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Diversity and ecology of silica-scaled chrysophytes (Synurophyceae, Chrysophyceae) in the National Nature Monument Swamp and Břehyňský Pond, Czech Republic

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Abstract – The silica-scaled chrysophytes (Synurophyceae and Chrysophyceae) are a small group of freshwater flagellates with cells enclosed within a morphologically species-specific scale case. Thirty taxa were found during an investigation of peaty pools in the National Nature Monument Swamp and the plankton of Břehyňský Pond, Czech Republic. Along with cosmopolitan and widely distributed species, *Mallomonas adamas* and *M. maculata*, which shows a patchy geographic distribution, and *M. clavus, Synura lapponica* and *Chrysosphaerella longispina*, which show a northern temperate distribution, were found. *Mallomonas annulata, M. heterospina, M. paludosa, M. papillosa, M. calceolus, M. pumilio, Synura echinulata, S. lapponica* and *Chrysosphaerella longispina* belong to a group of cool-water taxa. *Mallomonas multisetigera, M. ouradion, M. papillosa, Synura echinulata, S. sphagnicola* and *Paraphysomonas vestita* have an ability to form dominant populations in extremely acidic environments (pH 3.5-4.0). The species *Mallomonas clavus, M. favosa, M. maculata, M. rasilis* and *Chrysosphaerella longispina* are recorded here for the first time from the Czech Republic.

acidic biotopes / Chrysophyceae / diversity / scale morphology / silica-scaled chrysophytes / Synurophyceae

Résumé – Diversité et écologie des chrysophytes à écailles siliceuses (Synurophyceae, Chrysophyceae) dans le National Nature Monument Swamp et l'Étang Břehyňský, République Tchèque. Les chrysophytes à écailles siliceuses (Synurophyceae et Chrysophyceae) forment un petit groupe de flagellées d'eau douce dans lequel les cellules sont recouverte par une enveloppe d'écailles dont la morphologie est caractéristique de l'espèce. Trente taxons ont été dénombrés lors d'une étude des bassins tourbeux du National Nature Monument Swamp et du plancton de l'étang de Břehyňský, République Tchèque. À côté d'espèces cosmopolites et largement distribuées, *Mallomonas adamas* et *M. maculata* présentent une distribution géographique inégale, et *M. clavus, Synura lapponica* et *Chrysosphaerella longispina* une distribution septentrionale tempérée. *Mallomonas annulata, M. heterospina, M. paludosa, M. papillosa, M. calceolus, M. pumilio, Synura echinulata, S. lapponica* et *Chrysosphaerella longispina* appartiennent à un groupe de taxons des eaux fraîches. *Mallomonas multisetigera, M. ouradion, M. papillosa, Synura echinulata, S. sphagnicola* et *Paraphysomonas vestita* sont capables de former des peuplements dominants dans des milieux extrêmement acides (pH 3.5-4.0). *Mallomonas clavus, M. favosa, M. maculata, M. rasilis* et *Chrysosphaerella longispina* ont été trouvées ici pour la première fois en République Tchèque.

biotopes acides / Chrysophyceae / chrysophytes à écailles siliceuses / diversité / morphologie des écailles / Synurophyceae

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INTRODUCTION

Silica-scaled chrysophytes are a small group of flagellates which may be identified taxonomically based on morphology alone, without any need for molecular sequence data. Cells are enclosed within a case formed by overlapping, morphologically species-specific silica scales. While in the Synurophyceae the scales are arranged very precisely, in the Chrysophyceae the scale layout is more or less random. Although the function of the siliceous casing still remains uncertain, a mechanical defence against grazing has been demonstrated experimentally using small cladocerans as grazers (Sandgren & Walton, 1995). During scale biogenesis, the construction principles at work are such that scales which are as light as possible are produced, whilst at the same time they are capable of retaining their firmness (Wee, 1997; Leadbeater & Barker, 1995). A wide variety of scale designs have been produced during the course of evolution, prompting investigators to use scale ultrastructural morphology for taxonomic identification ever since the invention of the transmission electron microscope.

Within the habitats investigated in the present paper, the National Nature Monument Swamp (referred to here as Swamp), with its adjacent Máchovo jezero Fishpond, has been studied by phycologists since the early 20th century. Adolf Pascher published studies on the chrysophytes and tribophytes in which he described tens of new species (Pascher, 1910, 1939). Matauch (1936) carried out a comprehensive study focussing on the variations of physico-chemical parameters in peat-bog pools throughout the year. The green alga *Dicranochaete bohemica* Nováková *et* Popovský was also described from samples taken from the Swamp (Nováková & Popovský, 1972). Stojanovski & Kalina (1989) characterized the algal community as an oligotrophic-dystrophic association, *Tetmemoro granulati-Anomoeoneietum seriantis*. Recently, Šťastný (2010) used the species composition of desmid communities to evaluate the ecological conditions on both parts of the Swamp. *Mallomonas ouradion* Harris *et* Bradley (referred to as *Mallomonopsis ouradion* (Harris *et* Bradley) Harris) was observed in the Swamp by Kalina (1969), and one additional species, *Synura sphagnicola* (Korshikov) Korshikov, was added following the investigation of the locality in 1998 by Kalina *et al.* (2000), who also reported ten taxa of silica-scaled chrysophytes from Břehyňský Pond, including *M. parvula* Dürrschmidt and *M. striata* Asmund which were reported for the first time from the Czech Republic.

