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Cyanoprokaryota and algae of Arctic terrestrial ecosystems in the Hornsund area, Spitsbergen

Jan MATUŁA, Mirosława PIETRYKA, Dorota RICHTER and Bronisław WOJTUŃ

Katedra Botaniki i Ekologii Roślin, Uniwersytet Przyrodniczy we Wrocławiu,
Plac Grunwaldzki 24a, 50-363 Wrocław, Poland
<matula@ozi.ar.wroc.pl>

Abstract: In 72 samples collected from various types of habitats of West Spitsbergen 150 algal taxa have been identified, including 100 taxa of Cyanoprokaryota, 40 of Chlorophyceae, and 10 of Xanthophyceae. Seventy-two species, mainly blue-green algae (55 taxa) are considered as new for Svalbard flora.

Key words: Arctic, Spitsbergen, Cyanoprokaryota (Cyanophyta), Chlorophyceae, Xanthophyceae.

Introduction

Based on the literature data published so far it can be concluded that algae (including blue-greens) are, in terms of species number, the richest group in Svalbard's terrestrial ecosystems flora, encompassing in total as many as 766 taxa (Skulberg 1996). They outnumber lichens (653 taxa), fungi (564) and mosses (373). Vascular plants are represented by only 173 taxa (Elvebakk and Prestrud 1996). Above data concerning algae should be considered as incomplete, since in the area of Svalbard archipelago algae have still been studied only in few sites. The oldest known report on Spitsbergen's algae comes from 1675. Even the current knowledge is based mainly on the old literature from 1873–1938 (Skulberg 1966). Since that time only short reports on this subject are known (Thomasson 1958, 1961; Kole and Eurola 1974). Recent studies (Matuła 1982, 1989; Oleksowicz 1984; Oleksowicz and Luścińska 1992; Oleksowicz *et al.* 1993) and a work summarizing the knowledge on blue-green algae and algae of Svalbard (Skulberg 1996) were published more than ten years ago. Nowadays the knowledge on the taxonomy, ecology and role of cyanoprokaryotes and algae in the environment has considerably developed. Studies upon these organisms in the Arctic have focused

mainly on their role in various Svalbard ecosystems. Intensive research on the participation of blue-greens and algae in organic mass and humus production and on their influence upon tundra soils development and erosion were performed (Plichta and Luścińska 1988; Solheim *et al*. 1996; Liengen and Olsen 1997a, b; Olsen 1999). Solheim *et al*. (1996); Zielke *et al*. (2002) and Zielke *et al*. (2005) carried out the research on the role of cyanoprokaryotes in free nitrogen fixation. However, no detailed floristic or taxonomic study has been done so far. The present knowledge on these plant groups is limited to the freshwater habitats, like small lakes and ponds, rivers and streams, sporadically to peat bogs, wet soils and snowy surfaces. There is a lack of research directly connected with such habitat types; the only exception is the paper by Plichta and Luścińska (1988) concerning the distribution of blue-greens in relation to some soil types. However, no information about the role and quantitative proportion of these organisms in plant associations can be found.

Our study conducted in 2003 and 2005 in Hornsund region revealed that cyanoprokaryota and algae develop not only their own species-rich associations, but also are present in numerous plant communities, where, besides mosses and lichens, they form an important constituent of plant cover. The aim of this publication is to present preliminary floristic data, without any detailed quantitative analysis.

Study area, material and methods

Samples were collected during the Wrocław Scientific Expedition organized by University of Wrocław and Wrocław University of Environmental and Life Science – „Spitsbergen 2003", and partly during the 2005 within the framework of the project „Impact of climatic change on zooplankton communities and seabird populations in Arctic and Antarcitc ecosystems" (coordinated by Institute of Biology of Gdańsk University) that is a part of package entitled „Structure, evolution and dynamics of lithosphere, cryosphere and biosphere in European sector of Arctic and in Antarctic" (PBZ-KBN-108/PO4/2004).

The studies were carried out during the Arctic summer in July and August in the area covering the Revdalen valley with the Revelva river, plain of raised marine terrace Fuglebergsletta, Fuglebekken outwash plain and fans, as well as the Ariekammen, Fugleberget and Gnalberget slopes (Fig. 1).

Samples were collected from all habitats characteristic of tundra in the studied region. Seventeen habitat types characterized by various humidity and trophy, soil type, slope, microrelief of ground surface and also by periglacial structures type, were distinguished. These different habitats were covered by various plant associations. These associations varied from dry lichens and lichen-mosses tundra, through moderately moist moss tundra, to permanently wet mosses surrounding

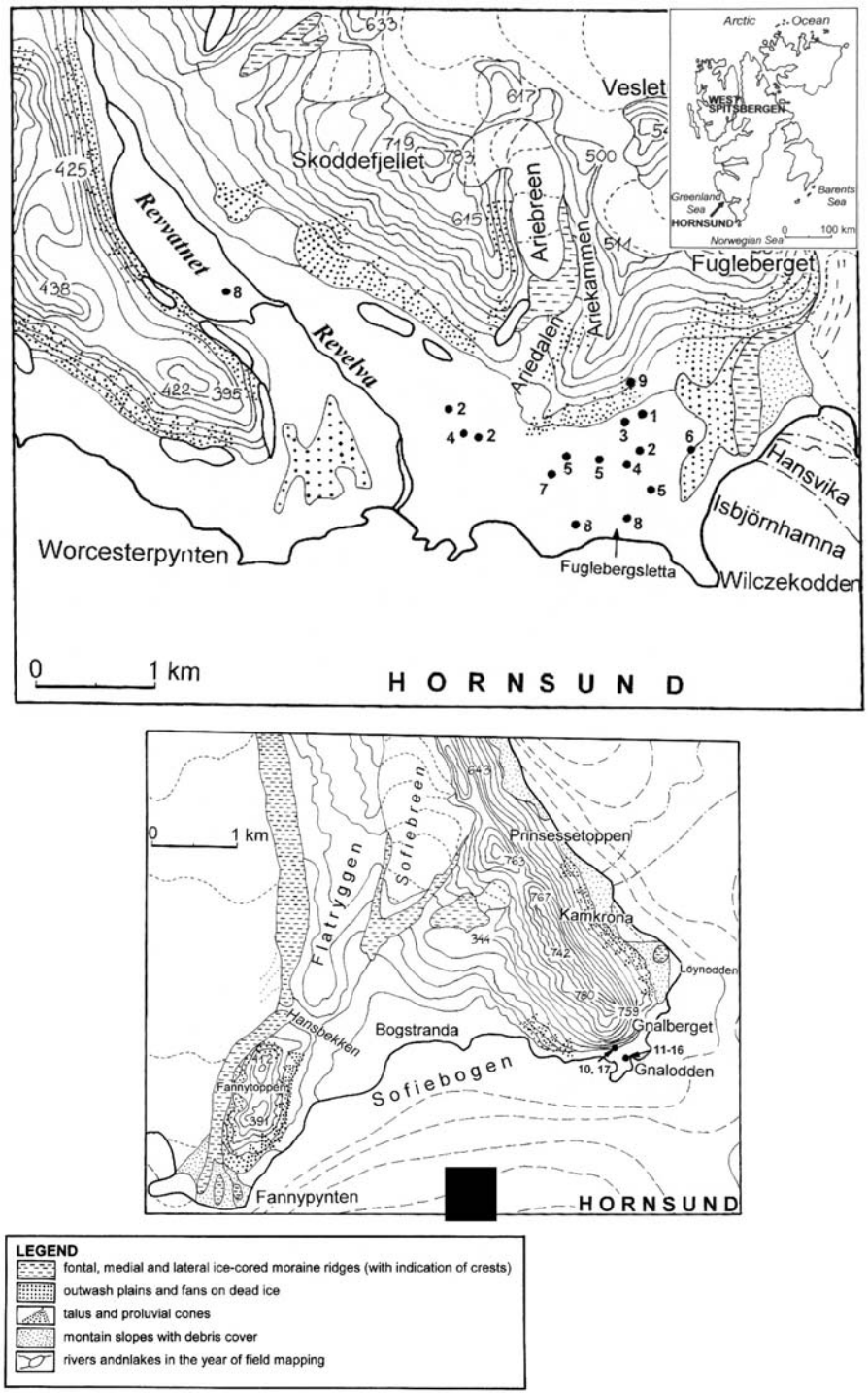

Fig. 1. Localization of the sites from where the samples were taken.

ponds, lakes and water hollows. Altogether in all the above habitats we collected 72 samples.

For species identification the authors used essential monographs (Starmach 1966, 1968, 1972; Etll 1978; Komárek and Fott 1983; Komárek and Anagnostidis 1989, 1999, 2005), as well as detailed descriptions of particular species (see references). The samples were analysed under microscopes equipped with the image computer analysis device: Aksioskop 2 plus (Zeiss©) and Nikon Eclipse 80*i* with interferencial contrast DIC. The Nikon Eclipse microscope was purchased with funds provided within project co-financed by European Union (European Regional Development Fund). For image analysis the following software packages were used: Axio Vision 2.05 and Lucia Image Analysis Systems version 5.0. The samples were collected with a plankton net No 25 (algae floating in water ponds, lakes, streams), or with a spoon (algae from peat and mineral soil, stones, cliffs surface).

Site and habitat type descriptions (Fig. 1)

1. Below the Ariekammen slope – eutrophic moist moss-tundra composed of *Calliergon sarmentosum* community and *Tetraplodon mnioides* community.

Samples containing mats of *Prasiola crispa*, filamentous green algae and blue-greens were collected from erosive hollows filled with water (up to 20 cm), and lined with a thin (a few centimetres thick) light-brown coat of dead plants. This habitat remained under strong influence of streams flowing from the Ariekammen slope and containing enormous amount of bird excrements. Site was situated at a distance of 200 m from bird colonies nesting on the Ariekammen slope.

2. Fuglebergsletta plain of raised marine terrace and the Revdalen valley on the Revelva river – mesotrophic moist moss-tundra composed of: *Calliergon sarmentosum* community, *Tetraplodon mnioides* community and *Saxifraga hyperborea–Ranunculus spitsbergensis* community. Algae were collected in shallow pools and from erosive surfaces on a thin peat layer filled with stagnant water of the depth ±5–10 cm.

3. Fuglebergsletta plain of raised marine terrace. Samples were collected in streams flowing through the eutrophic moist moss-tundra. Highly eutrophic waters were influenced by numerous colonies of plankton-eating Little Auks (*Alle alle*) nesting on the Ariekammen slope.

4. Fuglebergsletta plain of raised marine terrace; Revdalen and Ariedalen valleys. Samples were collected from streams periodically overflowing the turf surface in mesotrophic moist moss-tundra.

5. Fuglebergsletta plain of raised marine terrace – moist *Saxifraga oppositifolia* community. During the whole vegetation period surfaces were supplied by snow melting water, streams and groundwater seepage. Samples were collected from soil surface, stones, gravel and sand.

6. Fuglebergsletta plain of raised marine terrace – dry *Saxifraga oppositifolia* community. Material was collected from soil surface, stones and gravel.

7. Fuglebergsletta shore streams on the mineral substratum – mesotrophic water.

8. Lakes, ponds and shallow pools on the Fuglebergsletta plain of raised marine terrace and the Revvatnet lake in the Revdalen valley. Samples were collected on the shallow bottom at the banks of waterbodies from stones and sand.

9. Lower part of the Ariekammen slope situated over the Isobjørnhamna Bay – algae and blue-green algae were collected from the vertical rocky walls permanently sprinkled with water containing an enormous amount of bird excrements.

10. Walls of rocky cliff on the Gnalberget slope occupied by colonies of fish-eating birds (*Uria lomvia, Rissa tridactyla*). Algae and blue-green algae were collected from rocky surfaces directly under birds colonies. These places were in permanent contact with flowing water containing bird excrements.

11. At the foot of the Gnalberget rocky cliffs. Material was collected from soil surface, between single tussocks of *Poa alpina* var. *vivipara* and *Cochlearia groenlandica*. Soils were strongly fertilized with nitrogen and phosphorus from bird excrements.

12. Gnalberget slope, in the community of *Cochlearia groenlandica–Poa alpina* and *Prasiola crispa*. This strongly nitrophilous communities developed in a distance of 6–15 m from the foot of rocky cliffs with a giant colony of guillemots. Material was collected from soil surface.

13. Gnalberget slope; community similar to the above one but 50 to 80 m away from the rocky cliffs.

14. Gnalberget slope; community of *Saxifraga cespitosa* and *Deschampsia borealis* with *Plagomnium ellipticum* and *Pohlia nutans*, at a distance of about 125 m from guillemot colonies. Material collected from soil and turf composed of dominating mosses.

