Algae from aquatic, peat bog, and aerial biotopes in the catchment area of the River Křemelná in Šumava National Park

Řasy z vodních, rašelinných a aerických biotopů v povodí Křemelné v Šumavském národním parku

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Abstract

The paper reports on algae found in the catchment area of the River Křemelná. In total, 100 species were determined. The main attention was paid to silica scaled chrysophytes, xanthophytes, and some genera of green algae. Morphological and ecological remarks to some species are included.

Introduction

Šumava National Park represents one of the primary biodiversity centres in the Czech Republic. Various algal groups have been investigated in the Šumava Mts. in the past (e.g. PASCHER 1903, CEJP 1929, FOTT 1957, RŮŽIČKA 1957). However, because of the great extent of the area and a high diversity of suitable microbiotopes, rare or new species of cyanophytes and algae have been reported recently (LEDERER 1995a, 1995b, LEDERER & LUKAVSKÝ 1998).

The territory investigated in this study is situated in the north-eastern part of the National Park in the altitude of 700 – 900 m. The prime algal biotopes comprise numerous peat bogs (N.P. core zones Hůrecké slatě, U Cetlovy Hůrky and Frauenthal), the spring area and headwaters of the River Křemelná, occasionally ox-bow lakes of these streams, and various aerophytic microbiotopes.

Since the expulsion of German population in the year 1945, the area has been practically uninhabited. The main recent direct anthropogenic pressure consists of sylviculture management and pasturage on the deforested areas of former settlements.

The main aim of this study was to report the occurrence of rare or interesting algal species at the investigated localities. A special attention was paid to the diversity of silica-scaled chrysophytes, Xanthophyceae, selected genera of coccal and filamentous green algae, and desmids.

Localities and methods

Table 1 presents a list and descriptions of the investigated localities. In the field, water temperature, pH and conductivity were measured using portable electronic WTW 330 pH-meter and WTW LF 315 conductometer. The coordinates of the sampling localities were ascertained with the GPS Magellan 300. Selected samples were cultivated and unialgal cultures were established following the methods described in NEUSTUPA (2001). The microphotographs were taken with the Olympus BX51 light microscope and Olympus Z300 microphotographic equipment.

The samples for the investigation of silica-scaled chrysophytes were fixed with acidified Lugol's solution. The preparation of silica scales for TEM was described in KALINA et al. (2000). Specimens were examined with the Philips T300 transmission electron microscope.

Results and discussion

In total, 100 species were determined during the investigation (Table 2).

Chrysophyceae and Synurophyceae

In two samples, the silica-scaled chrysophytes were encountered. The ultrastructural investigation revealed 5 species of three genera. *Chrysosphaerella brevispina* is a widely distributed cosmopolitan species known to occur in neutral to acidic waters (SIVER 1989). In the Šumava Mts., it has been found in alluvial pools of the River Vltava and in plankton of glacial Černé lake (NĚMCOVÁ et al. 2000, NOVÁKOVÁ & NEUSTUPA 2001). *Mallomonas akrokomos* (Fig. 1) is a cosmopolitan, pH indifferent species, which is reported from the Šumava Mts. for the first time. However, it has been already found an several localities in the Czech Republic (NOVÁKOVÁ & NEUSTUPA 2001). *Mallomonas intermedia* var. *intermedia* (Figs 2, 7) is considered to be a European endemite (KRISTIANSEN 2001). It inhabits temperate acidic localities (NĚMCOVÁ et al., in press). In the Czech Republic, it has been found only in alluvial pools of the upper River Lužnice so far (NOVÁKOVÁ & NEUSTUPA 2001). *Synura petersenii* (Fig. 3) and *S. uvella* (Fig. 4) are widely distributed, pH indifferent species. They have been found at numerous localities in the Czech Republic (NEUSTUPA et al. 2001, NOVÁKOVÁ & NEUSTUPA 2001).

Xanthophyceae

Several interesting xanthophycean species were also encountered. As the most specific descriptions in this class are based only on the observation of natural material without knowledge of their variability and life cycles, the acceptable species concept is still missing. Therefore, the correct determination of numerous species is problematic and misidentifications are common. Moreover, a lot of coccal xanthophycean species actually belong to the class *Eustigmatophyceae*. Therefore, there is a strong need for observations indicating the nature of these organisms.

Gloeobotrys cf. *chlorinus* has globular cells, 5.8-8.3 µm in diameter, which are irregularly placed in common mucilage. The cells have one to four parietal chloroplasts. The eustigmatophycean features (e.g. reddish globule, polyhedral pyrenoid) were not observed. The organism fits well into the *G. chlorinus* description except the cell dimensions, which should be 4-5 µm in typical populations (PASCHER, 1939).

A typical form of *Tetraëdriella regularis* (KÜTZ.) FOTT was observed (Fig. 15). No eustigmatophycean features were encountered. The cells (32-38 µm in diameter) possess numerous parietal chloroplasts. Prominent sap vacuoles, described by KRIENITZ & HEYNIG (1992), were not observed. The species is known to occur in Europe relatively frequently (ETTL 1978).

Two species of *Tribonema* were observed. *T. affine* G.S.WEST has cylindrical to slightly inflated cells (6.5-6.9 µm x 17-38 µm). The width : length ratio is 1 : 2.5-6. The cells mostly possess two chloroplasts. The organism can be interpreted as *T. affine* satisfactorily. However, in the original description, filaments are slightly thinner and the W : L ratio extends up to 1:14 (ETTL, 1978). *T. regulare* PASCHER was found in its typical form (6.5 x 12-20 µm, W : L ratio = 1 : 2-3).