The silica-scaled chrysophyte flora of a newly established nature reserve in the southern portion of the Swamp is hitherto unstudied and the present study extends our knowledge of the taxonomic identity, autecology and biogeography of silica-scaled chrysophytes in this area, including a survey of a number of interesting extremely acidic biotopes.

MATERIAL AND METHODS

Both areas investigated in this study constitute unique biotopes in Europe. The National Nature Monument Swamp (Swamp) is located in the south-eastern part of the Máchovo jezero Fishpond (originally known as the Great Fishpond, Northern Bohemia) and is composed of two adjacent peat-bogs. Both peat-bogs emerged as consequence of groundwater elevation, when the Máchovo

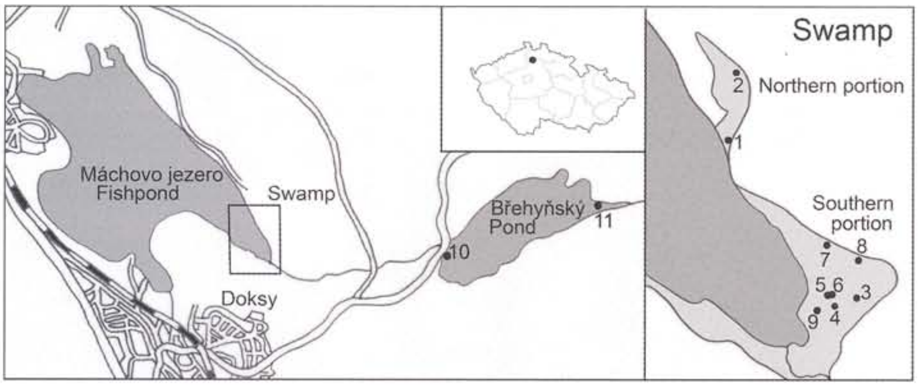


Fig. 1. Map of the investigated area. The stations are indicated by numbers referring to the text and Table 1.

jezero Fishpond was founded in the 14th century. The water regime of the Swamp is strongly influenced by Máchovo jezero Fishpond water level management. A northern part of the Swamp (area of 1.45 ha, 50°34'48.19'' N, 14°40'4.77'' E) has been protected since 1972. The transitional bog is characterized by oligotrophic, acidic conditions (stations 1 and 2, Fig.1), and is only separated from the eutrophic and alkaline fishpond by a narrow dam that is constantly disrupted by ice cover and surge. To prevent erosion of the Swamp's organic sediments and mixing of water with the fish pond, the dam was reinforced recently. A southern portion of the Swamp, included in the National Nature Monument Swamp in 2007 (Šťastný, in press) (area of ca. 2.5 ha, 50°34'34.44'' N, 14°40'14.45'' E) is more heterogeneous because the peat-bog gradually changes into a mesotrophic littoral reed belt that verges to the fishpond (stations 3-9, Fig. 1).

Břehyňský Pond (50°34' 45'' N; 14°42'13'' E) is part of the Břehyně-Pecopala National Nature Reserve, created in 1967 but enjoying protected status since 1933 as part of a larger protected area. The pond was established in the 14th century and has an elevated water level preventing the terrestrialization of a peat bog. The surface area of the pond is 90 ha and the maximum depth is 2 m. Together with its accompanying reed beds, peat-bogs and wet meadows, Břehyňský Pond has been included in the List of Wetlands of International Importance under the Ramsar Convention since 1991, and has been preserved under the Natura 2000 system since 2004. The Břehyně-Pecopala National Nature Reserve has been included in the network of biogenetic reserves of the Council of Europe (Mackovčin *et al.*, 2002).

The investigated stations were sampled during the winter and spring months of 2007. Water temperature, pH and conductivity were measured at the time of collection with combined pH-conductometer WTW 340. Plankton samples from Břehyňský Pond were taken using a 20 μm-mesh net. Samples from shallow peat-bog pools (depth 0.1-0.3 m) were obtained by collecting water and squeezing the submerged vegetation. Water samples were centrifuged or concentrated by sedimentation. Subsequently, drops of the sample were dried onto Formvar-coated transmission electron mcirsocopy (TEM) grids. Dried material was washed by repeated transfer of the grid into drops of deionized water dispensed on the hydrophobic surface of a Parafilm strip. Dried grids were examined with a JEOL 1011 TEM.

Table 1. List of investigated stations and main physico-chemical parameters.

Station	*Locality*	*Sampling date*	*pH*	*Conductivity* ($\mu S \cdot cm^{-1}$)	*Temperature (°C)*
1	Swamp – Northern portion	13/02/07	3.5	85	3.9
2		13/02/07	3.7	94	3.7
3		13/02/07	4.0	75	3.8
4		13/02/07	4.8	81	4.0
5		01/03/07	4.6	62	7.3
6	Swamp – Southern portion	01/03/07	5.0	54	7.5
7		01/03/07	4.8	70	7.4
8		01/03/07	5.2	63	7.5
9		21/03/07	6.1	83	3.5
10	Břehyňský Pond	21/03/07	5.6	189	4.7
11		11/04/07	5.8	152	–

RESULTS

The main physico-chemical parameters of the investigated stations are summarized in Table 1. A total of 30 taxa (Table 2), representing five genera, were identified in the eleven investigated stations. Between 4 and 14 species were found per station. The genera *Mallomonas* and *Synura* were the most represented, with 20 and 6 taxa, respectively. *Mallomonas clavus*, *M. favosa*, *M. maculata*, *M. rasilis* and *Chrysosphaerella longispina* were found for the first time for the Czech Republic. Selected species are commented upon below.