15. Gnalodden plain terrace, community of *Saxifraga oppositifolia* with *Sanionia uncinata* and *Aulacomnium palustre*, community of *Deschampsia borealis* with *Plagomnium elipticum, Sanionia uncinata, Aplodon wormskioldii* and *Pohlia nutans*. Samples collected from soil and moss.

16. Gnalodden plain terrace, community of *Saxifraga oppositifolia* with *Sanionia uncinata* and *Aulacomnium palustre*. Black, crusty, thick ridge mats of blue-green algae and algae were found there. Samples collected from soil and mosses.

17. At the foot of the Gnalberget rocky cliffs, patches of firn. Material collected from ice crystals in firn patches.

Results

In the investigated habitats 150 algal taxa have been identified, including 100 taxa of Cyanoprokaryota, 40 of Chlorophyceae, and 10 of Xantophyceae. Seventy-two species, mainly blue-greens (55 taxa) are new for Svalbard flora.

Our study indicates a high diversity of cyanobacteriae and algae resulting from the diversified habitat conditions, *i.e.* geological, hydrological, trophic and edaphic conditions, microclimate, relief etc. Each type of habitat studied has its own specific flora, depending on the local ecological, especially trophic conditions.

Important influence of plankton-eating and fish-eating bird colonies was observed, mainly upon the communities of Cyanoprokaryota. The diet of birds, reflected in guano mineral composition, determines the diversity of algal communities, especially in the case of Cyanoprokaryota that are able to fixate nitrogen. In some habitats (1–3, 9–13) lack of heterocytes, filamentous members of the Nostocales was observed, distinguishig them from the others (5, 6, 8, 16).

In Table 1 the list of blue-greens and algae identified in particular habitats is presented. In Figs 2–12 some particularly interesting taxa are illustrated.

Table 1

List of blue-greens and algae identified in particular habitats

Name of species	No of habitats															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Cyanoprokaryota																	
Aphanocapsa delicatissima W. West *et* G.S. West		+						+									
Aphanocapsa incerta (Lemmermann) Cronberg *et* Komárek	+							+									
Aphanocapsa muscicola (Meneghini) Wille	+				+												
Aphanocapsa parasitica (Kützing) Komárek *et* Anagnostidis										+		+					
Aphanothece caldariorum P. Richter		+			+												
Aphanothece castagnei (Brébisson) Rabenhorst					+												
Aphanothece clathrata W. West *et* G.S. West	+			+	+			+									
Aphanothece cf. *minutissima* (W. West) Komárková Legnerová *et* Cromberg								+									
Aphanothece nebulosa Skuja								+									
Aphanothece saxicola Nägeli		+			+			+									
Aphanothece stagnina (Sprengel) A. Braun in Rabenhorst		+			+			+									
Calothrix gelatinosa (Böcher) V.Poljanskij								+									
Calothrix gypsophila (Kützing) Thuret		+			+			+									
Calothrix cf. *fusca* (Kützing) Bornet *et* Flahault		+															
Chamaesiphon incrustans Grunow in Rabenhorst										+							
Chlorogloea purpurea Geitler								+									
Chondrocystis cf. *dermochroa* (Nägeli) Komárek *et* Anagnostidis					+	+		+									
Chroococcus cohaerens (Brébisson) Nägeli		+															
Chroococcus turgidus (Kützing) Nägeli	+	+			+			+									
Coelomoron cf. *pusillum* (Van Goor) Komárek					+					+							
Cyanobacterium synechococcoides Komárek *et* al.										+							
Cyanobium sp.						+											
Cyanogranis ferruginea (Wawrik) Hindák													+				
Cyanothece aeruginosa (Nägeli) Komárek								+									
Geitlerinema ionicum (Skuja) Anagnostidis						+											
Geitlerinema cf. *acuminatum* Anagnostidis										+							

Table 1 – continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Geitlerinema acutissimum (Kufferath) Anagnostidis								+									
Gloeocapsa kuetzingiana Nägeli					+												
Gloeocapsa sanguinea (Agardth) Kützing					+												
Gloeocapsopsis crepidinum (Thuret) Geitler *et* Komárek		+															
Gloeocapsopsis magma (Brébisson) Komárek *et* Anagnostidis			+		+				+								
Gloeocapsa atrata Kützing		+															
Gloeocapsa biformis Ercegović		+			+												
Gloeocapsa compacta Kützing		+			+												
Gloeocapsa lignicola Rabenhorst								+									
Gloeocapsa punctata Nägeli								+									
Gloeocapsa rupestris Kützing					+												
Gloeocapsa tornensis Skuja					+												
Gloeothece subtilis Skuja		+															
Gloeothece incerta Skuja															+		
Gomphosphaeria natans Komárek *et* Hindák	+	+															
Jaaginema kuetzingianum (Nägeli in Kützing) Anagnostidis *et* Komárek								+									
Jaaginema gracile (Böcher) Anagnostidis *et* Komárek		+		+													
Komvophoron cf. *constrictum* (Szafer) Anagnostidis *et* Komárek		+						+									
Komvophoron groenlandicum Anagnostidis *et* Komárek		+															
Komvophoron minutum (Skuja) Anagnostidis *et* Komárek	+							+									
Leptolyngbya cf. *foveolarum* (Rabenhorst ex Gomont) Anagnostidis *et* Komárek	+				+			+		+							
Leptolyngbya bigranulata (Gardner) Anagnostidis *et* Komárek					+												
Leptolyngbya glacialis (W. West *et* G.S. West) Anagnostidis *et* Komárek					+					+							
Leptolyngbya cf. *margaretheana* (Schmid) Anagnostidis *et* Komárek		+															
Leptolyngbya cf. *treleasii* (Gomont) Anagnostidis *et* Komárek	+		+	+						+							
Leptolyngbya cf. *valderiana* (Gomont) Anagnostidis *et* Komárek					+												
Leptolyngbya voronichiniana Anagnostidis *et* Komárek		+			+												
Limnothrix guttulata (Van Goor) Umezaki *et* M. Watanabe	+					+		+									
Limnothrix cf. *radekei* (Van Goor) Meffert					+												
Lyngbya aestuarii Liebman ex Gomont								+									
Merismopedia punctata Meyen					+												
Merismopedia tenuissima Lemmermann	+		+				+			+	+						
Microcoleus vaginatus Gomont ex Gomont					+			+									
Nostoc calcicola Brébisson					+												
Nostoc commune Vaucher	+	+			+			+						+	+		
Nostoc minutissimum Kützing		+						+							+		
Nostoc minutum Desmaziéres					+	+											

Table 1 – continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Nostoc paludosum Kützing		+			+			+							+		
Nostoc piscinale Kützing								+									
Nostoc punctiforme (Kützing) Hariod					+	+		+	+			+	+	+	+		
Nostoc zetterstedtii Arreschoug		+															
Oscillatoria sancta Kützing ex Gomont								+									
Oscillatoria tenuis Agardh ex Gomont	+	+						+		+							
Phormidium ambiguum Gomont ex Gomont	+			+													
Phormidium autumnale (Agardh) Trevisan ex Gomont	+	+	+							+	+						
Phormidium cf. *boryanum* (Bory ex Gomont) Anagnostidis *et* Komárek						+			+								
Phormidium favosum Gomont ex Gomont	+							+									
Phormidium formosum (Bory ex Gomont) Anagnostidis *et* Komárek					+			+		+							
Phormidium cf. *insigne* (Skuja) Anagnostidis	+																
Phormidium irriguum (Kützing ex Gomont) Anagnostidis *et* Komárek		+					+										
Phormidium subcapitatum Boye-Peterson				+													
Phormidium terebriforme (Agardh ex Gomont) Anagnostidis *et* Komárek								+									
Phormidium uncinatum Gomont ex Gomont											+						
Planktolyngbya limnetica (Lemmermann) Komárková-Legnerová		+		+				+									
Pleurocapsa fusca Godward									+	+							
Pseudanabaena frigida (Fritsch) Anagnostidis	+	+	+	+	+	+	+	+	+	+	+						
Pseudanabaena catentata Lauterborn								+									
Pseudanabaena galeata Böcher				+	+			+		+							
Pseudanabaena limnetica (Lemmermann) Komárek								+									
Pseudanabaena biceps Böcher								+									
Schizothrix cf. *calcicola* Gomont	+	+		+	+			+									
Schizothrix fragilis Kützing ex Gomont	+			+	+			+									
Scytonema subtile Moebius		+															
Siphononema polonicum (Raciborski) Geitler					+												
Snowella lacustris (Chodat) Anagnostidis *et* Komŕrek					+												
Spirulina tenuior (Lagerheim) Kirchner										+							
Stigonema hormoides (Kützing) Bornet ex Flahault		+															
Symplocastrum penicillatum (Kützing ex Gomont) Anagnostidis					+			+									
Tolypothrix conglutinata Borzi			+					+									
Tolypothrix tenuis Kützing					+												
Trichormus variabilis (Kützing) Komárek *et* Anagnostidis														+			
Tychonema bornetii (Zukal) Anagnostidis *et* Komárek						+											
Woronichinia compacta (Lemmermann)Komárek *et* Hindák		+			+						+						
Woronichinia delicatula (Skuja) Komárek *et* Hindák					+												
Chlorophyceae																	
Binuclearia tectorum (Kützing) Beger in Wichmann		+	+					+									
Borodinellopsis texensis Dykstra												+	+				
Chaetophora tuberculosa (Roth) Agardh								+									
Chlamydocapsa sp.			+														

Table 1 – continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Chlamydomonas nivalis (Bayer) Wille										+	+	+	+	+			+
Chlorella luteoviridis Chod. in Conr. *et* Kuffer.												+					
Chlorella vulgaris Beij.												+					+
Coccomyxa confluens (Kützing) Fott										+							
Coelastrum microporum Näg.																	
Coenocystis sp.	+																
Desmococcus vulgaris (Näg.) Brand																+	
Excentrosphaera viridis Moore																+	
Geminella ordinata (W. West *et* G.S. West) Heering				+													
Gloeocystis polydermatica (Kützing) Hind.																	+
Keratococcus mucicola (Hust.) Hind.	+																
Kirchneriella rotunda (Korš.) Hind.										+							
Microspora loefgreni (Nordstedt) Lagerheim									+								
Microspora stagnorum (Kützing) Lagerheim					+												
Microspora tumidula Hazen		+															
Oedogonium sp.		+															
Oocystis eliptica W. West										+							
Pandorina morum (Müller) Bory		+								+							
Pediastrum boryanum var. *brevicorme* A. Br.								+									
Planctonema lauterborni Schmidle	+																
Prasiola crispa(Lightf.) Menegh.	+	+	+	+						+	+	+	+	+			
Prasiola fluviatilis (Sommerfeld) Areschoug							+										
Scenedesmus ecornis (Ehrenb.) Chod.								+									
Scotiella norvegica Kol															+		
Scotiellopsis terrestris (Reisigl) Punčoch. *et* Kalina	+				+												
Sphaerocystis sp.			+														
Tetrastrum triangulare (Chod.) Kom.										+							
Trochiscia aciculifera (Lagerh.) Hansg.				+											+		
Trochiscia granulata (Reinsch) Hansg. *sensu* Croasd.		+		+			+	+							+		
Trochiscia naumannii Kol										+							
Trochiscia prescottii Sieminska	+																
Trochiscia sp.		+															
Trochiscia reticularis (Reinsch) Hansg.	+																
Ulothrix limnetica Lemmerman			+							+							
Ulothrix punctata Nygaard										+				+			
Ulothrix subtilis Kützing	+			+													
Xanthophyceae																	
Chlorobotrys regularis (W. West) Bohlin																	
Chlorobotrys simplex Pascher	+																
Chlorocloster pyreniger Pascher	+																
Elipsoidon anulatum Pascher								+		+		+					
Polyedriella irregularis Pascher															+		
Tribonama pyreningerum Pascher										+							
Tribonema minus (Klebs) Hazen	+	+	+	+						+		+					
Tribonema subtillisimum Pascher		+							+								
Tribonema viride Pascher	+		+				+										
Tribonema vulgare Pascher												+					

Taxonomic comments on some interesting taxa or taxa new to Svalbard flora

Cyanoprokaryota

Aphanothece caldariorum P. Richter 1880

Fig. 2 (1–4)

Aphanothece microspora (Meneghini) Rabenhorst 1863; *Aphanothece trentepohlii* (Mohr) Grunow in Rabenhorst 1865; *Aphanothece muralis* (Tomaschek) Lemmermann 1907; *Gloeothece caldariorum* (Richter) Hollerbach in Elenkin 1938

Microscopic colonies, widely gelatinous, composed of single or double cells. Sheaths gelatinous, spreading, well visible, sometimes with visible granules. Cells elongated, cylindrical, straight or croissant-shaped, 6.5–10 µm long, 3–3.5 µm wide, on both ends of the cell one shining granule. Nanocystes spherical, densely packed in gelatinous sheaths. It is a definitely areo- and subareophitic species. *A. caldariorum* was present in mats of other blue-green algae on a soil surface inside polygons and rings of small stones; it was also collected from eroded surfaces on a thin peat layer and in mossy turfs. These sites are over-dried for a long period. It was accompanied by: *Polytrichastum alpina*, *Sanonia uncinata*, *Anthelia juratzkana*, *Salix polaris*, *Sagina* sp. *Saxifraga oppositifolia*, *S. cespitosa*. The species was observed on surfaces with fine gravel and stones, periodically intensely moistened with snow-melting waters. These surfaces were covered by sparse *Saxifraga oppostifolia* clusters. It was present also in more humid sites in mesotrophic moist moss-tundra composed of the *Calliergon sarmentosum* community, *Tetraplodon mnioides* community and *Saxifraga hyperborea–Ranunculus spitsbergensis* community. The species was found in habitat types 2 and 5.

