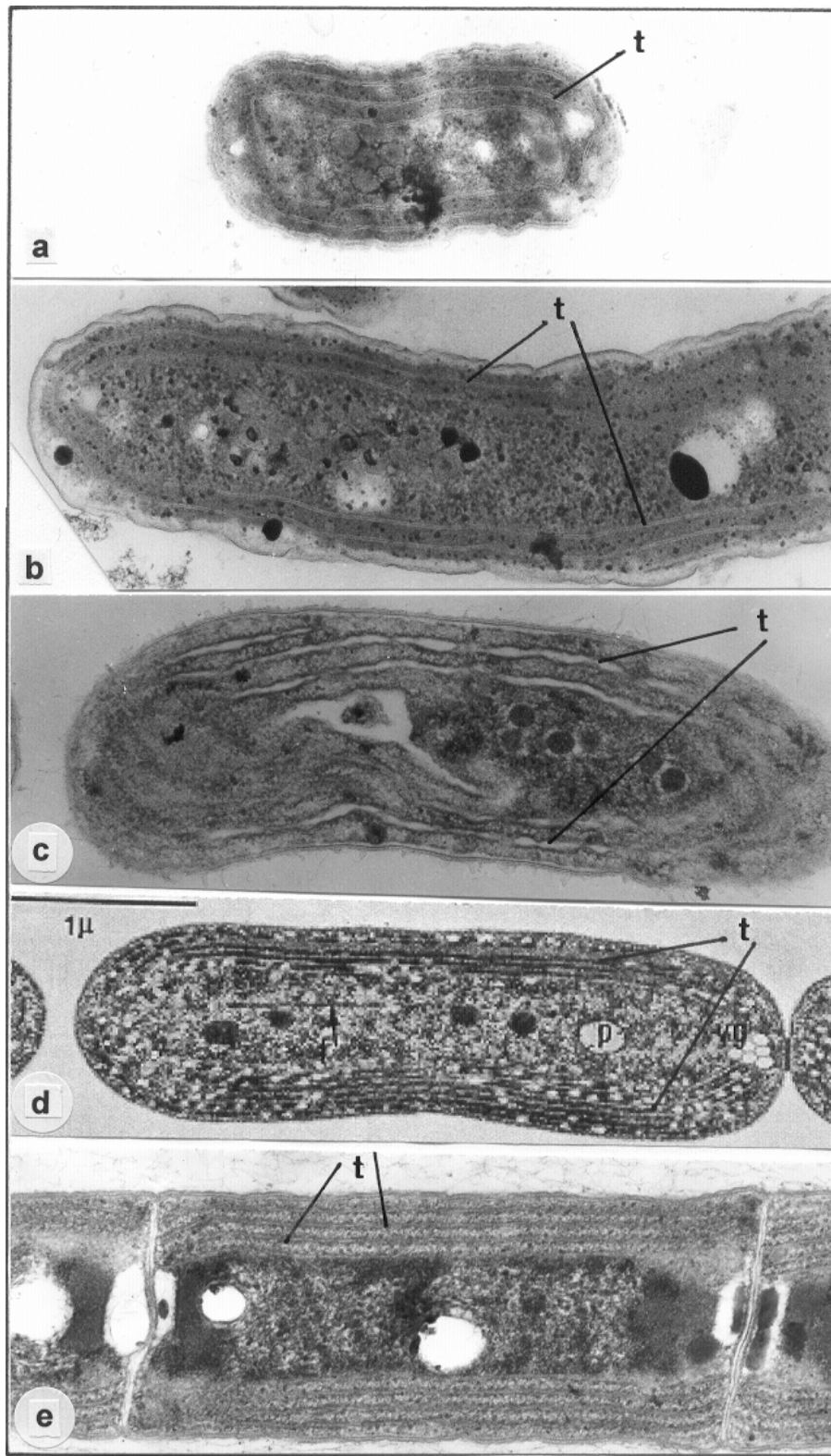


Fig. 2. Example of thylakoid arrangement in coccoid and simple filamentous cyanoprokaryotes: **a** = *Aphanothece stratus*, **b** = *Romeria caruaru*, **c** = *R. leopoliensis*, **d** = *Pseudanabaena* sp. (after GUGLIELMI & COHEN-BAZIRE 1984), **e** = *Geitlerinema unigranulatum* (after KOMÁREK & AZEVEDO 2000); **t** = thylakoids.