Class Synurophyceae

***Mallomonas adamas* Harris *et* Bradley** **Fig. 3**

M. adamas was a frequent component of chysophyte communities in the investigated stations. In shallow peat-bog pools (stations 4, 5, 7-9) populations of this species were extremely abundant. Undisturbed, intact scale cases were often observed using TEM, appearing as thick scales firmly adhering to one another by means an adhesive material. The environmental conditions in which this species was found agree with Harris & Bradley (1960) and Nováková *et al.* (2004), who also reported its presence in peaty pools.

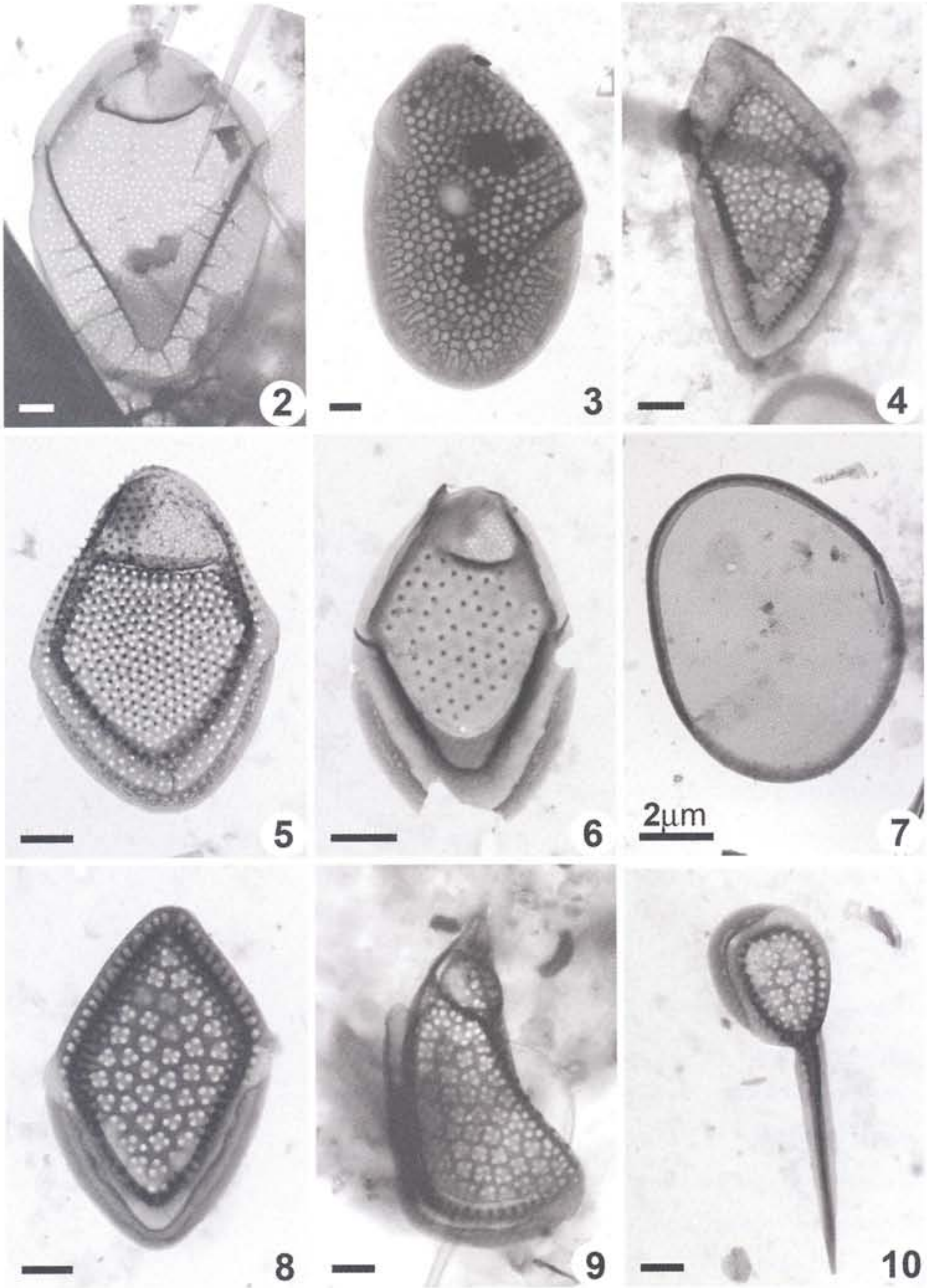
Distribution: Scattered and rare species (Kristiansen, 2002).

Previous Czech record: Nováková *et al.* (2004).