Aphanothece* cf. *minutissima (W. West) Komárková-Legnerová *et* Cromberg 1994

Fig. 3 (4–5)

Microcystis sp. *sensu* Bachmann 1911; *Microcystis minutissima* W. West 1912; *Aphanothece pulverulenta* Bachmann 1921

Microscopic colonies, rounded, oval or cylindrical, gelatinous. Cells oval or cylindrical, blue-green or yellowish, 1.3–1.8 µm long, 0.9–1.1 µm wide, irregularly clustered inside the colony. Mucilage surrounding colonies colourless, homogenous, spreading at the edges. Species collected at the shore of small pond 60 cm deep, periodically filled with water among floating. moss *Bryum* sp. and laminar thalli of *Nostoc commune*. This pond was dry for the most of vegetative season. The species is known from oligotrophic, mesotrophic and eutrophic lakes, also in polar regions (Komárek and Anagnostidis 1999). In the present study it was found in habitat type 8.

Aphanothece nebulosa Skuja 1964

Microscopic colonies, rounded or slightly irregular, surrounded with homogenous, colourless, clearly visible mucilage. Colonies about 40–55 µm in diameter.

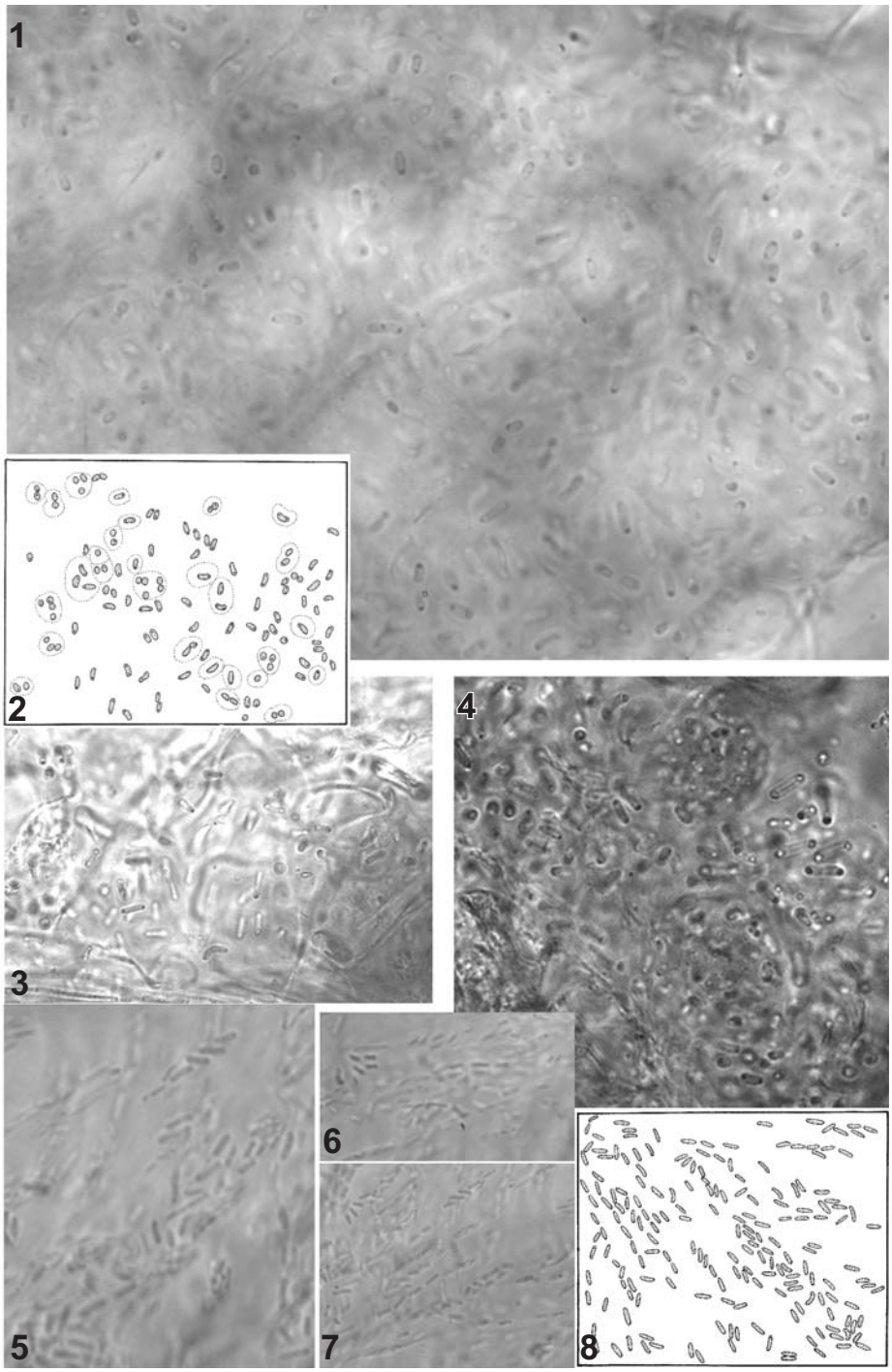

Fig. 2. Cyanoprokariota. 1–4 *Aphanothece caldariorum* P. Richter, 5–8 *Aphanothaece clathrata* W. West *et* G.S. West.

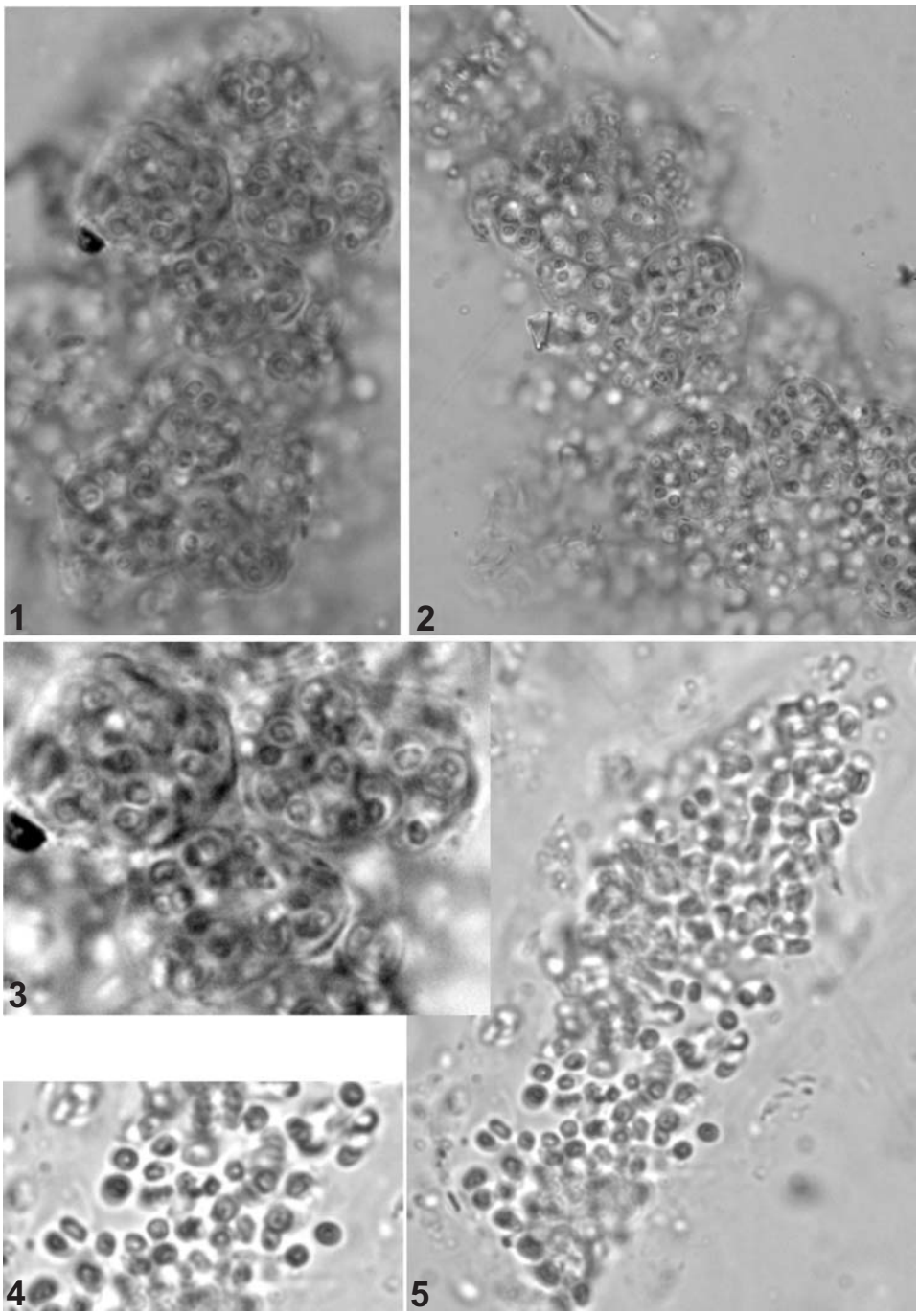

Fig. 3. Cyanoprokaryota. 1–3 *Chondrocystis* cf. *dermochroa* (Nägeli) Komárek *et* Anagnostidis, 4–5 *Aphanothece* cf. *minutissima* (W. West) Komárkova-Legnerová *et* Cronberg.

Cells oval or cylindrical, densely packed inside the colony, light blue-green, 0.6–0.8 µm long, 0.3–0.4 µm wide. It is a freshwater species, occurring in clean lakes in N. Sweden (Abisko) (Komárek and Anagnostidis 1999).

Found in habitat type 8, in lakes, ponds and shallow pools.

Calothrix gelatinosa (Böcher) V. Poljanskij 1949

Dichothrix gelatinosa Böcher

Filaments 21–28 µm wide at the base, mostly dichotomously branched. Sheaths wide, layered, spreading at the edges, sometimes covering 2 or more trichomes. Trichomes 3.5–4 µm wide, unconstricted or slightly constricted at cross-walls. Cells 3–3.5 µm long, in upper part of trichome up to 7.5 µm long. Heterocytes intercalar or capped, oval or a bit flattened. Species was present in mesotrophic moist moss-tundra composed of the *Calliergon sarmentosum* community, *Tetraplodon mnioides* community and *Saxifraga hyperborea–Ranunculus spitsbergensis* community. Collected in gelatines of other blue-green algae. Occurred in habitat type 8, in lakes, ponds and shallow pools.

Calothrix* cf. *fusca (Kützing) Bornet *et* Flahault 1886

Fig. 4 (5–9)

Filaments single or clustered few at once, straight, not branched, occurring in gelatine of other blue-green algae. Trichomes onion-shaped, 8.5–9.0 µm wide at the bottom, in the middle of cells 7.3–8.4 µm wide. Trichomes sharply narrowing towards the end, forming segments composed of cells differing in lengths of lateral walls. Some trichomes ending with a thin, colourless hair. Cells of older filaments slightly cut by cross-walls. Basal heterocytes semicircular, wider than long (7.2–12.1 µm wide, 5.4–10.2 µm long). Sheaths brown-olive-yellow in older filaments, but colourless, slightly layered in young ones. Young filaments (hormogonia?) equinarrow or sometimes irregularly narrowing in middle parts. Lack of heterocysts at the ends of filaments. Cells of young trichomes two or three times wider than long, distinctly cut by cross-walls. Cross-walls usually flat, sometimes concave or slightly convex, lateral cells convex. The species was collected from eroded hollows and surface covered with stagnant water. Recorded in habitat type 2, *i.e.* in mesotrophic moist moss tundra composed of the *Calliergon sarmentosum* community, *Tetraplodon mnioides* community and *Saxifraga hyperborea–Ranunculus spitsbergensis* community.