<u>Euglenophyceae</u>

Menoidium pellucidum PERTY var. *steinii* POPOVA (Fig. 16) – the colourless euglenophyte was abundant in a small shallow shaded pool. The organism was determined according to ASAUL (1975).

<u>Chlorophyceae</u>

A rare green alga *Gloecoccus alsius* (SKUJA) FOTT (Figs 10, 11) was found in plankton of a peat bog pool. The organism forms mucilaginous colonies up to 150 µm in diameter. The cells are 8.4-9.5 µm in diameter. The cells possess one parietal chloroplast with a lateral stigma without pyrenoid. Some cells possess two apical flagella. The negligible thickening of the cell wall (papilla?) is visible in the apical pole of the cells. However, the motion of the cells is restricted within the common mucilage. The non-flagellated cells are often present in the population. So far, this rare alga has been observed several times in plankton of oligotrophic water bodies in Europe (ETTL & GÄRTNER 1988).

Numerous mucilaginous aerophytic growths were found on the surface of bare wood, on soil and on lithic substrates. *Coccomyxa confluens* (Fig. 8) was a dominant species at these environments. The species is defined as a polymorphic organism with highly variable cell dimensions and W : L ratio (ETTL & GÄRTNER 1995). The unialgal cultures were established from different localities for the morphological comparison. All numerous cultures exhibit the same features typical for *C. confluens* and these features can also be documented on the natural material. The cells have irregular oval shape, generally with one chloroplast. The cell dimensions are 1.5-6 x 3-12 µm. The morphological identity of investigated populations supports the delimitation of this species. Moreover, the populations determined as *C. olivacea* J.B. PETERSEN in the natural material, appeared as identical with *C. confluens* in culture. The only other species of *Coccomyxa* ascertained in investigated aerophytic growths is *Coccomyxa* cf. *thallosa* CHODAT (Fig. 9). This species was often considered uncertain in the published works (ETTL & GÄRTNER, 1995). However, our observations of natural as well as cultured material show the specific nature of this organism. The alga fits into the Chodat's description (JAAG 1933). However, it differs in dimensions of the cells to a certain degree, so the identification is not entirely doubtless.

The members of the genus *Podohedra* were other components of mucilaginous aerophytic growths. The genus *Podohedra* represents sessile coccal green algae reproducing entirely by autospores, which is the most important attribute distinguishing the genus *Podohedra* from a similar genus *Characium*, which produces zoospores in its life cycle. Within this study, we investigated three *Podohedra*-like morphotypes. In all three populations, only the autosporic reproduction was observed. In addition, the investigated morphotypes concurred in their cell dimensions and general shape with known *Podohedra* species rather than with members of the genus *Characium*. Hence, we classify our algae as members of the genus *Podohedra*.

One of the investigated organisms is readily interpretable as *P. longipes* DÜRINGER (Fig. 12). The dimensions of thin, even or slightly inflexed cells are 5-6 x 30-40 µm. Stalk is up to 8 µm long. The chloroplast possesses a small pyrenoid. The reproduction takes place by means of two or four autospores.

The morphotype designated as *Podohedra* sp. 1 (Fig. 13) has inflexed cells, sometimes with equally long apical projections. The cell dimensions are 2.5-6 x 10-32 µm. Chloroplast is without pyrenoid. The reproduction takes place by means of two autospores. The morphotype *Podohedra* sp. 2 (Fig. 14) has thin, even or inflexed cells with long apical projections. In the chloroplast, a small pyrenoid with several starch granules is visible. The cell dimensions are 3-4 x 30-40 µm. Stalk is up to 12 µm long. This species is somewhat similar to *P. distincta* or *P. bicaudata* (KOMÁREK & FOTT, 1983). However, the cell dimensions and the structure of the pyrenoid differs considerably.

The two undetermined morphotypes cannot be interpreted as any of the described species. However, as the observations were made only on the natural material without the comparison of cultures, we are not describing these organisms as new species. The present species concept within the genus *Podohedra* is fairly inconsistent and therefore needs a critical revision.

The populations of *Microspora* have been observed at numerous localities. An unclear species concept within this genus hinders the progress of knowledge on the distribution and ecology of single species. However, the recent monograph (LOKHORST 1999) enables satisfactory identification in floristic studies. Two species were determined. *M. floccosa* (VAUCHER) THURET (Fig. 17) is a species with a wide ecological distribution. The species occurs from eutrophic water bodies to dystrophic acidic peat bog pools (LOKHORST 1999). *M. tumidula* HAZEN (Fig. 18) is an acidophilic species with typical distribution in peat bog pools (LOKHORST 1999).

Conjugatophyceae

The diversity of the desmids was particularly high in some samples (13, 34, 45, 47 etc.). Several remarkable species were also encountered. *Cosmarium portianum* is a slightly acidophilic or neutrophilic species with a high indicative value for long term stability of an ecosystem (COESEL 1998). *Micrasterias papillifera* is a species which according to RŮŽIČKA (1981) occurs frequently. However, COESEL (1998) describes it as an acidophilic, relatively rare species with a high value for the indication of ecosystem stability. *Staurastrum trapezicum* is another rare species, which typically occurs in stable, well preserved acidic ecosystems (COESEL, 1998). The conjugation of several species was observed (Figs 5, 6, 19, 20). In *Staurastrum inflexum* (Fig. 19), triple branched cell wall projections were observed, whereas WURM (1987) described that the ontogeny of the zygospore terminates only by doubly branched projections.