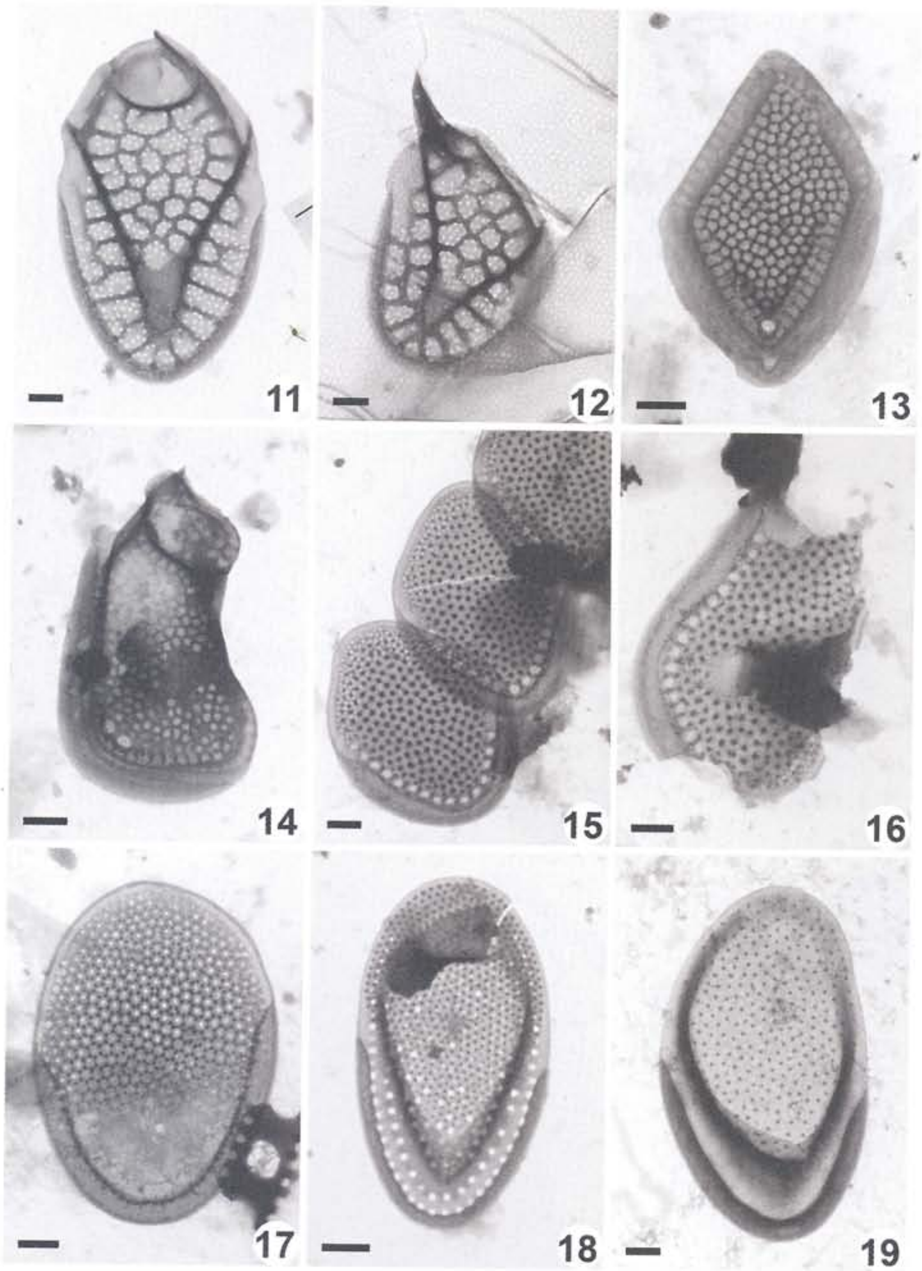
Table 2. Species list and distribution of the silica-scaled chrysophytes found here.

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Mallomonas acaroides Perty *em*. Iwanoff	Fig. 2										+	
M. adamas Harris *et* Bradley	Fig. 3				+	+		+	+	+		+
M. alata Asmund, Cronberg *et* Dürrschmidt	Fig. 4					+					+	
M. annulata (Bradley) Harris	Fig. 5										+	
M.calceolus Bradley	Fig. 6											+
M. caudata Iwanoff em. Krieger	Fig. 7										+	
M. clavus Bradley*	Figs 8-10				+		+					+
M. crassisquama (Asmund) Fott	Figs 11-12						+				+	
M. favosa Nicholls*	Figs 13-14				+	+	+		+			
M. heterospina Lund												+
M. maculata Bradley*	Figs 15-16				+					+		
M. matvienkoae (Matvienko) Asmund *et* Kristiansen	Fig. 17				+	+			+		+	
M. multisetigera Dürrschmidt	Fig. 18	+	+	+	+	+	+	+				
M. ouradion Harris *et* Bradley	Fig. 19	+	+	+		+						
M. paludosa Fott	Fig. 20											+
M. pillula Harris f. *valdiviana* Dürrschmidt	Fig. 23									+		+
M. pumilio Harris *et* Bradley	Fig. 24				+	+	+	+	+	+		
M. rasilis Dürrschmidt*	Fig. 25				+	+			+			
M. tubulosa Harris	Fig. 22									+		
Synura echinulata Korshikov	Fig. 26	+	+	+	+			+		+	+	+
S. lapponica Skuja	Fig. 27										+	
S. petersenii Korshikov	Fig. 28								+	+	+	
S. sphagnicola (Korshikov) Korshikov	Fig. 29	+	+	+	+					+		+
S. spinosa Korshikov	Fig. 30				+						+	
S. uvella Ehrenberg em. Korshikov	Figs 31-32						+		+	+	+	+
Chrysosphaerella brevispina Korshikov*	Figs 33-34										+	
C. longispina Lauterborn	Fig. 35				+				+			
Paraphysomonas vestita (Stokes) De Saedeleer	Fig. 36		+		+			+		+	+	+
Spiniferomonas cf. *trioralis* Takahashi	Fig. 37											+