Calothrix gypsophila (Kützing) Thuret 1875

Fig. 4 (1–4)

Dichothrix gypsophila (Kützing) Bornet *et* Flahault, *Dichothrix compacta* (Ag.) Bornet *et* Flahault

Spherical thalli of white-yellow-olive to white-brown colour, settled on stones and moist rocks in shallow lakes, ponds and outflowing leakages. Spheres of the diameter of about 3–7 mm. Filaments gradually widening towards the base.

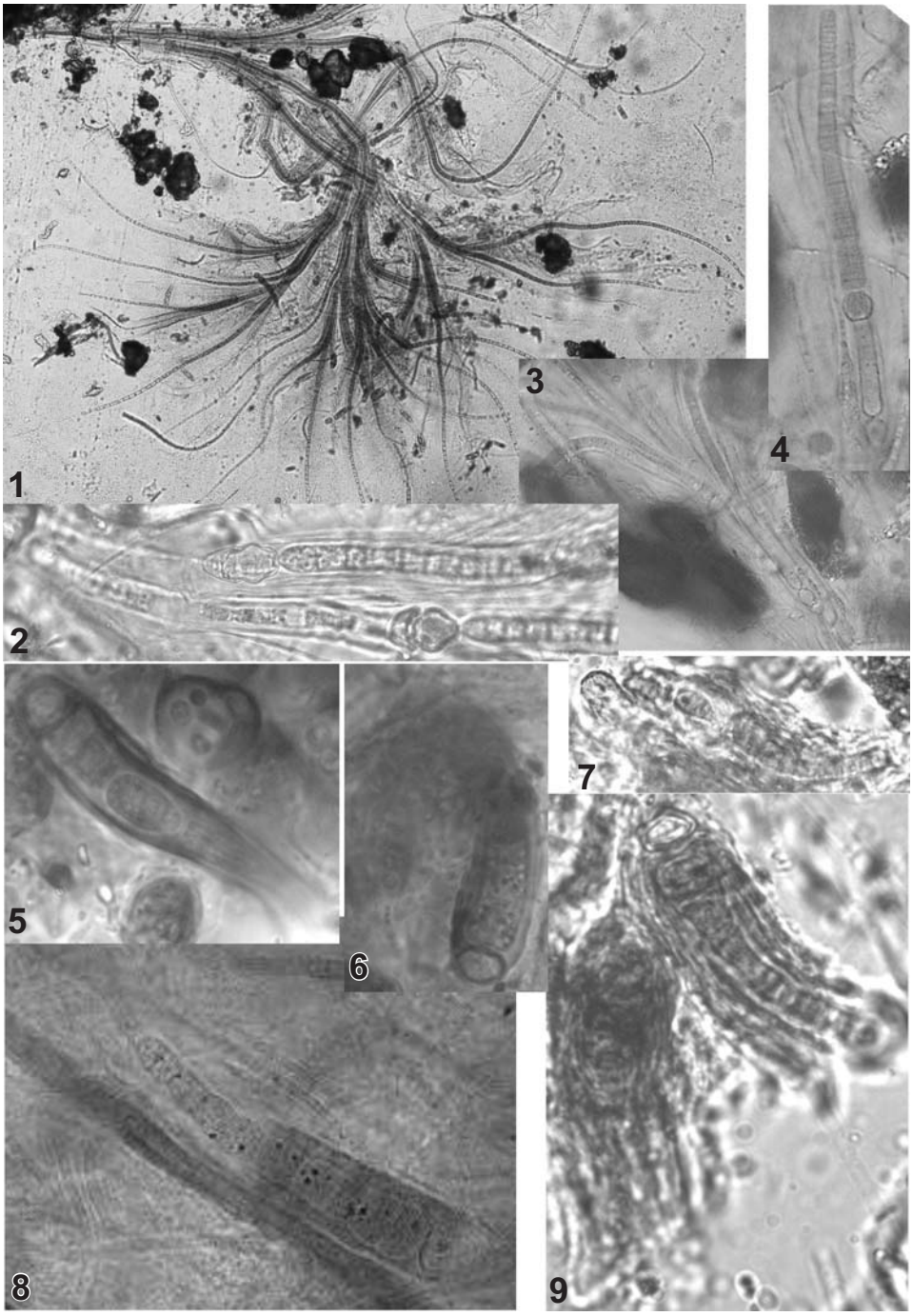

Fig. 4. Cyanoprokaryota. 1–4 *Calothrix gypsophila* (Kützing) Thuret, 5–9 *Calothrix* cf. *fusca* (Kützing) Bornet *et* Flahault.

Branches abundant, forming bushy clusters. Sheaths olive-yellow, layered, funnel-shaped widening towards the top, sometimes include 2–4 trichomes. Trichomes not cut by cross-walls, 8.6–10 µm wide at the base, 7.6–7.8 µm wide at the middle part, ending with a long, colourless hair. Basal heterocytes, single or double, semicircular or conoidal, longer than wide, (12–23.6 µm wide, 8–10.5 µm long). Sometimes trichomes create elongated spores surrounded by thick, wavy membrane. Recorded in habitat types 2, 5 and 8.

Chlorogloea purpurea Geitler 1928

Fig. 5 (1–3)

Microscopic colonies (28–35 µm wide, 29–54 µm long), small, oval or rounded, flat or dome-like erected, mucilage homogenous, reddish. Cells rounded or slightly elongated, 1.6–2.7 µm in diameter, purple or red-violet, densely clustered. Occurred in habitat type 8 *i.e*. in shallow mesotrophic pond (50–60 cm deep, area of 3 × 7m), periodically drying (filled with snow-melting water, from mid June till mid July). The bottom of this pond was stony, cracks of the stones were filled with silt. Pond edge was overgrown with compact turf composed of *Bryum* sp. Material was collected from moss turfs and lamellar thalli of *Nostoc commune* periodically floating on water surface, as well as from silt on the stony bottom.

Chondrocystis* cf. *dermochroa (Nägeli) Komárek *et* Anagnostidis 1995

Fig. 3 (1–3)

Gloeocapsa dermochroa Nägeli 1849

Small colonies, oval or slightly irregular, composed of many fine subcolonies (6.1–11.4 µm in diameter), comprising 2–8 cells, surrounded with olive, brown, smooth or slightly layered gelatine. Cells oval or rounded, blue-green, 1.6–2.3 µm in diameter, with granularities inside. Occurred in habitat types 5, 6 and 8.The species was found at the same site as *Chlorogloea purpurea* (8) and in oligotrophic moist and dry *Saxifraga oppositifolia* community.

Geitlerinema acutissimum (Kufferath) Anagnostidis 1989

Oscillatoria acutissima Kufferath 1914; *Phormidium acutissimum* (Kufferath) Anagnostidis *et* Komárek 1988

Trichomes solitary, blue-green, straight, 2.4–2.7 µm wide, motile, not constricted or slightly constricted at cross-walls, not attenuated apically, but unexpectedly curved at an obtuse angle. Cells 3–6.5 µm long, sometimes with granularities at cross-walls. Found in habitat type 8: in lakes, ponds and shallow pools.

Gomphosphaeria natans Komárek *et* Hindák 1988

Fig. 5 (6–7)

Colonies solitary, freely swimming, irregularly spherical or slightly elongated, 19.0–19.8 µm wide, 21.6–23.2 µm long, surrounded with clear or spreading mucilage, not layered. Cells inversely egg-like or heart-shaped, indented at the top,

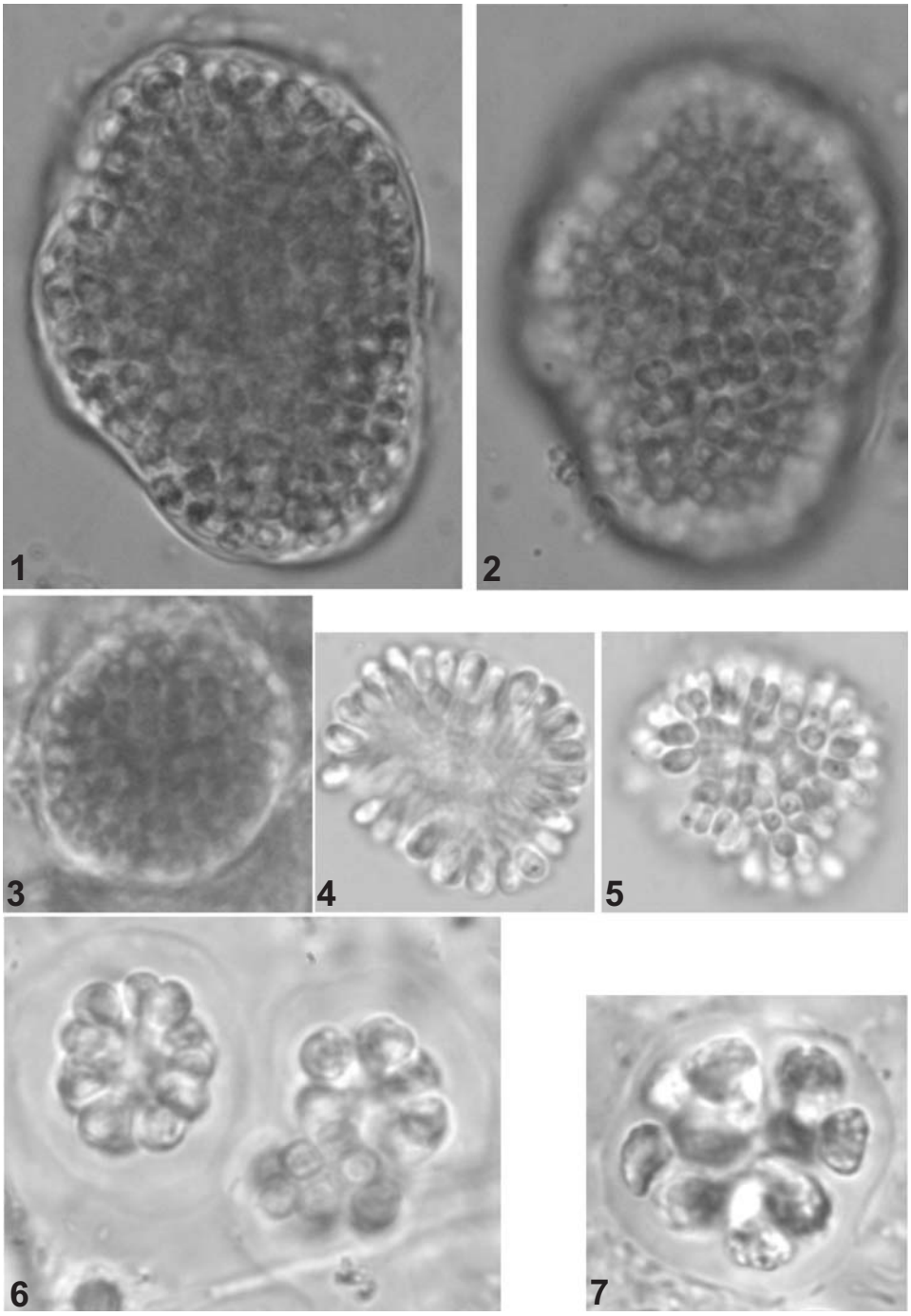

Fig. 5. Cyanoprokaryota. 1–3 *Chlorogloea purpurea* Geitler, 4–5 *Snowella lacustris* (Chodat) Komárek *et* Hindák, 6–7 *Gomphosphaeria natans* Komárek *et* Hindák.

grey-blue or olive-green, 4.5–6.8 µm long, 3.5–6.2 µm wide, placed on gelatinous, branched stalks. Cell inside homogenous. Occurred in habitat type 1: in moist logged surfaces, up to 20 cm deep, among turfs of *Paludella squarosa*, on thalli of laminar *Nostoc commune* and on other blue-green algae with crusty thalli. Also found in habitat type 2: eutrophic and mesotrophic moist moss-tundra on eroded surfaces with bare peat with stagnant water as well as in eutrophic moist moss-tundra composed of the *Calliergon sarmentosum* community and *Tetraplodon mnioides* community, among gelatinous thalli stuck together from filaments of *Phormidium autumnale* and *Prasiola crispa*. Algae were collected from small hollows filled with water, periodically dry.