Algological investigation of the area revealed numerous rare or little known species. Regarding the recent threat of elimination of some investigated localities from the National Park, the attention should be paid to special protection of those localities whose legislative status is not assured. Especially the desmid-rich peat bog locality in the River Křemelná valley near the former village of Stodůlky, which is not protected by law, should attract the attention of nature conservationists. The proposal for the declaration of nature reserve in this area will be worked out following this study.

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References

ASAUL, Z. I. (1975): Vyznačnik evglenovych vodorostěj Ukrainskoi RSR., 407 pp., Naukova Dumka, Kyiv.

CEJP, K. (1929): Flora Desmidiaceí horských rašelin šumavských. – Čas. Nár. Mus., sect. nat. 103: 28-32.

COESEL, P. F. M. (1998): Sieralgen en Natuurwaarden., 56 pp., KNNV Uitgeverij, Utrecht.

ETTL, H. (1978): *Xanthophyceae* 1. In: ETTL, H.; GERLOFF, J. & HEYNIG, H. (eds.), Süßwasseflora von Mitteleuropa, Bd. 3, 530 pp., G. Fischer, Stuttgart.

ETTL, H. & GÄRTNER, G. (1995): Syllabus der Boden-, Luft- und Flechtenalgen., 721 pp., G. Fischer, Stuttgart.

FOTT, B. (1957): Taxonomie drobnohledné flóry našich vod. – Preslia 29: 278-319.

JAAG, O. (1933): *Coccomyxa* Schmidle, Monographie einer Algengattung. – Beitr. Krypt. Schweiz 8: 1-132.

KALINA, T., NĚMCOVÁ, Y. & NEUSTUPA, J. (2000): Silica-scaled chrysophytes of the Czech Republic 1. District Česká Lípa (Northern Bohemia) and part of the Central Bohemia. – Algol. Stud. 96: 29-47.

KOMÁREK, J. & FOTT, B. (1983): *Chlorococcales*. In: HUBER-PESTALOZZI, G. (ed.), Das Phytoplankton des Süßwassers, Bd. 7., 1043 pp., Schweizerbart, Stuttgart.

KRIENITZ, L. & HEYNIG, H. (1992): *Tetraedriella verrucosa* (G. M. SMITH) comb. nova and its relation to *T. regularis* (KÜTZING) FOTT (*Xanthophyceae*). – Algol. Stud. 65: 1-10.

KRISTIANSEN, J. (2001): Biogeography of silica-scaled chrysophytes. – Nova Hedwigia Beih. 122: 23-39.

LEDERER, F. (1995a): Several little known *Cyanobacteria* from peat-bogs in the Šumava Mountains, Czech Republic. – Algol. Stud. 79: 57-65.

LEDERER, F. (1995b): A new species of *Cyanodictyon* (*Cyanoprocaryota*, *Chroococcales*) from peat-bogs in the Šumava Mts., Czech Republic. – Preslia 67: 117-121.

LEDERER, F. & LUKAVSKÝ, J. (1998): *Ankistrodesmopsis gabretae-silvae* (*Chlorophyta*, *Chlorellales*) a new genus and species from peat-bogs in the Šumava Mts., Czech Republic. – Algol. Stud. 89: 39-47.

LOKHORST, G. M. (1999): Taxonomic study of the genus *Microspora* Thuret (*Chlorophyceae*). – Algol. Stud. 93: 1-38.

NĚMCOVÁ, Y., KALINA, T. & NEUSTUPA, J. (2000): Chrysomonády s křemitými šupinami slepých ramen a tůní horního toku Vltavy. – In: PITHART, D. (ed.): Ekologie aluviálních tůní a říčních ramen, Sborník příspěvků z konference v Lužnici u Třeboně 2000: 58-60.

NĚMCOVÁ, Y., NEUSTUPA, J., KALINA, T. & NOVÁKOVÁ, S. (in press): Silica-scaled chrysophytes of the Šumava National Park and the Třeboňsko UNESCO Biosphere Reserve (Southern Bohemia, Czech Republic). – Nord. J. Bot.

NEUSTUPA, J. (2001): Soil algae from marlstone-substratum based biotopes in the Nature park Džbán (Central Bohemia, Czech Republic) with special attention to the natural treeless localities. – Algol. Stud. 101: 109-120.

NEUSTUPA, J., NĚMCOVÁ, Y. & KALINA, T. (2001): Silica-scaled Chrysophytes of Southern Bohemia and Českomoravská vrchovina (Czech-Moravian Highlands, Czech Republic). – Algol. Stud. 102: 23-34.

NOVÁKOVÁ, S. & NEUSTUPA, J. (2001): Silica-scaled Chrysophytes of Czech Republic. – http://www.natur.cuni.cz/botany/chryso/

PASCHER, A. (1903): Zur Algenflora des südlichen Böhmerwaldes. – Lotos 51: 161-211.

PASCHER, A. (1939): Heterokonten. – In: Rabenhorst's Kryptogamenflora, Bd. 11, 1092 pp., Akad. Verlagsges., Leipzig.

RŮŽIČKA, J. (1957): Krásivky horní Vltavy (Šumava). – Preslia 29: 132-154.

RŮŽIČKA, J. (1981): Die Desmidiaceen Mitteleuropas. Band 1, 2. Lieferung, 736 pp., E. Schwz. Vbh., Stuttgart.

SIVER, P. A. (1989): The distribution of scaled chrysophytes along a pH gradient. – Can. J. Bot. 67: 2120-2130.

WURM, E. (1987): Einige Funde von Desmidiaceenzygoten im Freiland. – Nova Hedwigia 45: 197-204.