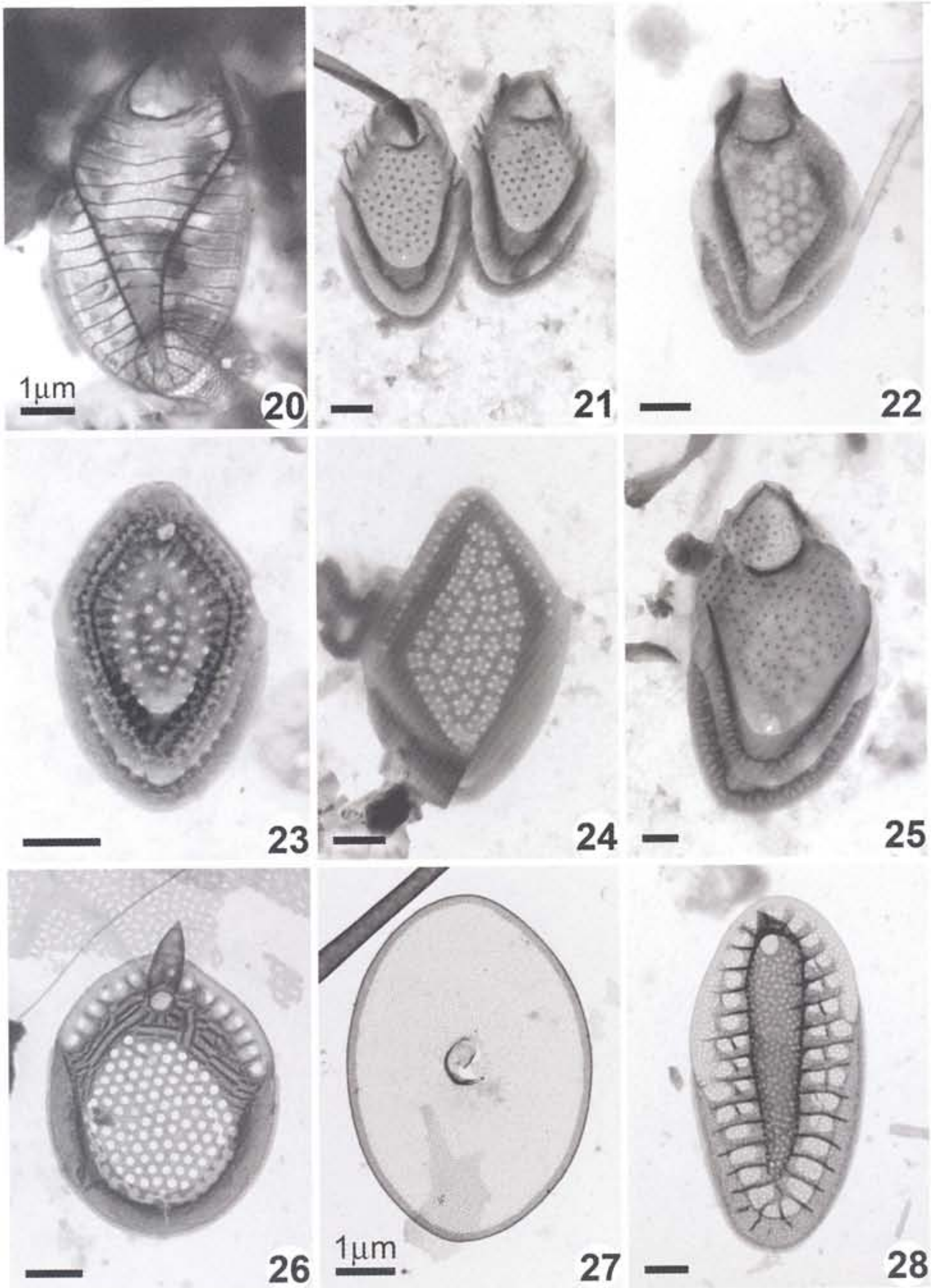
* = New record for the Czech Republic.