Komvophoron constrictum (Szafer) Anagnostidis *et* Komárek 1988

Oscillatoria constricta Szafer 1911; *Pseudanabaena constricta* (Szafer) Lauterborn 1915

Trichomes solitary, bright blue-green, straight or slightly curved, motile, 3.5–6.4 µm wide, deeply constricted at the cross-walls. Cells cylindrical, constricted in the middle part, inhomogeneous, with a few small granules and distinctly brighter line running through the middle of the whole trichome, 2.5–5.2 µm long. Found in habitat type 2 and 8.

Komvophoron groenlandicum Anagnostidis *et* Komárek 1988

Trichomes solitary, curved, quite short – 70–180 µm long, 2.8–3.2 µm wide, deeply constricted at the cross-walls. Cells blue-green, rounded or oval, homogeneous. Found in habitat type 2: mesotrophic moist moss-tundra. The species is known also from one lake in Greenland (Komárek J., Anagnostidis K. 2000).

Komvophoron minutum (Skuja) Anagnostidis *et* Komárek 1988

Pseudanabaena minuta Skuja 1948

Trichomes solitary, short, motile, grey-blue, 2.2–2.6 µm wide, deeply constricted at the cross-walls. Cells content nearly homogeneous or granulated, 0.5–1.5 × longer than wide, 1.9–3.8 µm long, spherical or cylindrical, apical cells rounded, without calyptra. Found in habitat type 1 and 8.

Leptolyngbya* cf. *foveolarum (Rabenhorst ex Gomont) Anagnostidis *et* Komárek 1988

Fig. 6 (1–6)

Phormidium foveolarum Gomont 1892; *Lyngbya foveolarum* Hansgirg 1892; *Phormidium foveolarum* f. *maior* Elenkin 1915

Thallus dark-green or blue-green, gelatinous. Filaments straight or slightly curved. Trichomes 0.9–1.6 µm wide, constricted at the cross-walls, without any granulation at the cross-walls. Sheaths thin, colourless, gelatinous, delicate and poorly visible. Cells oval or rounded, shorter or longer than wide, 0.7–1.8 µm long, homogenous. Apical cell rounded, without calyptra. Filaments occur individually among other algae, do not create thallus. Found in habitat types 1, 5, 8 and 10. Spe-

cies occurs in habitats varying in moisture and trophic conditions, from oligotrophic to strongly eutrophic, supplied with effluents rich in nitrogen from birds colonies. It was present on cliff walls intensively sprinkled with water, among water mosses. Also found in an oligotrophic lake in the alpine valley Revdalen: in plankton and in sediments on stones.

Leptolyngbya glacialis (W. West *et* G.S. West) Anagnostidis *et* Komárek 1988

Phormidium glaciale W. West *et* G.S. West 1911; *Phormidium glaciale* f. *longiarticulata* Wille 1928

Thallus thin, bright blue-green. Filaments densely plaited, curved, sheaths spreading. Trichomes 0.8–1.1 µm wide, constricted at the cross-walls, not attenuated at the ends. Cells 0.9–1.8 µm long, apical cell rounded. The species was described from stagnant freshwaters in Antarctica (Komárek and Anagnostidis 1999) and Alaska (Kole 1942). In the present study it was found in habitat types 5 and 10.

Leptolyngbya margaretheana (Schmid) Anagnostidis *et* Komárek 1988

Lyngbya margaretheana Schmid 1914

Filaments solitary, straight. Sheaths colourless, delicate, thin. Trichomes blue-green, 0.9–1.5 µm wide, not constricted at the cross-walls, not attenuated at the top. Cells almost square or up to two times longer than wide, 1.1–2.8 µm long, two shiny granules visible in cells at the cross-walls. Found in habitat type 2. The algae were collected on eroded peat surface covered with water.

Leptolyngbya treleasii (Gomont) Anagnostidis *et* Komárek 1988

Phormidium treleasii Gomont 1899, *Lyngbya treleasii* (Gomont) Compére 1974

Thallus olive-green or blue-green. Filaments straight, regularly arranged in thallus or solitary. Sheaths thin, delicate, colourless, poorly visible. Trichomes blue-green, delicate, thin, 0.5–0.7 µm wide, not constricted at the cross-walls, not attenuated at the top. Cells rectangular, up to 8 x longer than wide, 2.4–4.9 µm long. Apical cells rounded, without calyptra. Found in habitat types 1, 3, 4 and 10.

Leptolyngbya valderiana (Gomont) Anagnostidis *et* Komárek 1988

Phormidium valderianum Gomont 1892; *Lyngbya valderiana* (Gomont) Compére 1974; *Phormidium valderiae* (Delponte) Schmidle 1901

Thallus thick, green to yellow-green. Filaments tangled, dense. Sheaths thin, stable, gelatinous, colourless. Trichomes blue-green, not constricted at the cross-walls, not attenuated at the top, 1.9–2.3 µm wide. Cells up to three times longer than wide, 3.5–6.4 µm long, with one or two granules on either side of cross-walls. Apical cells rounded, without calyptra. Known from a lake in Antarctica (Starmach 1995). During the present study found in habitat type 5: moist *Saxifraga oppositifolia* community.

Leptolyngbya voronichiana Anagnostidis *et* Komárek 1988

Phormidium tenuissimum Voronichin 1930; *Lyngbya delicatula* Compére 1985

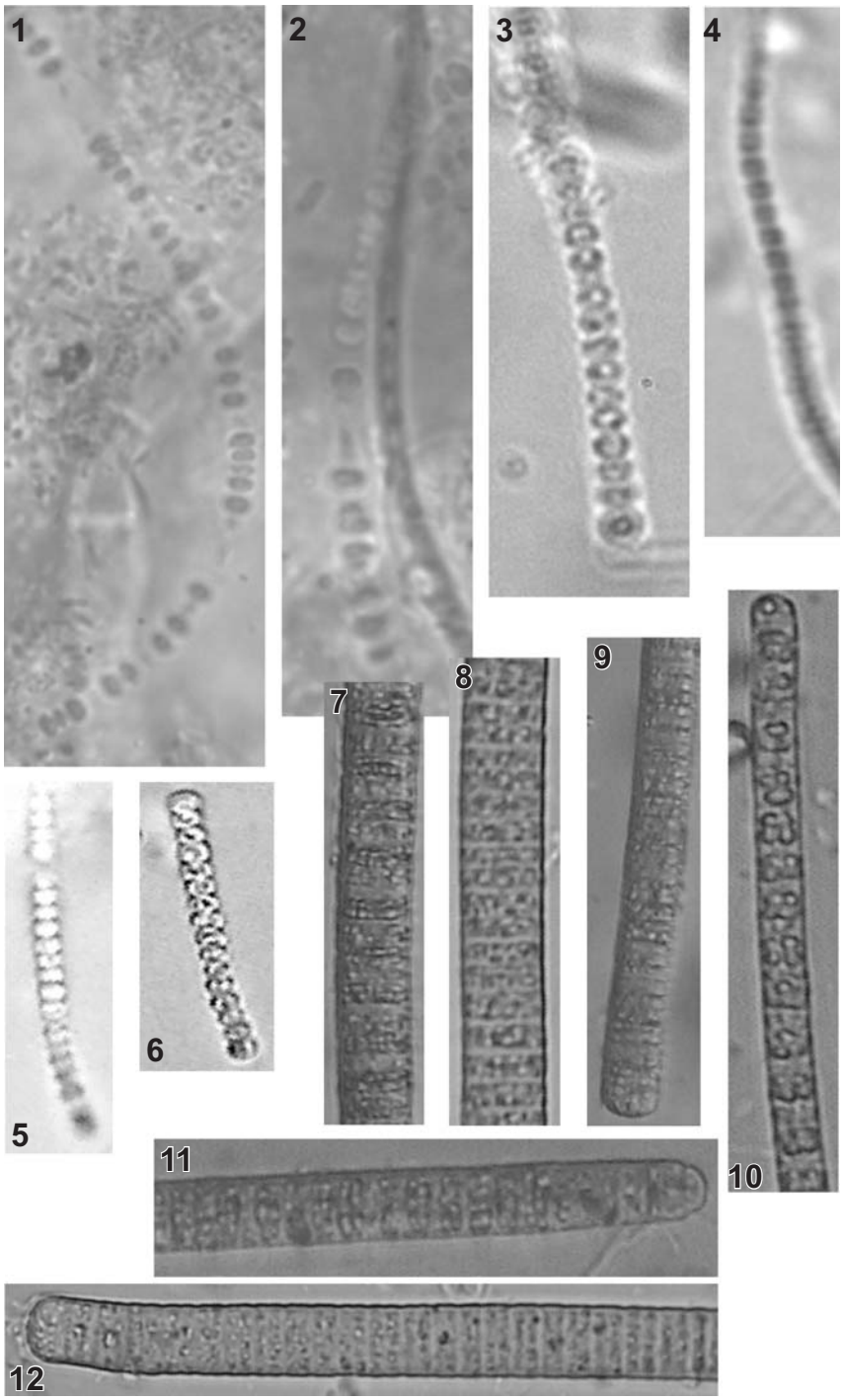

Fig. 6. Cyanoprokaryota. 1–6 *Leptolyngbya* cf. *foveolarum* (Rabenhorst ex Gomont) Anagnostidis *et* Komárek, 7–12 *Oscillatoria sancta* Kützing ex Gomont.

Filamensts curved, sheaths very thin, delicate, colourless, poorly visible. Trichomes 0.8 µm wide, not constricted at the cross-walls, not attenuated at the top. Cells rectangular or cylindrical, 1.6–1.8 µm long, homogenous. Found in habitat types 2 and 5, epiphytic on colonies of *Nostoc commune*.

Limnothrix guttulata (Van Goor) Umezaki *et* M. Watanabe 1994

Oscillatoria guttulata Van Goor 1918

Trichomes solitary, curved, pale blue-green, 3.4–4.2 µm wide, not constricted at the cross-walls, not attenuated at the top. Cells quadrate or a bit longer than wide, 3.5–5.2 µm long, with scattered aerotopes, that causes the cell looks like filled with big granules. Apical cells rounded, without calyptra. Found in habitat types 1, 6 and 8.

Limnothrix redekei (Van Goor) Meffert 1988

Fig. 7 (1–11)

Oscillatoria redekei Van Goor 1918

Trichomes solitary, straight, do not create thallus, pale blue-green, 1.5–2.9 µm wide, slightly constricted at the cross-walls, not attenuated at the top. Cross-walls poorly visible. Cells longer than wide, 6.2–12.5 µm long. Inside, the cells filled with gas vesicles, that may be fine, spherical, placed by the cross-walls or randomly distributed. However, in most of trichomes gas vescicles are large, irregularly shaped, arranged by 2 in a cell, at cross-walls. Apical cells rounded, without rounded calyptra. Found in habitat type 5: moist *Saxifraga oppositifolia* community on periodically flooded surfaces, up to 5 cm in depth.

Lyngbya aestuarii Liebman ex Gomont 1982

Thallus thin, dark green or olive-green. Filaments straight or curved, 16–28 µm wide. Sheaths wide, yellow-bronze, layered, uneven on the surface. Trichomes blue-green, 10–18 µm wide, not constricted at the cross-walls, that are often granulated. Cells shorter than wide, 3.5–7.2 µm long. Apical cells flat or rounded, without calyptra, with thickened outer membrane.

The species is generally known to occur in polar areas (Starmach 1995). In the present study found in habitat type 8: lakes, ponds and shallow pools.

Oscillatoria sancta Kützing ex Gomont 1892

Fig. 6 (7–12)

Lyngbya sancta (Kützing) ex Hansgirg 1892

Thallus dark blue-green, thin, gelatinous. Trichomes blue-green, 7.9–16.3 µm wide, straight, not constricted but slightly attenuated at the cross-walls. Cells shorter than wide, 2.2–5.3 µm long, with distinct granulation at the cross-walls. Apical cells rounded, with thickened outer membrane. Previously reported by Starmach from Antarctic lakes (1995). During the present investigation found in habitat type 8.