Table 1: List of localities. M – peat bog "Mossau", 49°04'55" n.l., 13°27'32" e.l. (N.P. core zone), **S** – surroundings of Srní village, 49°05'00" n.l., 13°27'25" e.l., **H** – peat bog "Hůrecká slat", 49°09'40" n.l., 13°19'56" e.l. (N.P. core zone), **SP** – an abandoned sand pit north of Frauenthal N.P. core zone and near surroundings, 49°09'55" n.l., 13°24'12" e.l., **C** – „U Cetlovy Hůrky", 49°08'00" n.l., 13°22'15" e.l., N.P. core zone, **F** – peat bog „Frauenthal", 49°08'58" n.l., 13°23'40" e.l., N.P. core zone, **K** – peat bog in canyon of the Křemelná river, 49°07'40" n.l., 13°24'10" e.l.

No.	Loc.	Description	**Date**	**Temp. (°C)**	**pH**	**Cond.** (µS.cm^{-1})
1	M	algal growth in a small stream	17.9.	11	6,55	149
2	M	mucilaginous growth in a small stream	17.9.	11	6,55	149
3	M	aerophytic growth on the granite wall near by the stream	17.9.			
4	M	peat bog pool, wringed biomass of submersed *Sphagnum*	17.9.	10	4,4	52,7
5	M	peat bog pool, the mucilaginous growths on submersed wood	17.9.	10	4,4	52,7
6	M	watterloged peat bog meadow, wringed *Sphagnum*	17.9.	9	5,1	46,2
7	S	aerophytic growth on bare wood	17.9.			
9	S	aerophytic growth on the surface of the spruce forest soil	17.9.			
10	S	aerophytic growth on a bone	17.9.			
11	H	aerophytic growth on the surface of a forest path	18.9.			
12	H	aerophytic growth on the surface of bare spruce wood	18.9.			
13	SP	mucilaginous growth from a puddle	18.9.	12	5,9	28,4
14	SP	filamentous algal growth from a puddle	18.9.	12	5,9	28,4
15	SP	submersed algal growth from a small desiccating pool	18.9.	11	5,5	34
16	SP	submersed algal growth in a small desiccating pool	18.9.	11	5,5	34
17	SP	aerophytic growth on the surface of wet soil	18.9.			
18	H	wringed *Sphagnum* from a peat bog	18.9.			
19	H	algal growths from a peat bog pool	18.9.	9	3,9	58
20	H	aerophytic mucilaginous growth on a granite	18.9.			
21	H	aerophytic mucilaginous growth on a granite	18.9.			
22	H	aerophytic mucilaginous growth on a sandstone	18.9.			
23	H	shaded peat bog pool in a spruce forest	18.9.	10	5,2	45
24	SP	small pond, plankton	18.9.	8,5	5,95	67
25	SP	small pond, submersed growths on a granite	18.9.	8,5	5,95	67
26	SP	aerophytic growth on the surface of wet soil	18.9.			
31	C	wetted spruce wood near by the stream	19.9.			
33	C	submersed algal growth on a granite in a stream	19.9.	6	5,9	28
32	F	small pool in a spruce windthrow root hole	19.9.	13	4,6	62
28	F	wringed *Sphagnum* form a peat bog	19.9.			
34	F	overflowed drain alongside a peat bog	19.9.	13	4,9	36
35	F	submersed growths from an overflowed peat bog drain	19.9.	13	4,9	36
36	F	growth in a peat bog pool	19.9.	10	3,5	85
27	F	aerophytic algal growth on a *Sphagnum*	19.9.			
30	F	mucilaginous growth in bottom of windthrow root hole pool	19.9.			
37	F	algal growth in bottom of spruce windthrow root hole pool	19.9.	9,5	3,6	96
38	F	aerophytic growths on the surface of the soil of a path	19.9.			
29	F	submersed epiphytic growths in an ox-bow lake of Křemelná	19.9.	7,5	4,5	36
39	F	wringed *Sphagnum* in an ox-bow lake of Křemelná river	19.9.	7,5	4,5	36
40	K	aerophytic growth on dead spruce wood	20.9.			
41	K	submersed algal growths in a peat bog pool	20.9.	8	5,5	48
44	K	bottom growth from puddles of waterlogged *Carex* meadow	20.9.			
42	K	aerophytic growth on the surface of a wet soil	20.9.			
46	K	subaerophytic algal growth on the mud surface	20.9.	8	5,8	53
43	K	mucialginous growth in a small peat bog pool	20.9.	8	5,8	53
47	K	mucilaginous growth in desiccating *Sphagnum* puddles	15.6.			
45	K	mucilaginous growth on bottom of a small peat bog pool	20.9.	7,5	5,4	60