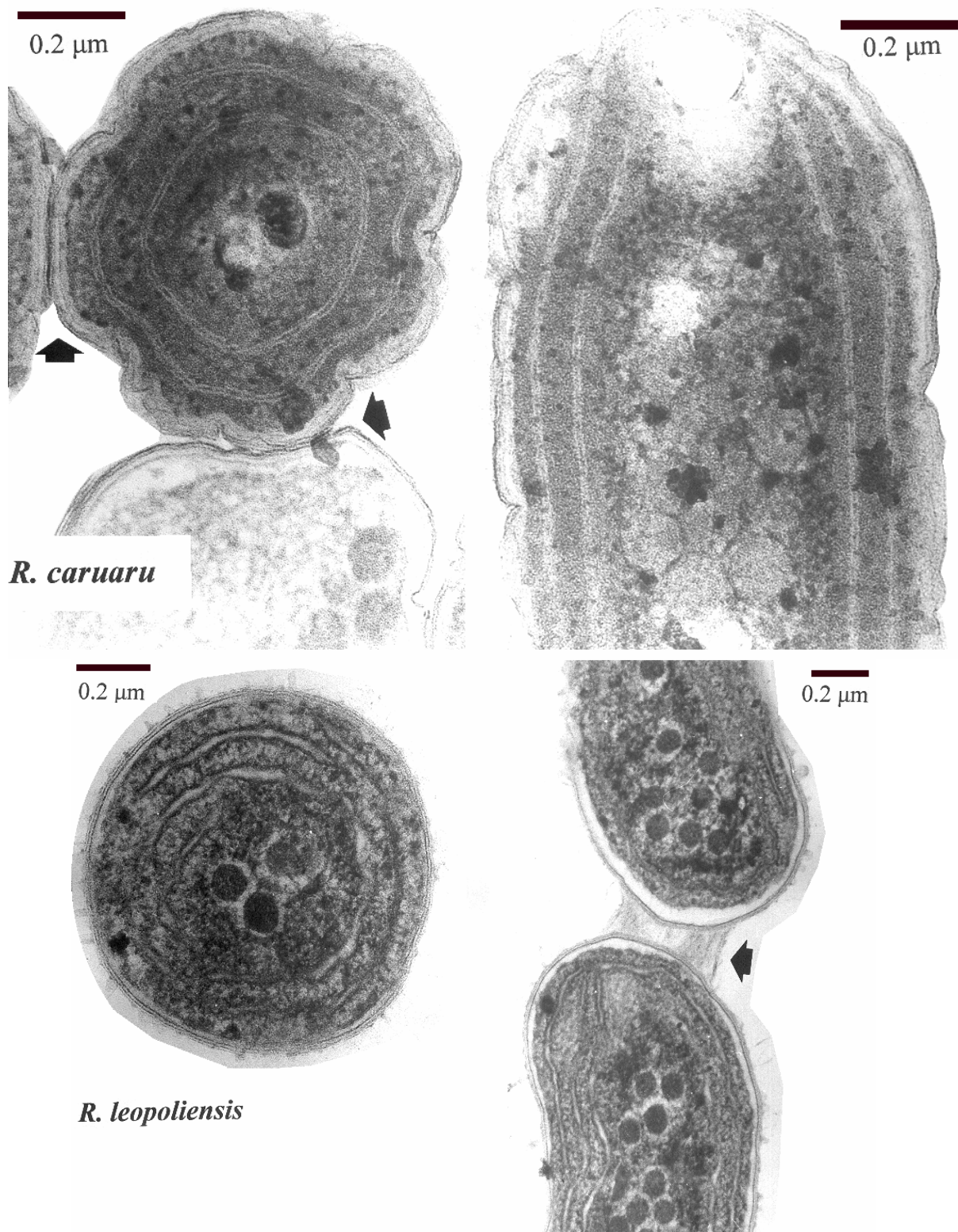


Fig. 3. Thylakoid position in cells (cross and length-wise sections) and connections of cells in pseudofilaments (arrows) in two species, tropical *R. caruaru* and temperate *R. leopoliensis* (type species).