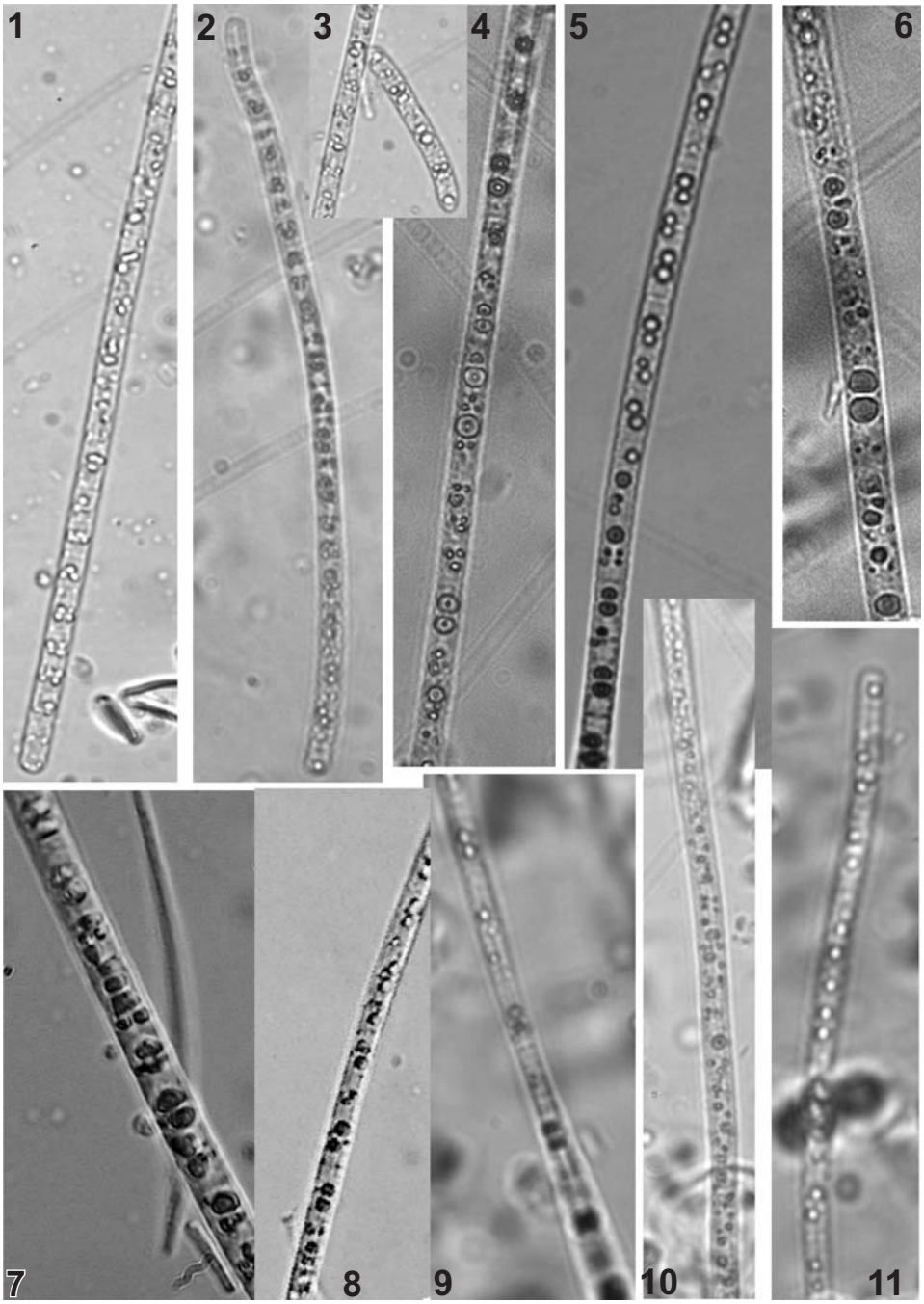

Fig. 7. Cyanoprokaryota. 1–11 *Limnothrix redekei* (Van Goor) Meffert.

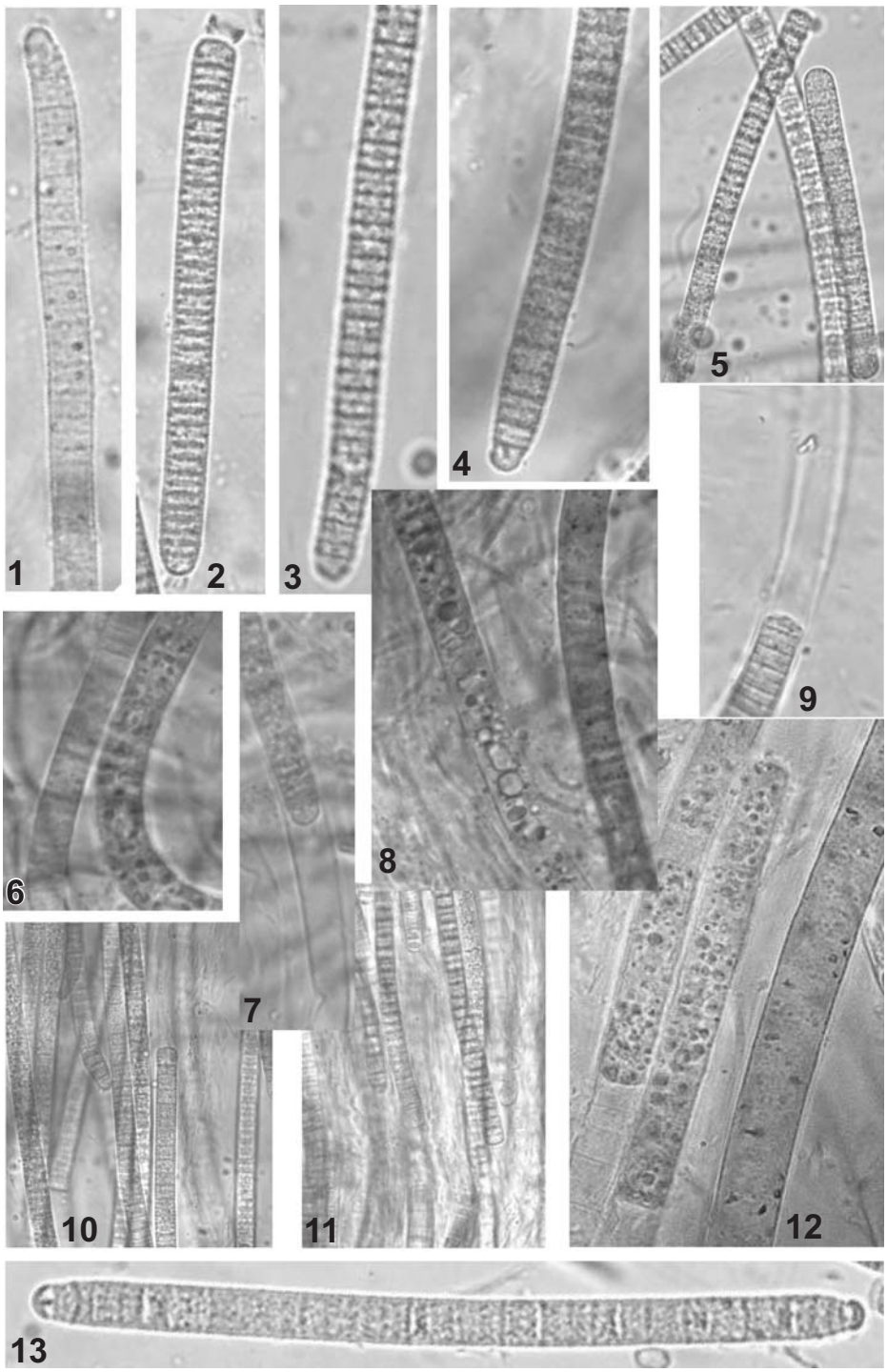

Fig. 8. Cyanoprokaryota. 1–13 *Phormidium autumnale* (Agardh) Trevisan ex Gomont.

Phormidium autumnale (Agardh) Trevisan ex Gomont 1892

Fig. 8 (1–13)

Phormidium membranaceum Kützing ex Gomont 1892, *Phormidium autumnale* var. *minus* Gardner 1927, *Lyngbya autumnalis* (Agardh) ex Bourrelly 1970, *Lyngbya antliaria* (Mertens in Jürgens) Hansgirg ex Hansgirg 1892, *Phormidium pannosum* Kützing ex Gomont 1892

Thallus packed, dark blue or dark blue-green to red-violet, delicate, silky, gelatinous. Trichomes straight, not indented by cross-walls, sometimes hooked at the top. Cross-walls clearly visible; cells of some trichomes divided by an incomplete cell wall. Trichomes 4.6–7.7 µm wide, cells shorter than wide (1.6–3.9 µm long), sometimes granulations visible by cross-walls. In some trichomes large, irregular, olive granulations may be observed. Top cell rounded with conoidal or rounded calyptra. Found in habitat type 1, 2, 3, 10 and 11. The species is strongly nitrophilous, in habitats 1 and 10 (richest in nitrogen) it dominated, creating large spread thallus.

Pseudanabaena biceps Böcher 1946

Trichomes short, composed of 15–25 cells, solitary, straight, strongly constricted at the cross-walls, 2.5–2.8 µm wide. Cells cylindrical, longer than wide, blue-green. Cell content inhomogeneous, brighter line through the middle of the cell. Apical cells conical, sharpened. Found in habitat type 8: lakes, ponds and shallow pools.

Schizothrix calcicola Gomont 1892

Oscillatoria calcicola Agardh 1812; *Leptothrix calcicola* Kützing 1943; *Lyngbya calcicola* Agardh ex Hansgirg 1892

Thallus thin, a bit rindy at older age, dark blue-green. Filaments plaited, poorly branched. Sheaths colourless, uneven outside, distinct, slightly layered. Trichomes solitary, sporadically two in the sheath, 0.8–1.7 µm wide, not constricted, with granulations. Found in habitat types 1, 2, 4, 5 and 8.

Schizothrix fragilis Kützing ex Gomont 1892

Sheaths colourless, spreading, uneven outside. Filaments curved, arranged parallelly, collected in wisps. Trichomes pale blue-green, from a few to around dozen in each sheath, constricted at cross-walls, cells 1.4–2.5 µm wide, 1–2.5 µm long. Found in habitat types 1, 4, 5 and 8.

Scytonema subtile Moebius 1892

Filaments solitary, 12–18 µm wide, branched. Sheaths colourless, parallelly layered. Trichomes 2–6 µm wide. Cells in the middle part of filament quadrate or elongated, at the ends shorter than wider. Heterocyte quadrate or elongated. Found in habitat type 2.

Siphononema polonicum (Raciborski) Geitler 1925

Fig. 9 (4)

Pleurocapsa polonica Raciborski 1910

Thallus olive-bronze or brown, about 30 µm wide, up to 95 µm long, consisting of 3–4 straightened filaments, created by solitary cylindrical or cubic cells. Thallus may also be composed of multi-rowed short filaments, covered with thick, brown sheaths, sometimes similar to species of genus *Gloeocapsa*. Cells spherical, oval or a bit flattened, up to 7.3 µm in diameter without sheaths. Found in habitat type 5: moist *Saxifraga oppositifolia* community.

Stigonema hormoides (Kützing) Bornet ex Flahault 1887

Thallus composed of curved, plaited and branched filaments. Filaments composed of one row of spherical or oval cells, older filaments sometimes two- or multi-rowed. Side filaments as thick as main filaments, 8.9–13.4 µm wide. Heterocytes intercalar, oval or a bit flattened. Sheaths thick, colourless or yellowish. Found in habitat type 2.

Symplocastrum penicillatum (Kützing ex Gomont) Anagnostidis 2001

Schizothrix penicillata Kützing ex Gomont 1892

Thallus thin, delicate, soft, green-blue. Sheaths colourless, wide, spreading, uneven on the edges, a bit layered. Filaments composed of single trichomes or placed by 2–3 in a common sheath. Trichomes straight or slightly curved, dark green-blue to blue, not constricted at the cross-walls, 2.6–4.7 µm wide. Cells shorter or up to 1.5 times longer than wide, 2.5–5.5 µm long, irregularly granulated. Top cell a bit rounded. Found in habitat type 5 and 8.

Tolypothrix conglutinata Borzi 1879

Fig. 9 (1–3)

Filaments 15–16 µm wide, branched, sheaths colourless, not layered, locally winded. Trichomes 8.5–9 µm wide, blue-green, a bit constricted at the cross-walls. Cells shorter than wide, 6.8–8.7 µm long, visible granulations inside. Heterocytes spherical, solitary, 8.2–10.5 µm in diameter. Found in habitat type 3 and 8.

Tolypothrix tenuis Kützing 1843

Filaments abundantly branched, solitary branches oriented at the same direction as main filament. Sheaths narrow, colourless, spreading at the ends of trichomes. Trichomes 5.6–7.5 µm wide, blue-green, not constricted or only slightly constricted at the cross-walls. Cells quadrate or a bit shorter than wide, 5.2–7.9 µm long, heterocytes rounded, oval, cylindrical or rectangular, solitary or a few together. Found in habitat type 5. Algae were collected from soil surface, stones and sand.