Table 2. **List of species**

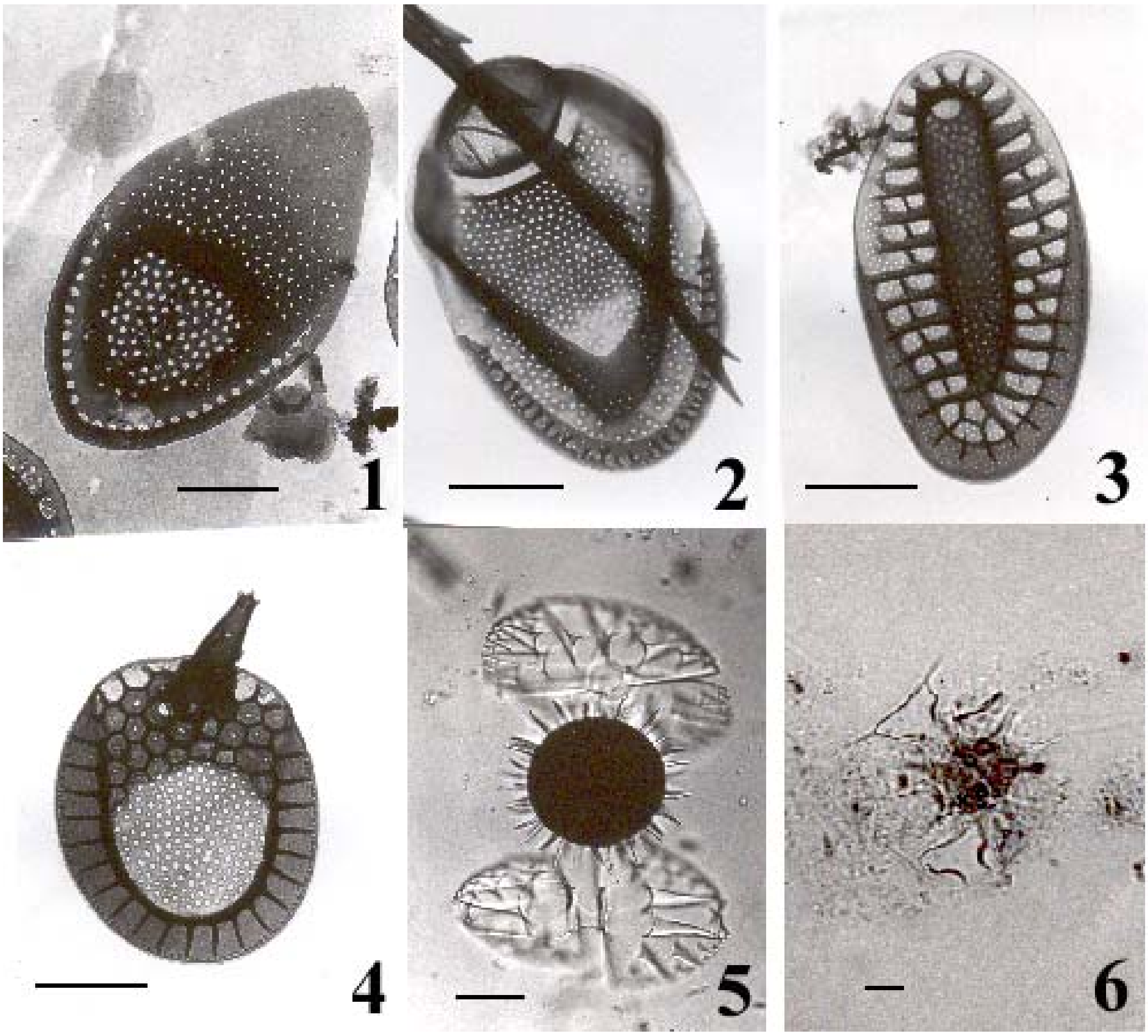
Name	**Designation of localities**
Cyanophyta	
Cylindrospermum stagnale (KÜTZ.) BORN. ET FLAH.	13
Nodularia sp.	47, 45
Dinophyta	
Peridinium willei HUITFELD-KAAS	28, 34
Haptophyta	
Rhipidodendron huxlei KENT	34
Chrysophyceae	
Chrysococcus rufescens *KLEBS*	***34***
Chrysosphaerella brevispina *KORŠ.*	***24***
Dinobryon sertularia *EHRENB.*	***13, 34***
Mallomonas akrokomo RUTTNER in PASCHERS	24, 34
M. intermedia *KISS.em. PÉT. & MOM.* var. intermedia	34
***Synura petersenii* KORŠ.**	**24, 34**
***S. uvella* (EHR.) KORŠ.**	**34**
Bacillariophyceae	
Eunotia bilunaris *(EHRENB.) MILLS*	***4, 39***
E. praerupta EHRENB.	45
E. serra EHRENB. var. *tetraodon* (EHRENB.) NÖRPEL	45
Frustulia rhomboides *(EHRENB.) DE TONI*	***13, 17***
Pinnularia microstauron (EHRENB.) CLEVE	45
P. viridis (NITZSCH) EHRENB.	6,14,18,19,28,39,44,45
Stauroneis anceps EHRENB.	13, 47, 45
Surirella biseriata BRÉB.	42, 44, 45, 47
Tabellaria flocculosa (ROTH) KÜTZ.	4,5,25,34,39,41,43,45
Xanthophyceae	
Gloeobotrys cf. *chlorinus* PASCHER	28
Pleurochloris sp.	10
Ophiocythium capitatum *WOLLE*	***35***
Tetraëdriella regularis (KÜTZ.) FOTT	35
Tribonema affine G.S.WEST	1
T. regulare PASCHER	41
Vaucheria sp.	1, 25, 33, 46
Euglenophyta	
Euglena adhaerens *MATV.*	***13, 23***
E. mutabilis SCHMITZ	13, 19, 36, 37
Menoidium pellucidum PERTY var. *steinii* POPOVA	23

Table 2. List of species (continuance)