Romeria species from Czech Republic

- *Raciborskia elegans* Koczw. Kosmos 53: 107, 1929
= ***Romeria elegans*** (Koczw.) Wołosz. et Koczw. in Geitl. Rabenh. 's Krypt.Fl. 14, 2ed., p. 916, 1932
= *Amalia elegans* (Koczw.) De-Toni Noter. Nomencl. Algol. 1: 5, 1934
- *Raciborskia gracilis* Koczw. Kosmos 53: 107, 1929
= ***Romeria gracilis*** (Koczw.) Koczw. in Geitl. Rabenh. 's Krypt.Fl. 14, 2ed., p. 916, 1932
= *Amalia gracilis* (Koczw.) De-Toni Noter. Nomencl. Algol. 1: 5, 1934
- *Arthrospira leopoliensis* Racib. Phycol. Polon. 1: 9, 1910; Kosmos 35: 82, 1910
= *Raciborskia leopoliensis* (Racib.) Koczw. Kosmos 53: 107, 1929
= ***Romeria leopoliensis*** (Racib.) Koczw. in Geitl. Rabenh. 's Krypt.Fl. 14, 2ed., p. 916, 1932
= *Amalia leopoliensis* (Racib.) De-Toni Noter. Nomencl. Algol. 1: 5, 1934
- *Rhabdoderma minimum* Lemm. Arch. Hydrobiol. Planktonk. 4: 187, 1909
= *Synechococcus minimus* (Lemm.) Kom. Arch. Protistenk. 112: 363, 1970
= ***Romeria minima*** (Lemm.) comb. nova
- *Arthrospira okensis* Meyer Arb. Oka Station, p.40, 1926
= *Spirulina okensis* (Meyer) Geitl. Rabenh. 's Krypt.-Fl. 14, 2ed., p.924, 1932
= ***Romeria okensis*** (Meyer) Hind. Arch. Hydrobiol./Algol. Stud. 13: 340, 1975

Other possible species:

- Romeria austriaca* – benthic in lakes, eastern Austria
Romeria chlorina – benthic (epipellic) in shallow lakes in Denmark
Romeria crassa – in eutrophic fishponds, Slovakia
Romeria cryophyla (?) – kryosestic, High Tatra Mts.
Romeria cylindrocellularis – eutrophic ponds, Slovakia
Romeria simplex – village ponds, Slovakia

