

The silica-scaled chrysophytes of the Czech-Moravian Highlands

Martina PICHRTOVÁ, Magda ŘEZÁČOVÁ-ŠKALOUDOVÁ & Pavel ŠKALOUĐ

Charles University in Prague, Faculty of Science, Department of Botany, Benátská 2, CZ-128 01 Prague; e-mail: drosophila@centrum.cz, skaloud@natur.cuni.cz

Abstract: Silica-scaled chrysophytes were studied in the region of the Czech-Moravian Highlands. A total of 40 taxa were found. Species *Paraphysomonas butcheri* was recorded for the first time from the territory of the Czech Republic. *Synura petersenii* was the most abundant species. The composition of the flora is typical of vernal phytoplankton.

Key words: Chrysophyceae, Synurophyceae, species composition, Czech-Moravian Highlands, phytoplankton, autecology

Introduction

Silica-scaled chrysophytes are unicellular or colonial flagellate organisms that belong to two classes of the division Heterokontophyta: Chrysophyceae and Synurophyceae (ANDERSEN 1987). All taxa of the class Synurophyceae and many of the Chrysophyceae carry on their surface a silica armour formed by scales. The ultrastructure of these structures is essential for the species determination.

Silica-scaled chrysophyte research has a long tradition in the Czech Republic. It began as far back as in 1950s (FOTT 1955). Recently, several papers have been published. For example, NĚMCOVÁ et al. (2003b) summarize data from the investigation period 1998–2001. Since that time further studies enriched the knowledge of the chrysophyte flora of the Czech Republic- they have been published by NĚMCOVÁ et al. (2003a), NOVÁKOVÁ et al. (2004a, b), ŘEZÁČOVÁ et al. (2004) and ŘEZÁČOVÁ & NEUSTUPA (2006).

The present paper reports silica-scaled chrysophyte flora of several localities in the Czech-Moravian Highlands. Investigations of the chrysophytes have taken place in this region previously (FOTT 1957, NEUSTUPA et al. 2001).

Material and methods

The samples were collected using a 20 µm mesh plankton net in April 2006. Water temperature, pH and conductivity were measured in the field using

portable instrument Combo HI 98129. Lugol fixed samples were rinsed with distilled water and centrifuged. Drops of the samples were placed on Formvar coated copper grids. After evaporating of the water, the grids were observed under a TEM JEOL 1011 microscope.

Localities

The Czech-Moravian Highland is quite an extensive upland on the Czech-Moravian border. The average altitude of the territory is about 500-600 m a.s.l. It is a region fruitful of water - the annual precipitation level is between 600 and 800 mm. Ten samples were collected from ponds, pools and a brook located in the Žďárské vrchy Protected Landscape Area. The names and short characteristics of the localities are presented below:

1. The Velké Dářko Pond, a pond used for recreation, area of 206 ha.
2. The Babín Pond, a slightly dystrophic fishpond, area of 18 ha.
3. The Matějovský Pond, a fishpond, area of 65 ha.
4. A shallow pool in the immediate vicinity of the Matějovský Pond.
5. The Šabrava Brook, a brook flowing from the Křivý Pond.
6. The Ranský Pond, a fishpond, area of 20 ha.
7. A small forest unnamed pool located near village Staré Ransko.
8. A forest pool in the Ranská jezírka Nature Reserve
9. The Řeka Pond, a pond used for recreation, area of 64 ha.
10. A small unnamed pond near village Světnov.

The values of measured environmental variables and the dates of the sampling are given in Tab. 1.

Table 1. Values of measured environmental variables of the investigated localities and the dates of the sampling in 2006.

Number of locality	1	2	3	4	5	6	7	8	9	10
Date of sampling	24.4.	27.4.	27.4.	27.4.	27.4.	28.4.	28.4.	28.4.	28.4.	29.4.
Water temperature (°C)	16	19	21	20	15.5	17.5	16	15	15.5	12
pH	6.5	5.6	6.2	6.5	6.9	6.1	6.5	6.3	6.2	5.8
Conductivity ($\mu\text{S} \cdot \text{cm}^{-1}$)	80	52	106	208	175	115	63	112	123	87

Results and discussion

Silica-scaled chrysophytes were found in all ten investigated localities. Altogether, 36 species were identified. Most of them belong to the genus *Mallomonas* (26 species). The others are species of genera *Synura*, *Spiniferomonas*, *Paraphysomonas* and *Chrysosphaerella*. The complete list of the recorded species is presented in Tab. 2.