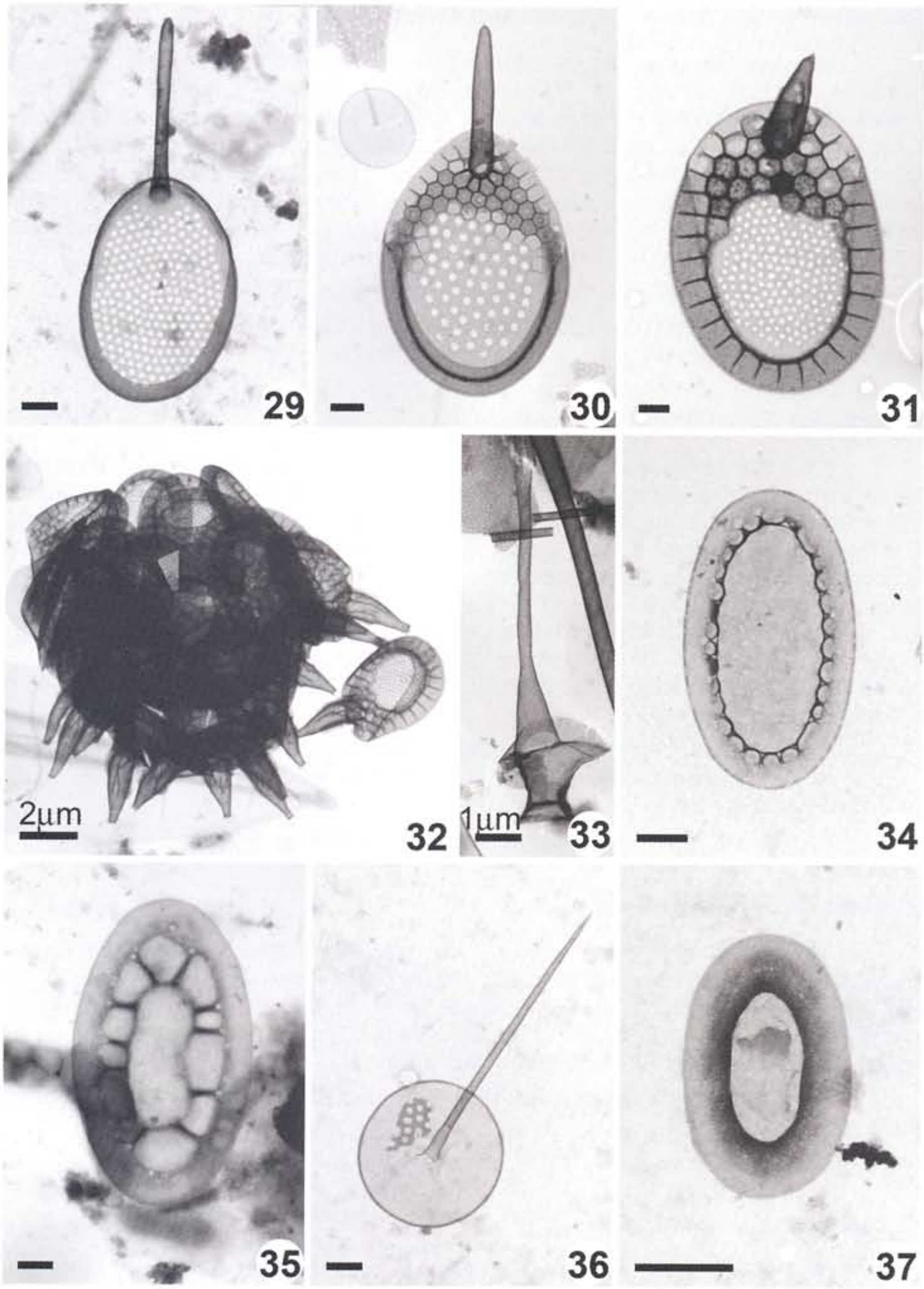
Figs 2-10. **2.** *Mallomonas acaroides*. **3.** *Mallomonas adamas*. **4.** *Mallomonas alata*. **5.** *Mallomonas annulata*. **6.** *Mallomonas calceolus*. **7.** *Mallomonas caudata*. **8.** *Mallomonas clavus*. A body scale. **9.** *Mallomonas clavus*. A collar scale with a pointed dome peak. **10.** *Mallomonas clavus*. A caudal scale with a long tapered spine. Bar = 0.5 µm if not stated otherwise.



Figs 11-19. **11.** *Mallomonas crassisquama*. A body scale. **12.** *Mallomonas crassisquama*. A caudal scale with a spine. **13.** *Mallomonas favosa*. A body scale with a pit containing a small pore in the v-rib. **14.** *Mallomonas favosa*. A collar scale with two pits. **15.** *Mallomonas maculata*. A group of body scales. **16.** *Mallomonas maculata*. A collar scale with two large shallow pits. **17.** *Mallomonas matvienkoae*. **18.** *Mallomonas multisetigera*. **19.** *Mallomonas ouradion*. An asymmetrical apical scale. Bar = 0.5 µm.



Figs 20-28. **20.** *Mallomonas paludosa*. **21.** *Mallomonas papillosa*. Two body scales. **22.** *Mallomonas tubulosa*. A dome bearing body scale. **23.** *Mallomonas pillula* f. *valdiviana*. **24.** *Mallomonas pumilio*. **25.** *Mallomonas rasilis*. An asymmetrical apical scale with irregularly spaced papillae. **26.** *Synura echinulata*. **27.** *Synura lapponica*. A scale with a hollow spherical protuberance. **28.** *Synura petersenii*. Bar = 0.5 µm if not stated otherwise.



Figs 29-37. **29.** *Synura sphagnicola*. **30.** *Synura spinosa*. **31.** *Synura uvella*. A body scale. **32.** *Synura uvella*. A scale case of the whole cell. **33.** *Chrysosphaerella brevispina*. A spine scale. **34.** *Chrysosphaerella brevispina*. A plate scale. **35.** *Chrysosphaerella longispina*. A plate scale. **36.** *Paraphysomonas vestita*. A spine scale. **37.** *Spiniferomonas* cf. *trioralis*. A plate scale. Bar = 0.5 µm if not stated otherwise.

Mallomonas alata Asmund, Cronberg _et_ Dürrschmidt **Fig. 4**

M. alata has often been confused with *M. pumilio* var. *munda* Asmund, Cronberg *et* Dürrschmidt, or *M. clavus* Bradley. However, scales of *M. alata* possess a unilateral wing, while in *M. pumilio* var. *munda* both anterior flanges are of the same length. The caudal scales of *M. alata* are provided with short spines, while the extreme caudal scales of *M. clavus* bear long tapered spines. It was also noted (Siver, 1991) that *M. alata* seems to occur predominantly during the cooler months of the year; my finding supports its preference for cold water conditions, as *M. alata* was found in station 5, where the recorded temperature was 7.3°C.