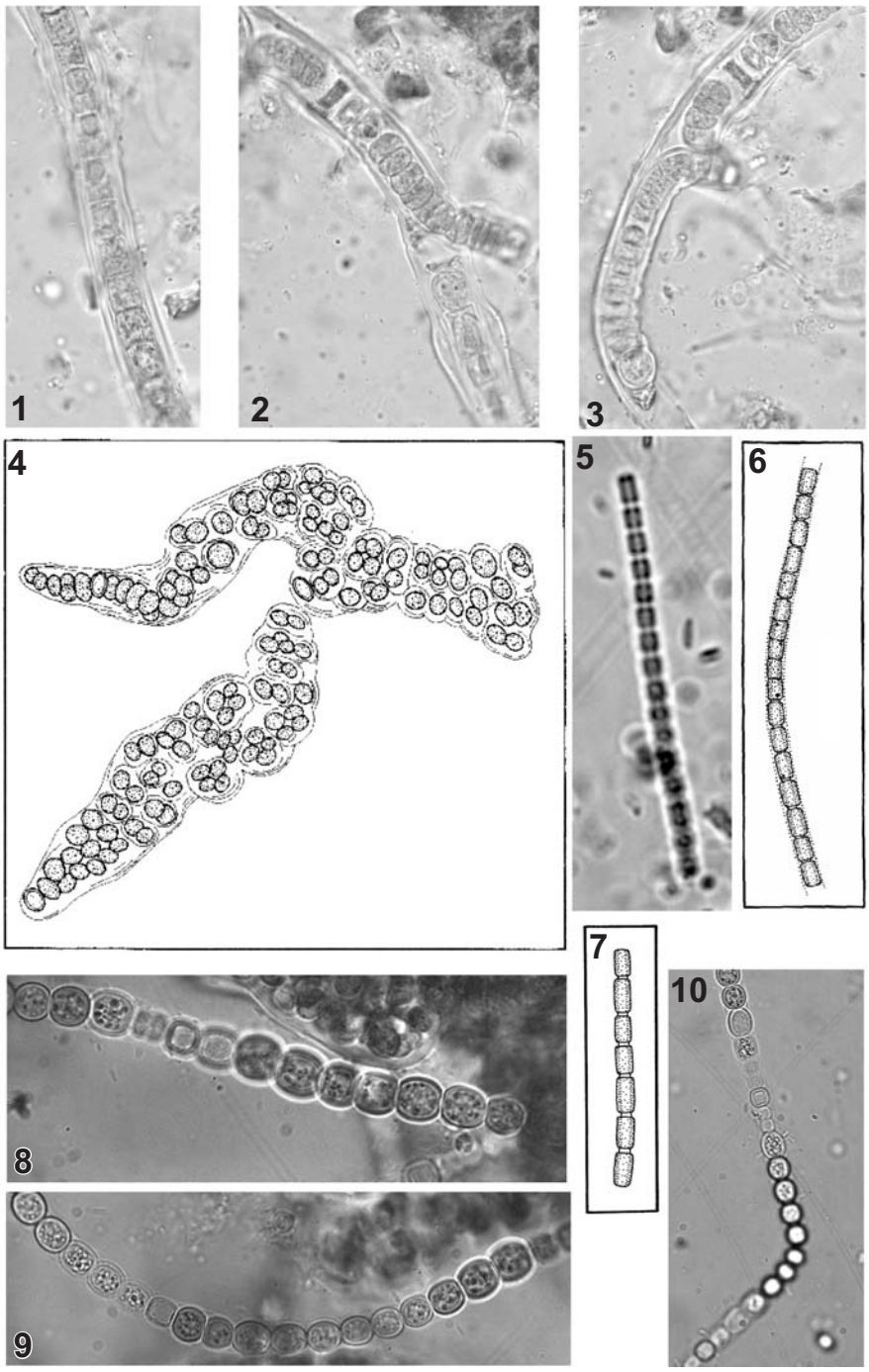

Fig. 9. Cyanoprokaryota. 1–3 *Tolypothrix conglutinata* Borzi, 4 *Siphononema polonicum* (Raciborski) Geitler, 5–7 *Pseudanabaena frigida* (Fritsch) Anagnostidis, 8–10 *Trichormus variabilis* (Kützing) Komárek *et* Anagnostidis.

Trichormus variabilis (Kützing ex Born. *et* Flah.) Komárek 1989

Fig. 9 (8–10)

Anabaena varabilis Kützing ex Born. *et* Flah. 1886

Trichomes solitary, without sheaths. Vegetative cells 2.5–3.5 µm wide, 3–3.8 µm long. Heterocytes solitary, intercalary, rounded or slightly oval, 3.5–4.5 µm wide, 4.2–5.5 µm long. Spores oval or elliptical, arranged by a few together, without any connection with heterocytes, 3.8–4.8 µm wide, 5.8–7.2 µm long. Found in habitat type 14: community of *Saxifraga cespitosa* and *Deschampsia borealis*. Samples were collected from soil and turf composed of dominant mosses.

Tychonema bornetii (Zukal) Anagnostidis *et* Kamárek 1988

Lyngbya bornetii Zukal 1894; *Oscillatoria bornetii* (Zukal) Forti 1907

Trichomes straight or a bit curved, 10.5–12 µm wide, not constricted or slightly constricted at the cross-walls, surrounded with thin and delicate sheaths, often invisible. Cells shorter than wide or as long as wide, 5.5–11.4 µm long, with clear, abundant granulation at the cross-walls. Top cell rounded, with distinctly thickened outer membrane. Found in habitat type 6: dry *Saxifraga oppositifolia* community.

Chlorophyceae

Borodinellopsis texensis Dykstra 1971

Fig. 10 (5–10)

Cells solitary or packed in tetraedric groups, sometimes clustered to form big complexes. Cells spherical or ellipsoidal; in large colonies, because of mutual pressure, polygonal, 15.6–24.7 µm in diameter. Cell wall thin, not gelatinous. One central chromatophore, dark green, radiating, with one big, centrally placed pyrenoid. Found in habitat types 12 and 13, situated 6–80 m from a giant colony of guillemots nesting on rocky cliffs.

Excentrosphaera viridis Moore 1901

Fig. 10 (1–4)

Cells solitary, oval, ellipsoidal or irregular, 62–65 µm long, 31.5–32 µm wide, cell wall thin, on the shorter side of the cell usually converting into short or long and layered petiole. Chromatophores numerous, lamellar, with pyrenoid, densely packed in the cell. Autospores spherical, not big, up to 2 µm in diameter. Found in habitat type 16: algae collected on soil and moss surface.

Keratococcus mucicola (Hust.) Hindak 1977

Fig. 11 (9–13)

Dactylococcopsis mucicola Hust 1909; *Ankistrodesmus mucicola* (Hust.) Teil. 1944

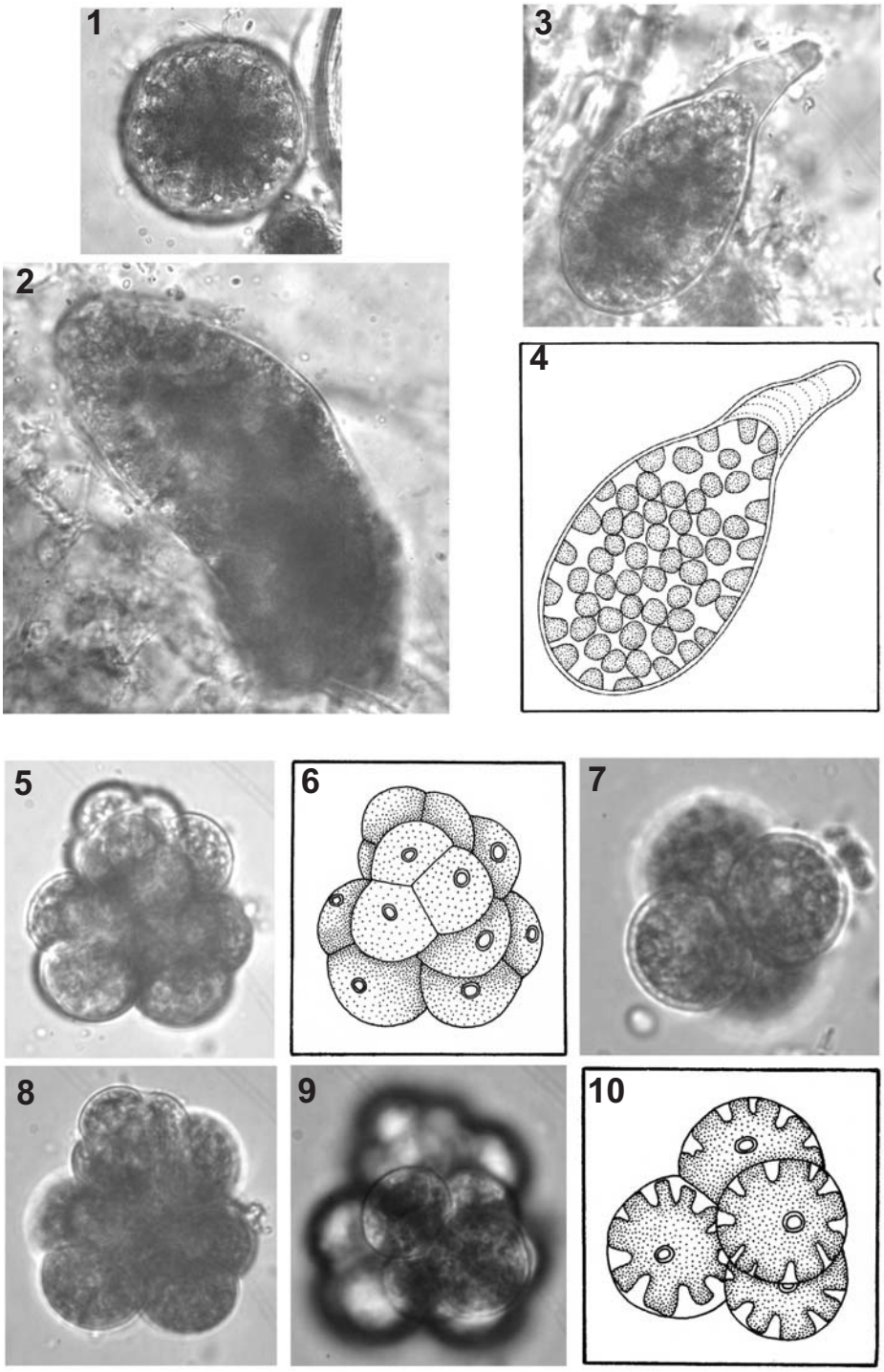

Fig. 10. Chlorophyta. 1–4 *Excentosphaera viridis* Moore, 5–10 *Borodinellopsis texensis* Dykstra.

Cells elongated, tear or diamond-shaped, variably curved, usually sharp-ended, 9–16 µm long, 2.5–3 µm wide. Chromatophore solitary, centrally placed, with one pyrenoid. Cells arranged densely in well visible colourless mucilage. Colonies patchy, branchy, of different shapes. Found in habitat type 1: eutrophic moist moss-tundra.

Prasiola crispa (Lightf.) Meneghini 1838

Fig. 12 (1–8)

Hormidium parietinum Kützing; *Schizogonium crispum* Gay; *Gayella polyrhiza* Kold.-Rosenvinge 1893, Pankow 1971

Thallus in variable forms, in the young phase cells may be solitary or set in small packets, also may form flat filaments composed of one row of cells, surrounded with a very thick wall. Older thallus composed of a few parallel rows, flat filaments or widespread thallus built from regular fields consisting of four cells or arranged in square to rectangular blocks. Young cells surrounded with quite thick, not gelatinous cell wall, in older cells the wall is a bit thinner. Chromatophore solitary, stellate, with centrally placed pyrenoid. Cells solitary, 12.5–13.4 µm in diameter, cells forming a filament 5–9.5 µm wide, up to two times shorter than wide. Occurrs in nitrogen-rich, polluted by birds colonies, together with *Borodinellopsis texensis.* Found in habitat types 1, 2, 3, 4, 10, 11, 12, 13 and 14.

Prasiola fluviatilis (Sommerfeld) Areschoug 1866

Fig. 12 (9–10)

Thallus delicate, lobed, dark-green attached to the basis. Edges of thallus strongly crimped. Cells creating thallus square, 4.6–6.2 µm wide. In a marginal part of thallus cells arranged in rows, while in the middle part they create areas of 4–8 and more cells. Found in habitat type 7.