Rhabdomonas incurva FRES.	23
Trachelomonas volvocinopsis SWIR.	34
Chlorophyceae s.l.	
Ankistrodesmus falcatus (CORDA) RALFS	34, 35
Asterococcus superbus (CIENKOWSKI) SCHERFFEL	5
Binuclearia tectorum (KÜTZ) BEGER in WITTMANN	5
Bulbochaete sp.	34
Chaetophora pisiformis (ROTH) AGARDH	2
Coccomyxa confluens (KÜTZ) FOTT	7, 9, 10, 12, 22, 27
C. cf. *thallosa* CHODAT	26
cf. *Coenochloris* sp.	27
Dicranochate reniformis HIER. in HAUCK & RICHTER	4
Geminella interrupta (TURPIN) LAGERH.	40
Gloeococcus alsius (SKUJA) FOTT	34
Gonium sociale *(DUJARDIN) WARMING*	34
Microspora floccosa (VAUCH.) THURET	17, 32
M. tumidula HAZEN	29, 41
M. spp.	4, 5, 14, 18
Microthamnion strictissimum RABENHORST	4
Oedogonium sp. steril.	1, 13, 45
Pandorina morum (O.F. MÜLLER) BORY	34
Pediastrum boryanum (TURPIN) MENEGHINI	35
Podohedra longipes DÜRINGER	21
P. sp. *1*	31
P. sp. *2*	20, 40
Pseudococcomyxa sp.	31
Sphaerellocystis lateralis FOTT & NOVÁKOVÁ	34
Trentepohlia iolithus (L.) WALLROTH	3
Ulothrix variabilis KÜTZ.	1, 8
Charophyceae	
Klebsormidium flaccidum *(KÜTZ.) SILVA et al.*	11, 38
K. nitens LOKHORST	38
K. montanum (HANSG.) HINDÁK	38
Zygnematophyceae	
Closterium acerosum *SCHRANK EX RALFS*	45
Cl. costatum CORDA ex RALFS	13
Cl. cynthia DE – NOT.	34, 35
Cl. dianae EHR. ex RALFS	34, 47

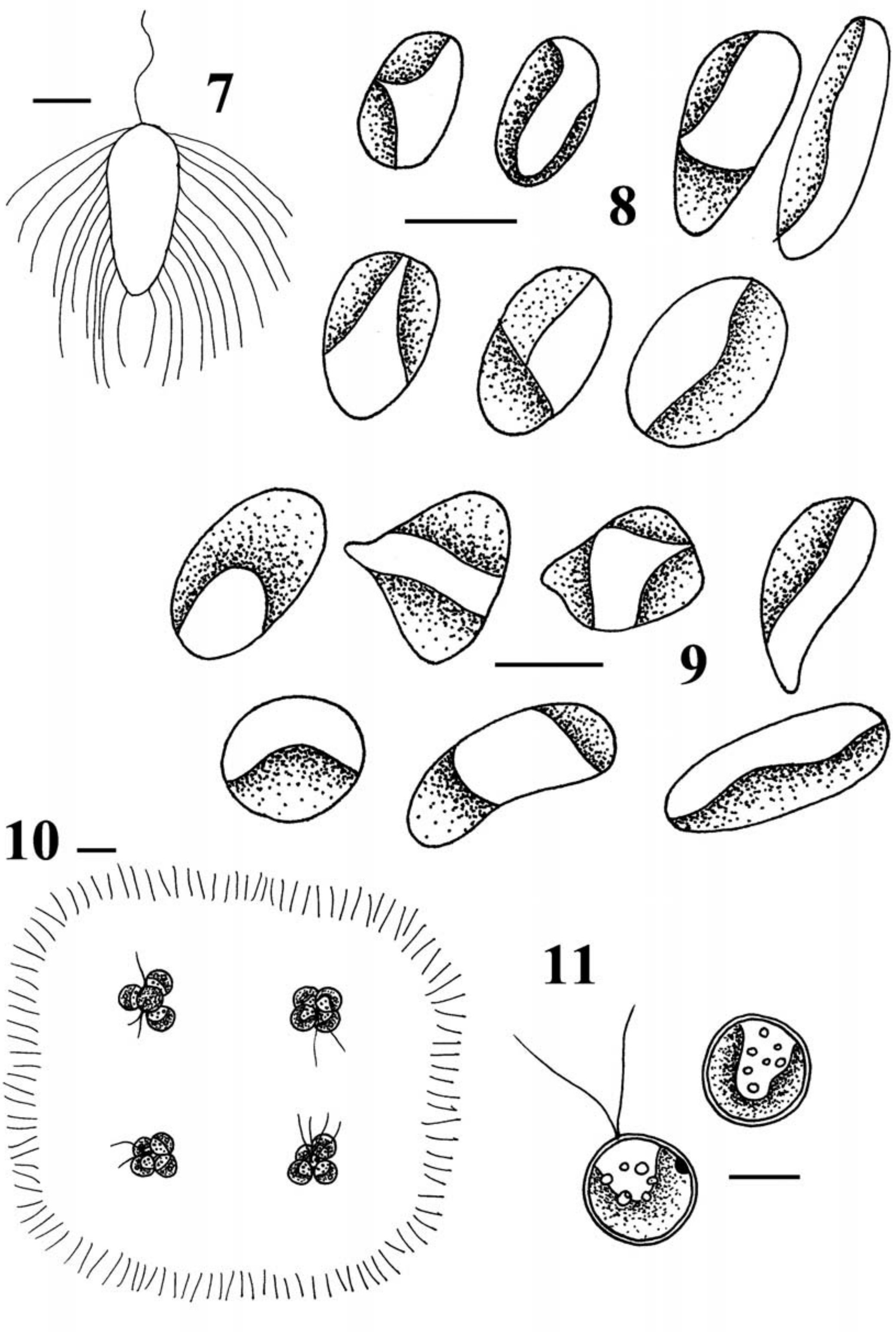
Table 2. List of species (continuance)