Distribution: Widely distributed (Kristiansen, 2002).

Previous Czech records: Kalina *et al.* (2000), Němcová *et al.* (2003a), Řezáčová *et al.* (2004), Pichrtová *et al.* (2007), Řezáčová & Neustupa (2007).

Mallomonas clavus Bradley **Figs 8-10**

An abundant population of *M. clavus* was found in station 11 (Břehyňský Pond). The structure of scales from the middle region of the cell is very similar to that of the scales of *M. pumilio* var. *munda*. However, in *M. clavus* the dome leads to a more pointed peak and is perforated by circular pores (Fig. 9). The most distinctive difference between these two species is the presence of long tapered spines on the caudal scales (Fig. 10). The observation of a partly disturbed scale case with various scale types and transition scales was useful for determining *M. clavus*. Hartmann & Steinberg (1989) suggested that this species is acidobiontic or acidophilic. This agrees with Siver (1989) and Gutowski (1997) as well as the present study.

Distribution: Northern temperate (Kristiansen, 2002). *M. clavus* was thought to be a European endemic species, but it was later observed in North America (Nicholls, 2001).

Previous Czech record: Recorded for the first time in this paper.

Mallomonas favosa Nicholls **Figs 13, 14**

M. favosa was found frequent in peat-bog stations, but in only small numbers. This species has very similar scales to *M. alveolata* Dürrschmidt. The primary difference consists in the presence, in *M. favosa,* of a large pit containing a small pore in the v-rib angle (Fig. 13). Two large pits were observed in the posterior part of all examined collar scales (Fig. 14).

Distribution: Cosmopolitan but rare species (Kristiansen, 2002; Siver, 1991).

Previous Czech record: Recorded for the first time in this paper.

Mallomonas maculata Bradley **Figs 15, 16**

M. maculata was observed in stations with slightly acidic water (stations 4 and 9; pH 4.8 and 6.1, respectively). Typical large shallow pits (0.5 µm in diameter) were visible in the centre and at one anterior edge of the collar scales (Fig. 16).

Distribution: Patchy (Kristiansen, 2002).

Previous Czech record: Recorded for the first time in this paper.

***Mallomonas multisetigera* Dürrschmidt** **Fig. 18**

Abundant populations of *M. multisetigera* were found in extremely acidic peaty pools (stations 1 and 2; pH 3.5 and 3.7, respectively). Previously, this species has been reported mainly from habitats with near-neutral (pH 6.3-6.8) water and low to moderate (16-56 $\mu S \cdot cm^{-1}$) conductivity (Jacobsen, 1985; Dürrschmidt, 1980; 1982).

Distribution: Cosmopolitan (Kristiansen, 2002).

Previous Czech record: Recorded from a shallow pool connected to desiccating stream (Bohemian Switzerland National Park), but not yet published (Pichrtová, personal communication).

***Mallomonas paludosa* Fott** **Fig. 20**

Only a small population of *M. paludosa* was found in station 11 (pH 5.8). This species is well documented in the literature as being characteristic of acidic (Roijackers & Kessels, 1986; Siver, 1995) and cold habitats (Siver, 1991).

Distribution: Widely distributed (Kristiansen, 2002).

Previous Czech records: Fott, (1957); Šejnohová, (2003).

***Mallomonas rasilis* Dürrschmidt** **Fig. 25**

M. rasilis was a relatively common species in this investigation (stations 4, 5, 8). Scales of *M. rasilis* are distinguished from those of *M. kalinae* Řezáčová mainly in the lack of an anterior submarginal rib. *M. rasilis* was previously found in neutral to slightly alkaline habitats (Gretz *et al.*, 1983; Barreto, 2005; Menezes *et al.*, 2005).

Distribution: Widely distributed (Kristiansen, 2002).

Previous Czech record: Recorded for the first time in this paper.

***Synura lapponica* Skuja** **Fig. 27**

S. lapponica was found only in station 1, where only a few scales were observed. Siver & Hamer (1992) found *S. lapponica* to be a true winter species with its greatest abundance occurring in December (with water temperatures not over 5°C), therefore it was assigned to the group of cold-water species (Siver 1995). My finding is consistent with this.

Distribution: Northern temperate and subarctic regions (Kristiansen, 2002). The estimated probability of its occurrence in the Southern Hemisphere is 22% (Němcová & Pichrtová, 2009).

Previous Czech record: Němcová & Pichrtová (2009).

Class Chrysophyceae

***Chrysosphaerella brevispina* Korshikov** **Figs 33, 34**

A common species, *C. brevispina* was found only in one station 10).

Distribution: Cosmopolitan (Kristiansen, 2000).

Previous Czech records: Fott & Ludvík, 1956; Štefanová & Kalina, 1992; Neustupa *et al.*, 2001; Němcová *et al.*, 2003a; Němcová *et al.*, 2003b).

Chrysosphaerella longispina **Lauterborn** **Fig. 35**

C. longispina was found in stations 4 and 8. In contrast to *C. brevispina*, *C. longispina* has a more restricted geographical distribution, being widespread at more northern latitudes (Kristiansen, 1994; Voloshko & Gavrilova, 2001), a distribution which is likely determineded ecologically, with water temperature (correlated with latitudinal or seasonal fluctuations) and lower pH playing primary roles.

Distribution: Northern temperate and subarctic regions (Siver *et al.*, 2005).

Previous Czech record: Recorded for the first time in the present paper.