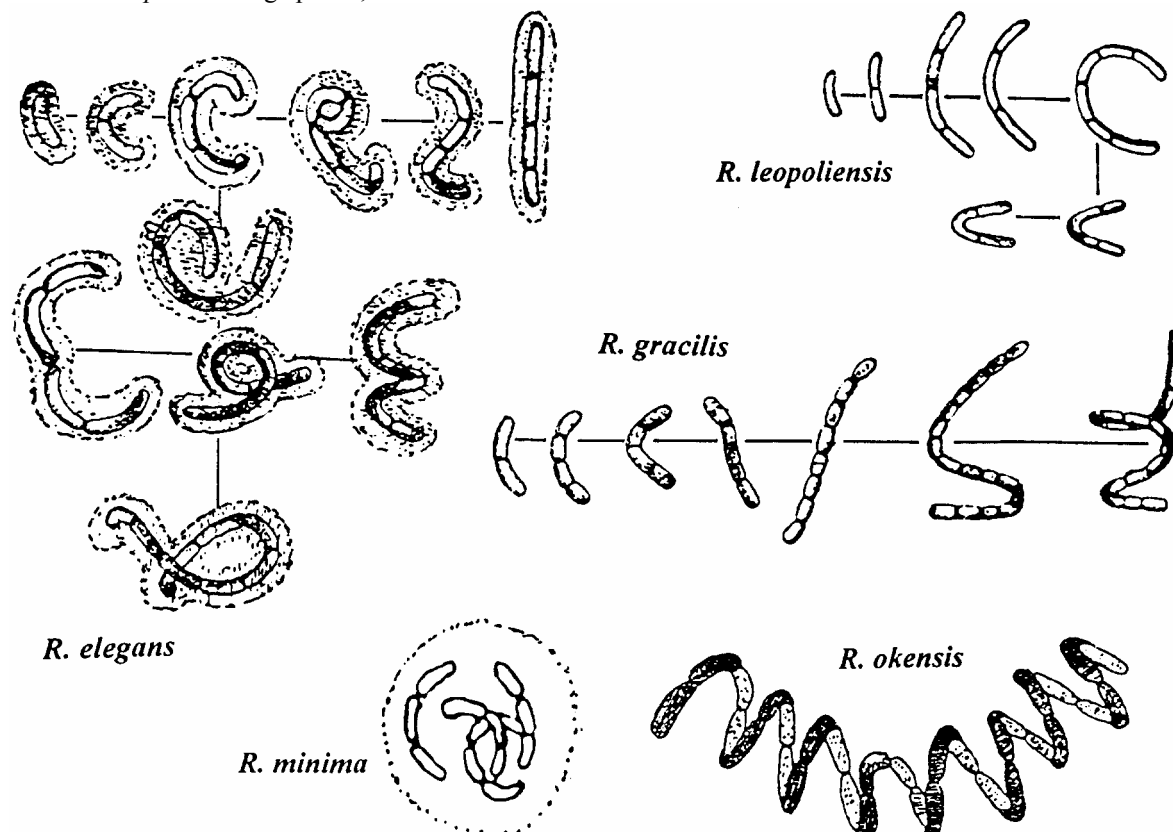
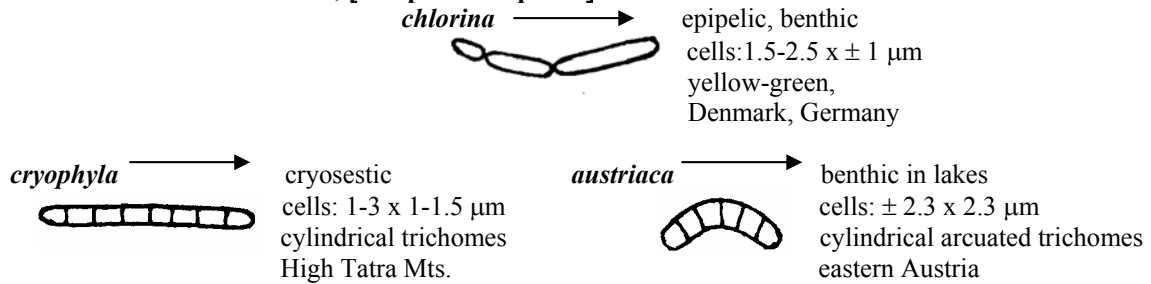


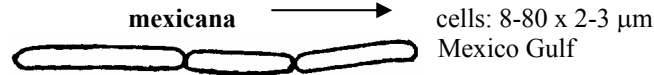
Table 1. *Romeria* species occurring in Czech Republic. The drawings are from GEITLER 1932 (original drawings of authors of corresponding species; KOCZWARA, LEMMERMANN and MEYER).

I. Non constricted trichomes; [non planktic species]



II. Constricted trichomes:

① Marine



② Not marine

Cells distinctly narrower than 1µm (max. to 1µm wide):					
Cells	1.5-3 x 0.7-0.8		<i>minima</i>	metaphytic in clear streams	Italy, CZ
	3.7-8.3 x 0.6-0.8		<i>alascensis</i>	planktic in oxidation ponds	Alaska
	1-12.8 x 0.7-1		<i>caruaru</i>	planktic in tropical reserv.	Brazil (Pernambuco)
Cells ± 1 µm wide (0.8-1.3 µm):					
Cells	1.5. x ± 1		<i>cylindrocellularis</i>	planktic in eutroph. ponds	Slovakia
	3-6 x 0.8-1.2		<i>leopoliensis</i>	planktic in ponds & lakes	temperate zones
	4.5-9.2 x 1-1.3		<i>hieroglyphica</i>	planktic, small ponds & lakes	Brazil (São Paulo)
	6 x 1		<i>westii</i>	epiphytic on mosses	Costa Rica
Cells 1.2-1.6 µm wide:					
cells	4-12 x ± 1.2-1.6		<i>simplex</i>	planktic, eutr. village ponds	Slovakia
	3.5-4.6 x 1.2-1.5		<i>gracilis</i>	planktic in ponds & lakes	cosmopolit.
	4.5-13 x 1.5	 ± straight	<i>victoriae</i>	planktic in reserv. & lakes	trop. E & SE Africa
Cells to 2 µm wide (± 1.6 – 2.2 µm):					
Cells	3-9 x 1.3-2	 curved	<i>elegans</i>	planktic in ponds & rivers	temperate Eurasia
	4-14 x ± 2	 heterocellular	<i>nivicola</i>	cryoseston	USA, Japan, Antarctica
Cells > 2 µm wide (2-3 µm):					
Cells	5.2-12 x 2-3		<i>okensis</i>	planktic, eutr. ponds & rivers	CZ, Russia, Hungary
	3-7 x 2-2.8		<i>crassa</i>	planktic in fishponds	Slovakia
	2.6-8.2 x 1.4-2.		<i>heterocellularis</i>	planktic in large reservoirs	tropical; Brazil