Cl. lunula (MÜLL) NITZSCH ex RALFS	45, 47
Cl. setaceum EHRENB. ex RALFS	34
Cl. striolatum EHRENB. ex RALFS	13, 45
Cosmarium difficile LÜTKEM.	13
C. portianum ARCH.	34
Cylindrocystis brebissonii (MEN. ex RAL.) BARY	6,13,17,18,19,30,32,36,37
C. crassa DE - BARY	19
Euastrum ansatum EHR. EX RALFS	13, 34
E. denticulatum GAY	34, 35
E. elegans BRÉB. ex RALFS	35
E. oblongum *GREV. ex RALFS*	45, 46, 47
E. verrucosum EHRENB. ex RALFS	34
Hyalotheca dissiliens J. E. SMITH ex BRÉB	13, 34
Mesotaenium chlamydosporum (BARY) BARY	1
M. macrococcum (KÜTZ.) ROY & BISSET	40
Micrasterias rotata GREV. ex RALFS	13, 45, 47
M. papilifera BRÉB.	44, 45, 47
Mougeotia sp. steril.	5, 13, 15, 42, 43,45, 47
Netrium digitus (EHR. ex BRÉB.) ITZ. & ROTHE	13, 19, 23, 45
Spirogyra grevilleana (HASSAL) KÜTZ.	29
Spirogyra sp. steril.	13, 15, 45, 47
Spirotaenia condensata BRÉB.	45, 47
Staurastrum aciculiferum ANDERSS.	34, 35
St. inflexum BRÉB.	34, 35
St. senarium (EHR.) RALFS	13
St. cf. *striolatum* (NÄG.) ARCH.	19
St. teliferum RALFS	13
St. trapezicum BOLDT	45
Staurodesmus extensus (BORGE) TEIL.	34
Std. dejectus (BRÉB.) TEIL.	34
Std. cf. *glaber* (EHR. ex RALFS) TEIL.	13, 34
Tetmemorus granulatus BRÉB. ex RALFS	13, 44,45, 47
T. laevis KÜTZ. ex RALFS	13, 19
Zygnema sp. steril	13, 15, 45, 46, 47
Zygogonium ericetorum KÜTZ.	5



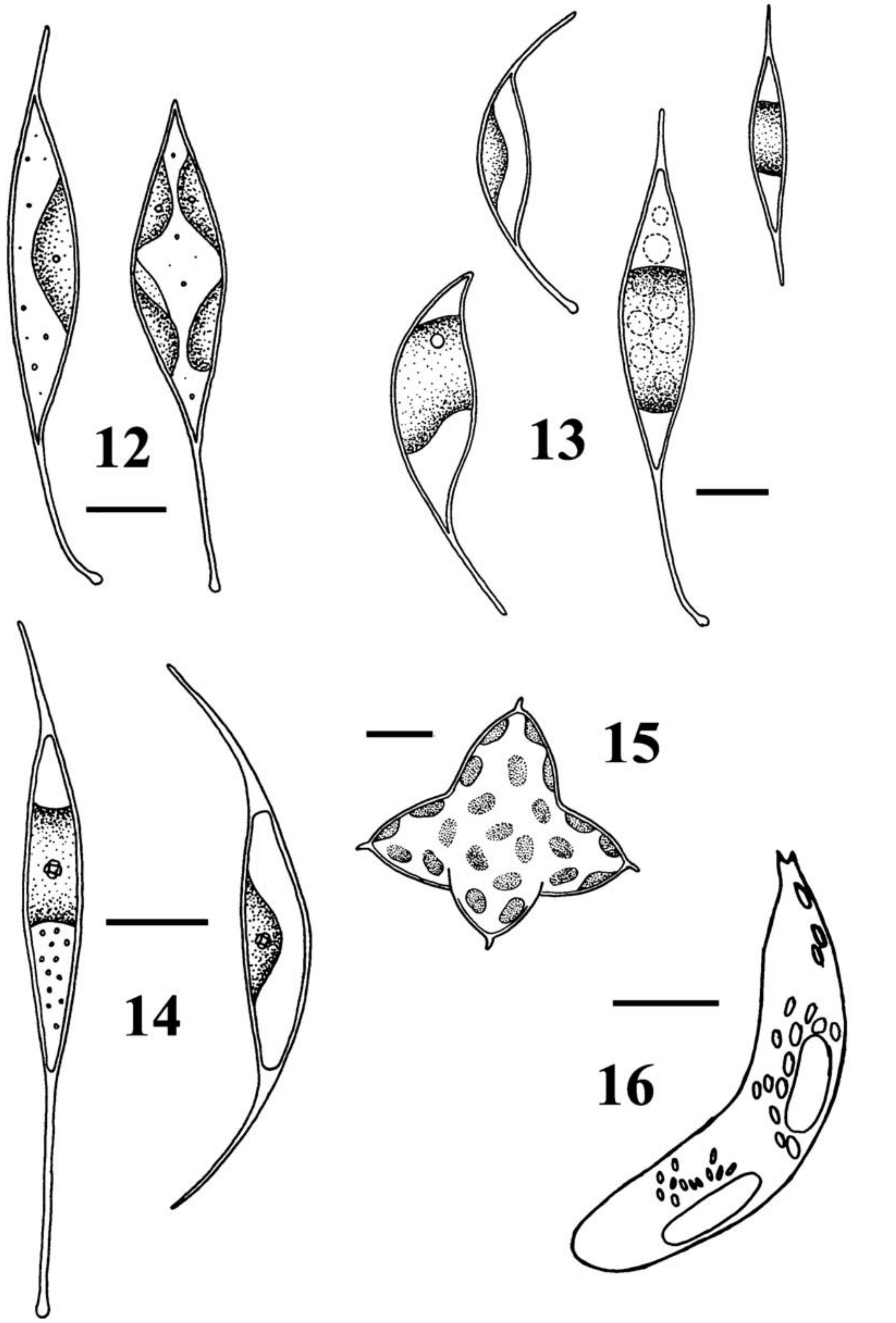
Figs 1 – 6. 1: *Mallomonas akrokomos*, body scale; 2: *Mallomonas intermedia* var. *intermedia*, dome-bearing body scale; 3: *Synura petersenii*, body scale; 4: *Synura uvella*, body scale; 5: *Micrasterias rotata*, zygospore; 6: *Staurodesmus extensus*, zygospore.