Spiniferomonas **cf.** ***trioralis*** **Takahashi** **Fig. 37**

Only isolated plate scales of this species were observed, very likely belonging to the common *S. trioralis* but a conclusive identification was not possible because spine-scales are essential in that respect and none were found.

Distribution: Cosmopolitan (Kristiansen, 2000).

Previous Czech record: Kalina *et al.*, 2000.

DISCUSSION

The National Nature Monument Swamp represents a typical peat-bog, in which organic matter tends to accumulate because of poorly aerated conditions. Particularly in the northern section, the pH of most of the pools does not exceed 4. This area of the peat-bog was sampled once in June 1967 by Kalina (1969), at which time the only recorded species was *Mallomonas ouradion*. The same area was investigated again in July 1998 (Kalina *el al.*, 2000), when *S. sphagnicola* was also found to occur in an extremely acidic pool (pH 3.3). In the present study, the list of species able to flourish at extremely acidic pH values (stations 1 and 2) was extended to six (*M. multisetigera*, *M. ouradion*, *M. papillosa*, *Synura echinulata*, *S. sphagnicola* and *Paraphysomonas vestita*). While *S. sphagnicola* has been reported mainly from acidic habitats, prompting Siver (1995) to assign it to the low-pH group, the other species have a wider pH tolerance.

Unsurprisingly, investigations on the silica-scaled chrysophytes of acidic peaty pools are scant owing to an extremely low species diversity in this kind of habitat. According to the biotope character, the Swamp's acidic stations may be compared to subalpine and mountain mires, e.g. in the Krkonoše Mountains (Czech Republic), where Němcová *et al.* (2001) reported *S. sphagnicola* and *M. calceolus* from peaty pools with pH 3.7-3.9. An abundant population of *S. echinulata* was found by Machová-Černá & Neustupa (2009) in a drainage ditch in the southern part of the Břehyně-Pecopala National Nature Reserve, Czech Republic, at pH 3.8. As the pH drops to 5 and lower, the bicarbonate-carbonate buffering system is lost (Yan, 1979), and the environment is further acidified by an active cation exchange. Polyuronic acids in *Sphagnum* cell walls bind with the cations in the water and H^+ a re released in the water (Richter & Dainty, 1989), thereby lowering the pH. The availability of phosphorus for cells decreases considerably bellow pH 4.5 (Lucas & Davis, 1961). It is this pH value which appears to be the border value between stations with low diversity versus those sustaining a high species diversity, as shown by a comparison of stations 1 and 3 in this investigation. Temperature may also be an important factor in relation to species diversity and distribution. An increase in temperature leads to increased bacterial activity, which in turn increases O_2 consumption and decreases the redox potential and pH (Rydin & Jeglum, 2006). This might be one of the reasons why more species were found in the present study compared to that of Kalina *et al.* (2000), when the temperature reached ca. 25°C. Lower predation pressure during the winter and spring months may also contribute to higher species richness and population abundance (Sandgren & Walton, 1995). While the northern part of the Swamp was rather poor in species richness, the number of taxa increased slightly in the southern part due to higher habitat heterogeneity. Station no. 3 resembles the highly acidic site described above in both its character and species composition. The other stations were characterized by slightly higher pH, especially stations 4-6 and 9, which were influenced by a supply of nutrients from a nearby Máchovo jezero Fishpond.

In Břehyňský Pond, a previous investigation (Kalina *et al.*, 2000) reported ten taxa of silica-scaled chrysophytes. Only six common taxa were found during that investigation and the present study, i.e. and previous research, (*Mallomonas acaroides*, *M. crassisquama*, *Synura echinulata*, *S. petersenii*, *S. spinosa* and *S. uvella*). However, *M. akrokomos*, *M. alpina*, *M. parvula* and *M. striata* were not found during the present survey. This may be due, perhaps, to long-term fluctuations of environmental conditions (pH 7.5, temperature 21.2°C, conductivity 195 $\mu S \cdot cm^{-1}$), or seasonal population changes.

The most common and abundant species observed during this study were *Mallomonas adamas*, *M. multisetigera*, *M. papillosa*, *M. pumilio*, *Synura sphagnicola* and *Paraphysomonas vestita*. The species *Mallomonas annulata*, *M. heterospina*, *M. paludosa*, *M. papillosa* (Siver, 1991), *M. calceolus* (Roijackers & Kessels, 1986), *M. pumilio* (Harris & Bradley, 1960), *Synura echinulata*, *S. lapponica* (Siver, 1995) and *Chrysosphaerella longispina* (Siver *et al.*, 2005; Voloshko & Gavrilova, 2001) have been found primarily in cold and/or cool conditions. *M. multisetigera*, *M. ouradion*, *M. papillosa*, *Synura echinulata*, *S. sphagnicola* and *Paraphysomonas vestita* represent ecologically adapted species that are able not only to survive but also to form dominant populations in extremely acidic habitats. In addition to cosmopolitan and widely distributed species, *Mallomonas adamas* and *M. maculata,* which show patchy distributions, and *M. clavus*, *S. lapponica* and *C. longispina,* which show a northern temperate distribution, were found.

In conclusion, the National Nature Monument Swamp and Břehyňský Pond represent unique biotopes containing diverse populations of silica scaled chrysophytes. In future, owing to extremely acidic pH values several stations in the Swamp may serve as model sites for investigating the occurrence and ecology of acidophilic or acidobiontic species.

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