Table 2. Review of species – identification key.

Table 3A

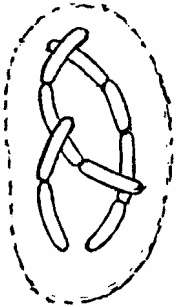



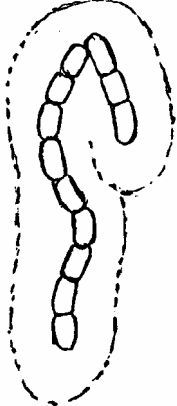
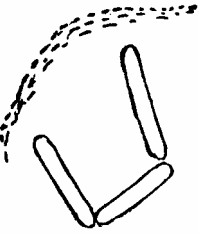
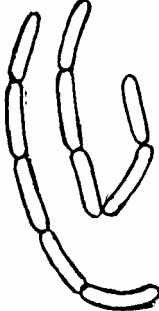
Species	<i>minima</i>	<i>alascensis</i>	<i>caruraru</i>	<i>chlorina</i>	<i>cylindrocell.</i>	<i>westii</i>	<i>leopoliensis</i>
Number of cells	(1)2 - 4(more?) few	2 - 4(8)	1 - 4(12)	several	many	3	1 - 4(8)
Dimensions (μm)	1.5 - 3 x 0.7 - 0.8	3.7 - 8.3 x 0.6 - 0.8	1 - 12.8 x 0.7 - 1	1.5 - 2.5 x ± 1	1 - 1.5 x ± 1	6 x 1	3 - 6 x 0.8 - 1.2
Constrictions	+	+	+	-	+	+?	(+)
Colour	pale blue-gray	pale blue-green	pale blue-grey	yellow green	yellow green or pale blue-green	blue-green	pale blue-green
							
Notes	colonies with 1-4 short trichomes		many solitary cells	disintegrated, indistinct cross-walls		in gelatinous mass	usually in trichomes
Ecology	metaphyton, clear small streams	oxidation pond	planktic in reservoirs	benthic, epipelic on organic mud	planktic in eutrophic ponds	epiphytic on mosses	planktic in ponds & lakes
Distribution	Italy, Czech Republic	USA (Alaska)	tropical – Brazil (PB)	Denmark, N Germany	Slovakia	tropical – Costarica	temperate

Table 3 (A – C). Review of species – main diagnostical characters.

Table 3B.