Scotiellopsis terrestris (Reisigl) Punčoch. *et* Kalina 1981

Fig. 11 (5–8)

Scotiella terrestris Reisigl 1964; *Scotiellocystis terrestris* (Reisigl) Fott 1976

Cells lemon-shaped, sharply ended tops oriented in opposite directions. On cell surface 6–8 (10) prominently sticking ribs, connecting the two poles of the cell. Chromatophore small, spherical or elongated, one pyrenoid, big and distinct. Cell 26–28 µm long, 16–18 µm wide. Found in habitat types 1 and 5.

Trochiscia granulata (Reinsch) Hansg. 1888

Fig. 11 (3–4)

Acanthococcus granulatus Reinsch 1886

Cells solitary, spherical, 21–23.5 µm in diameter, cell membrane with distinct sculpture, granulated, covered with small lumps. Found in habitat types 2, 4, 7, 8 and 15.

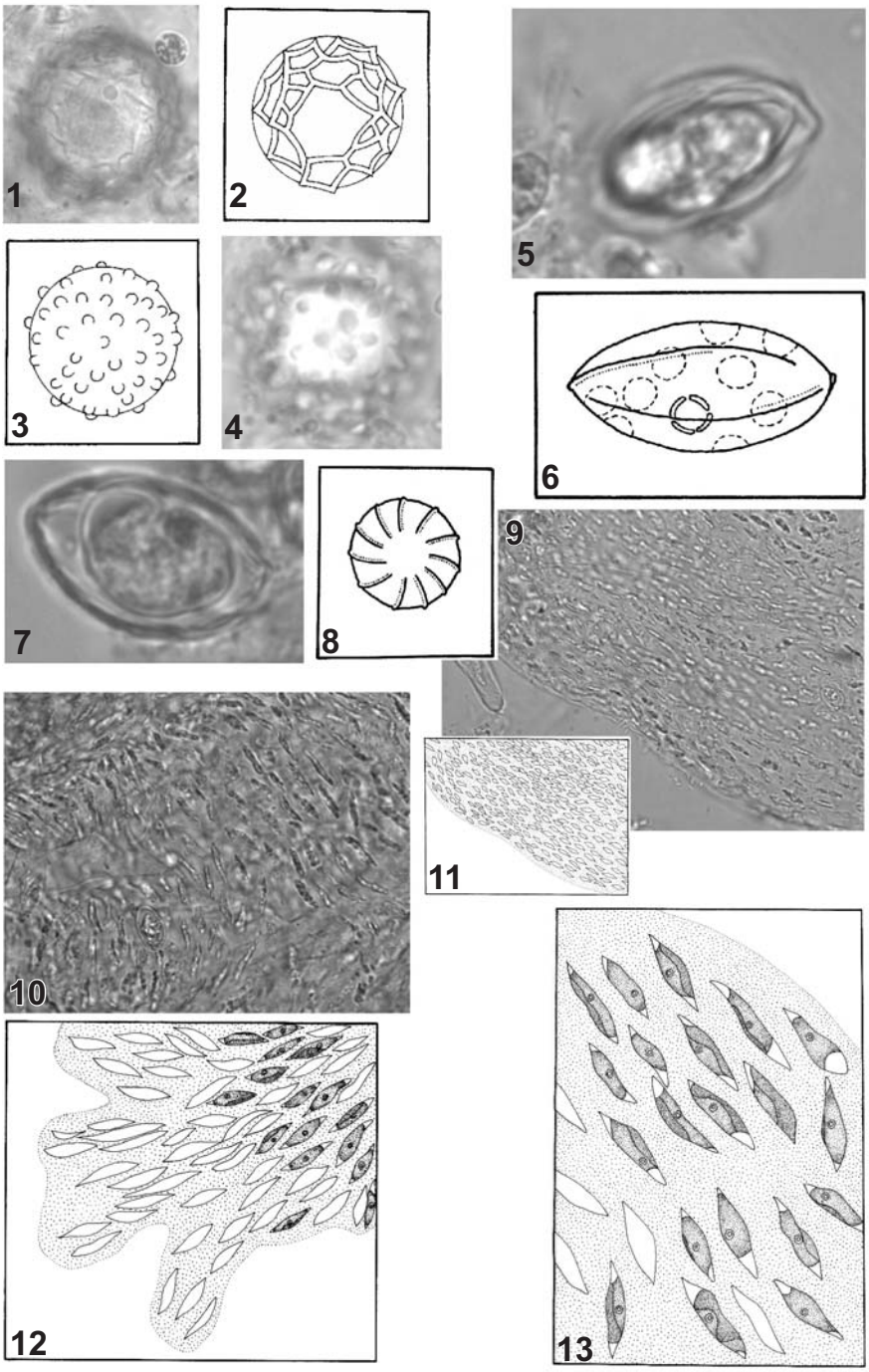

Fig. 11. Chlorophyta. 1–2 *Trochiscia prescottii* Sieminska, 3–4 *Trochiscia granulata* (Reinsch) Hansg. *sensu* Croasd., 5–8 *Scotiellopsis terrestris* (Reisigl) Punčoch. *et* Kalina, 9–13 *Keratococcus mucicola* (Hust.) Hind.

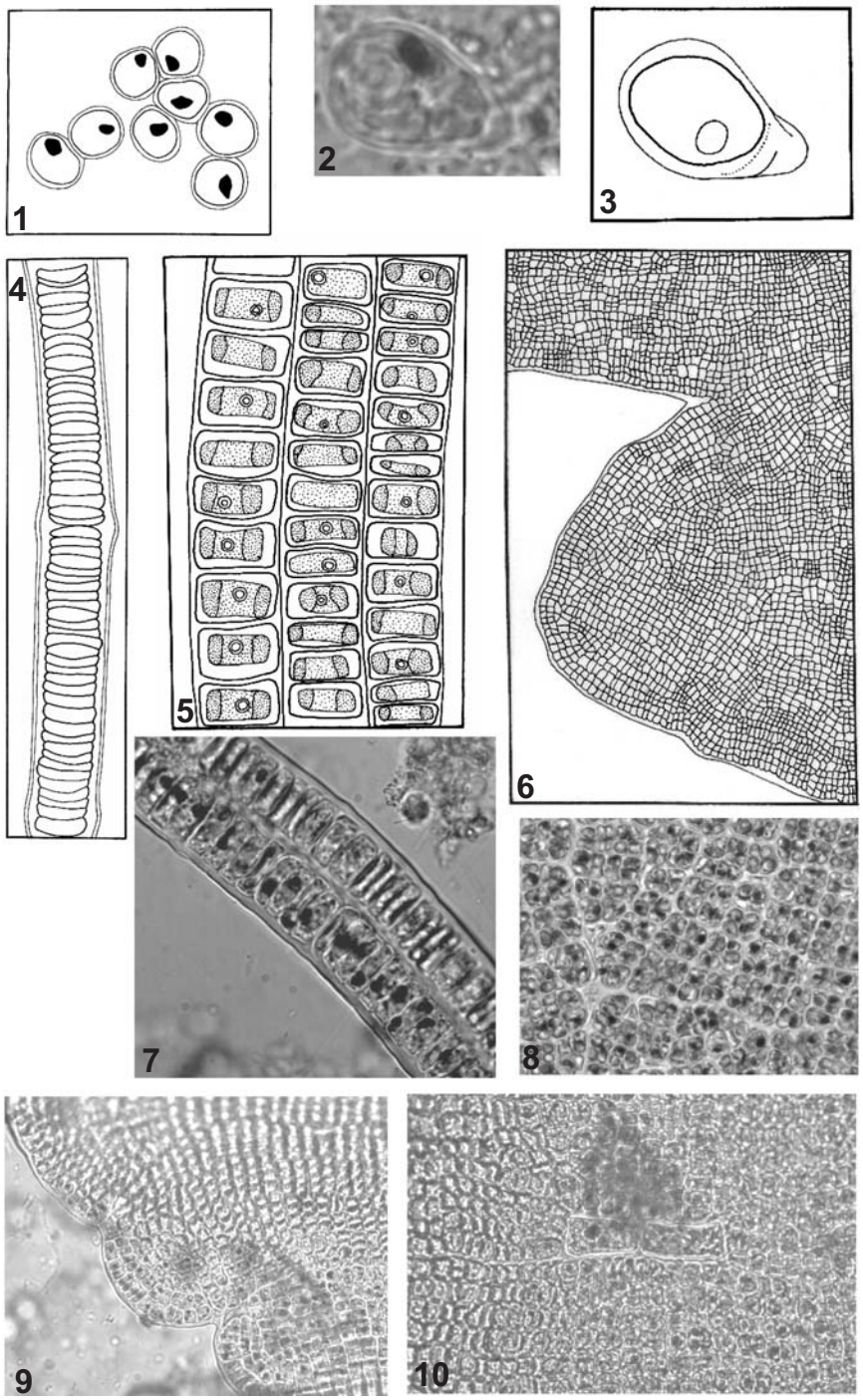

Fig. 12. Chlorophyta. 1–8 *Prasiola crispa* (Lightf.) Menegh., 9–10 *Prasiola fluviatilis* (Sommerfeld) Areschoug.

Trochiscia aciculifera (Lagerh.) Hansg. 1888

Cells solitary, spherical or a bit flattened, 19–19.5 µm in diameter. Cell membrane with a distinct sculpture (sharp spikes up to 2 µm long). Chromatophore patchy with one pyrenoid. Found in habitat type 4 and 15.

Xantophyceae

Chlorobotrys regularis (W. West) Bohlin 1901

Chlorococcum regulare W. West 1892

Colonies oval, surrounded with quite well visible gelatin, soft and layered. Colony made by 8–16 cells, arranged in groups of two. Cells spherical, surrounded with a strong membrane, about 14.5–15.0 µm in diameter. Two gutter-like chromatophores, small drops of fat in cells. In gels of old colonies, thorn walls of maternal cells visible near young descendant cells (autospores). Found in habitat type 8 and 10: algae collected on stony surfaces.

Chlorobotrys simplex Pascher 1939

Colonies composed of two cells, surrounded with soft, colourless, spreading gelatin, oftenwidely layered. Cells spherical or a bit flattened, 3.8–4.1 µm in diameter. Chromatophore one, at the wall, bowl-shaped, occupying the bigger part of the cell. Small drops of fat in protoplasm. The remains of indigenous cell membranes visible in gelatine surrounding the colonies. Found in habitat type 1: eutrophic moist moss-tundra.

Chlorocloster pyreniger Pascher 1939

Cells spindle-shaped, straight or curved, bulging at one side, 18.5–24 µm long, 6.3–7.2 µm wide. Cell membrane thin, gelatinous. Chromatophore one, gutter-like, with big pyrenoid. Found in habitat type 1: eutrophic moist moss-tundra.

Conclusions

The study revealed that Cyanoprokaryota and algae flora in the analysed area is rich and diversified. On the different surfaces the vegetation of Hornsund tundra is predominated by unique associations of these organisms, especially of blue-green algae, in other areas they form, with significant share, associations with mosses and lichens. The domination of these organisms is especially prominent in big areas of Fuglebergsletta plain (raised marine terrace) remote from avian colonies – particularly in the shore zone poor in nitrogen resources. Such conditions enhance the development and high biodiversity of algae (especially blue-greens), and limit the growth of vascular plants. Numerous species of genera *Gloeocapsa, Nostoc, Schizothrix, Tolypothrix, Calothrix, Scytonema*, *Dichothrix* are present there. Also, one

should emphasize the high qualitative and quantitative share of heterocystous, filamentous members of Nostocales (including *Anabaena*, *Calothrix*, *Tolypothrix*, *Scytonema*), capable to fixate free nitrogen. Soils and plants in the analysed areas are supplied with this element and its compounds mainly by blue-green algae that are able to fixate free nitrogen and, in small amount, by atmospheric falls.

The abundant occurrence of vascular plants is most often limited locally to sea-birds colony areas, where habitats rich in organic and mineral nitrogen are present. The sites are located on and below Skoddefjellet, Ariekammen, Fugleberget and Gnalberget slopes. Specific algae communities, including nitrophilous species like *Prasiola crispa*, *Aphanocapsa parasitica*, *Leptolyngbya treleasi*, *Phormidium uncinatum*, *Borodinellopsis texensis* may be found there. Also euryoecious species like green algae of the genera *Chlorella*, *Chlamydomonas* or *Ulothrix*, as well heterokonts of the genus *Tribonema* are present in these areas. On the other hand, heterocytes of blue-green algae are lacking there. Birds guano is the main source of nitrogen in these areas.

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