(Bars: Figs 1-4: 1 µm, Fig. 5: 50 µm, Fig. 6: 10 µm

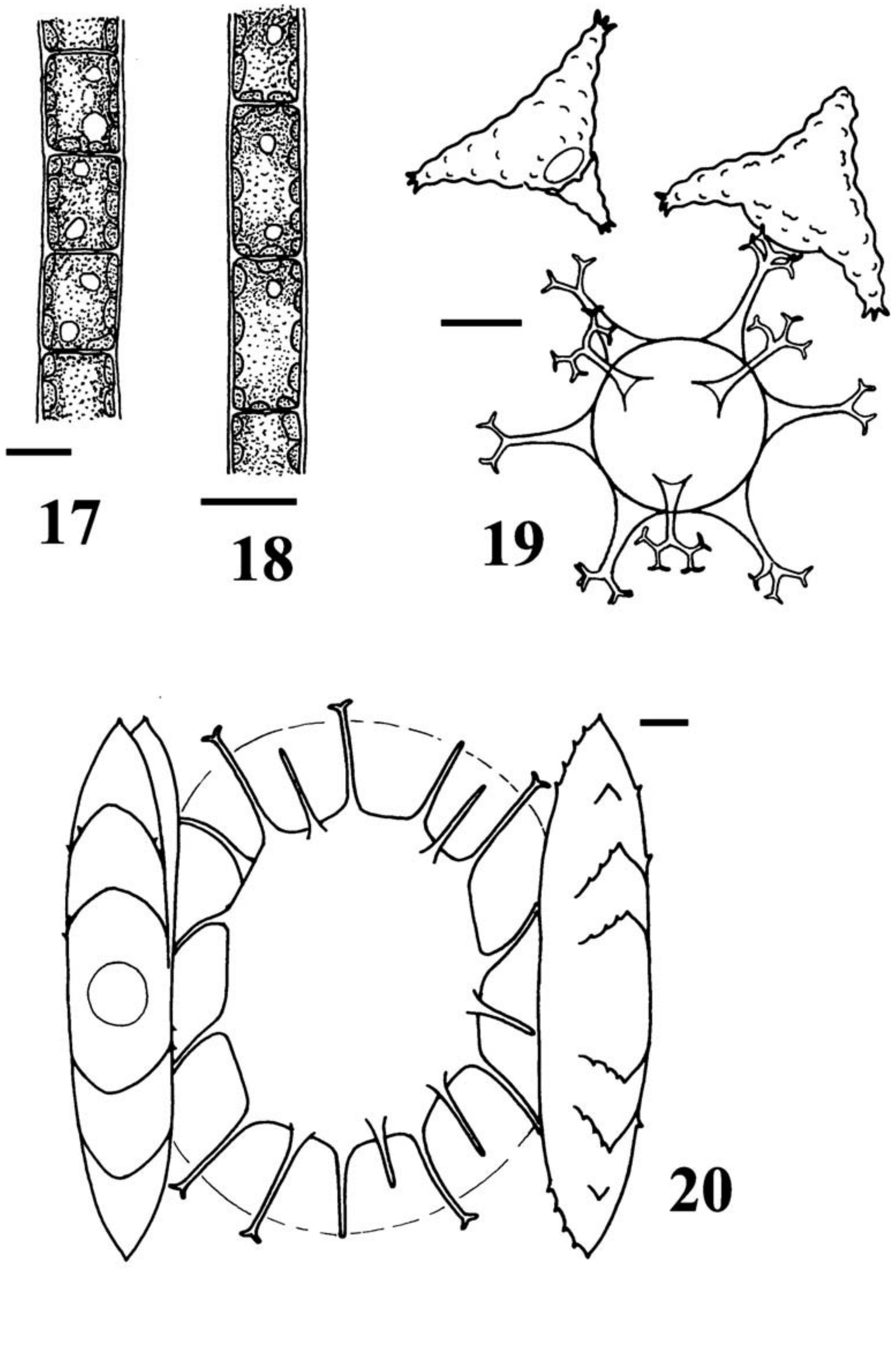


Figs 7 – 11. 7: *Mallomonas intermedia* var. *intermedia*; 8: *Coccomyxa confluens*, variability of vegetative cells; 9: *Coccomyxa* cf. *thallosa*, vegetative cells; Figs 10, 11: *Gloeococcus alsius*, 10: mucilaginous colony, 11: vegetative cells.

(Bars: Figs 7, 11: 10 µm, Figs 8, 9: 3 µm, Fig. 11: 5 µm)



Figs 12 – 16. 12: *Podohedra longipes*; 13: *Podohedra* sp. 1; 14: *Podohedra* sp. 2; 15: *Tetraëdriella regularis*; 16: *Menoidium pellucidum* var. *steinii.* (Bars: Figs 12-14: 5 µm, Figs 15, 16: 10 µm)



Figs 17 – 20. 17: *Microspora floccosa*; 18: *Microspora tumidula*; 19: *Staurastrum inflexum*, zygospore; 20: *Micrasterias papillifera,* zygospore. (Bars: Figs 17-20: 10 µm)