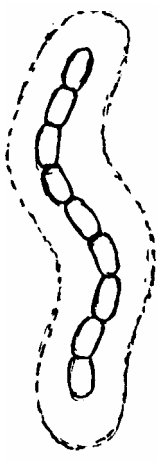
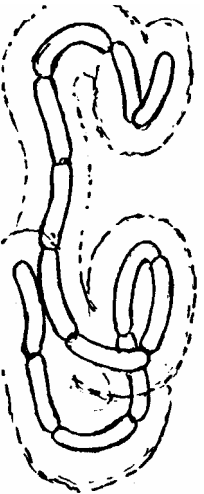
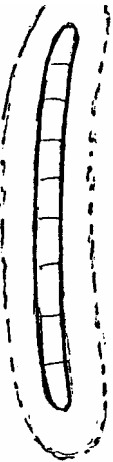
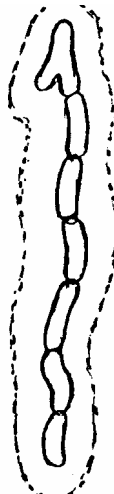
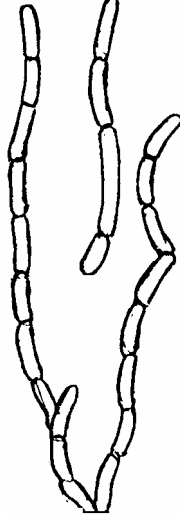
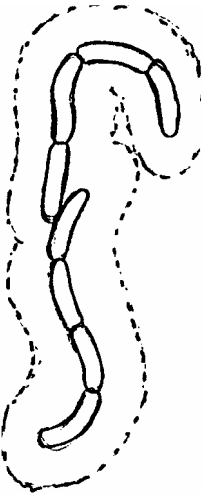
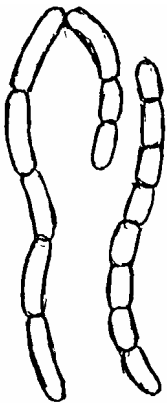

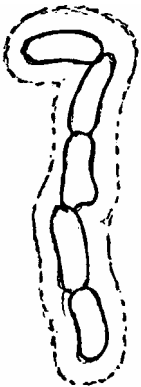
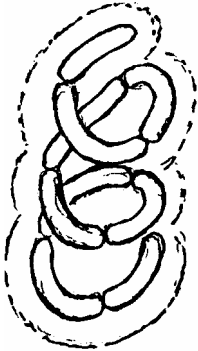
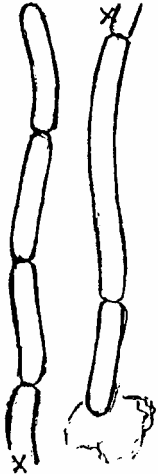
Species	<i>gracilis</i>	<i>hieroglyphica</i>	<i>cryophyla</i>	<i>simplex</i>	<i>victoriae</i>	<i>elegans</i>
Number of cells	2 – 18	12 - 24	8 - 16	4 - 16	(1)2 - 18 (→ 60)	2 - 12
Dimensions (µm)	3.5 – 4.6 x 1.2 - 1.5	4.5 - 9.2 x 1 - 1.3	1 - 3 x 1 - 1.5	4 - 12 x ± 1.2 - 1.6	4.5 – 9(13) x 1.5	(2.5?)3 - 9 x (1?)1.3 - 2
Constrictions	+	+	-	+	+	+
Colour	pale blue-green	pale blue-green	pale blue-green	pale blue-green	pale blue-grey	pale blue-green
						
Notes				Y-formed cells present	± straight trichomes	always ± wavy
Ecology	planktic in ponds & lakes	small ponds & pools	cryosestic	planktic in eutrophic village ponds	planktic in large reservoirs & lakes	planktic in ponds & rivers
Distribution	cosmopolitan?	tropical – Brazil (SP)	High Tatra Mts.: Poland, Slovakia	Slovakia	tropical-Africa: Victoria lake, Mozambique	temperate Eurasia, India

Table 3C.

Species	<i>nivicola</i>	<i>heterocellul.</i>	<i>crassa</i>	<i>okensis</i>	<i>mexicana</i>
Number of cells	- 12 (- many)	2 - 23	2 - 4(12)	-27	2 - 8(more?)
Dimensions (μm)	4 - 14 x ± 2	2.6 - 8.2 x (1.4)2.2 - 2.8	3 - 5(7) x (2)2.5 - 2.8	5.2 - 12 x 2 - 3	8 - 48(80) x 2 - 3
Constricted	(+) to +	+	+	(+) to +	+
Colour	pale blue-grey	pale blue-green	pale blue-green or greyish	pale blue-green	pale blue-grey
					
Notes	heterocellular trichomes	heterocellular trichomes	Y-formed cells present	\pm regular coiled trichomes	attached to planktic particles
Ecology	cryosestic	planktic and metaphytic in large reservoirs	planktic in fishponds (in summer)	planktic in eutr. ponds & rivers	marine, planktic
Distribution	USA, Japan, coastal Antarctica	tropical - Brazil (SP)	Slovakia	Czech Rep., Hungary, Russia	Mexico Gulf