The most common taxon, *Synura petersenii*, was found in all 10 localities and in 8 of them was dominant. Very abundant species were *Chrysosphaerella brevispina*, *Mallomonas annulata*, *M. akrokomos*, *M. crassisquama* and *M. heterospina*. These species often occur in vernal phytoplankton (NĚMCOVÁ et al. 2003a, ŘEZÁČOVÁ 2005).

On the other hand, many species were found in only one locality (*Paraphysomonas butcheri*, *Spiniferomonas bourrellyi*, *S. trioralis*, *Mallomonas areolata*, *M. calceolus*, *M. costata*, *M. cratis*, *M. elongata*, *M. eoa*, *M. flora*, *M. mangofera* f. *foveata*, *M. oviformis*, *M. prora*, *M. pumilio* var. *munda*, *M. retifera*).

Species recorded for the first time from the Czech Republic and rare species are discussed below:

Paraphysomonas butcheri PENNICK et CLARKE (Figs 1, 2)

This colourless species with spherical body bears two unequal flagella. It is characterized by two basic forms of scales: two-dimensional (with concentric rows of apertures) and three-dimensional (open box-like), consisting of basal and apical ring. They are also called plate and crown scales (PENNICK & CLARKE 1972). THOMSEN (1975) observed that the plate scales can vary a lot in different cells - some had a higher number of perforations, whereas other cells had fewer and larger ones.

Distribution: *P. butcheri* was described as a marine species, but now is considered to have a cosmopolitan distribution (BARETTO 2005) and belongs to the most abundant *Paraphysomonas* species (FINLAY & CLARKE 1999).

CZ records: recorded for the first time.

Paraphysomonas imperforata LUCAS (Fig. 3)

The baseplate of the scales is flat or slightly curved and does not possess a thickened rim. The spine ends in an abruptly pointed tip (PREISIG & HIBBERD 1982a).

Distribution: This species was described from a marine locality, however it is cosmopolitan (BARETTO 2005) and very common (FINLAY & CLARKE 1999).

CZ records: (ŘEZÁČOVÁ 2005).

Spiniferomonas bourrellyi TAKAHASHI (Fig. 4)

Scales of this species are elliptical, with one central hollow. The spine is smooth, straight, tubular and tapered, has a basal disc and terminates in biforked end (TAKAHASHI 1973).

It is a pigmented non-colonial flagellate (TAKAHASHI 1973), but it probably may lose its chloroplast under certain environmental conditions (NICHOLS 1985). This fact caused temporary invalidation of the genus *Spiniferomonas* after discovery of cells without chloroplast (PREISIG & HIBBERD 1982b).

Distribution: It is a widely distributed species (BARETTO 2005).

CZ records: (ŘEZÁČOVÁ 2005).

Mallomonas cratis HARRIS et BRADLEY (Fig. 5)

The V-rib has rounded base and in its angle there are small teeth. The dome is present and marked with strongly U-shaped ribs. The shield possesses about 18 ribs and their prolongations make struts on the anterior flanges. There are also ribs on the posterior flange (KRISTIANSEN 2002).

Distribution: widely distributed (BARETTO 2005).

CZ records: (ŘEZÁČOVÁ 2003).

Mallomonas eoa TAKAHASHI (Fig. 6)

The pits of the shield are large and circular. Rear scales bear stiff, straight spines with blunt tips (KRISTIANSEN 2002).

Distribution: widely distributed (KRISTIANSEN 2002).

CZ records: (ŘEZÁČOVÁ & NEUSTUPA 2006).

***Mallomonas flora* HARRIS et BRADLEY**

(Fig. 7)

A group of one to five larger pores placed posteriorly on the shield creates a flower-like pattern. V-rib has rounded base and it is strongly hooded. Anterior submarginal ribs are well developed, shorter than the sides of the V-rib (KRISTIANSEN 2002).

Distribution: widely distributed (KRISTIANSEN 2002).

CZ records: (NĚMCOVÁ et al. 2001, NĚMCOVÁ et al. 2003b).

***Mallomonas mangofera* HARRIS et BRADLEY f. *foveata* DÜRRSCHMIDT** (Fig. 8)

The scales have a characteristically arranged row of circular pits with a bordered pore at the bottom (KRISTIANSEN 2002).

Distribution: cosmopolitan (KRISTIANSEN 2002), but rarely encountered (SIVER 1991).

CZ records: (NOVÁKOVÁ et al. 2004).

***Mallomonas prora* DÜRRSCHMIDT** (Fig. 9)

Some body scales are strongly asymmetric. An additional pattern on the shield is created by irregularly arranged patches and stripes of particularly electron-dense material (KRISTIANSEN 2002).

Distribution: bipolar, rare, reported only a few times (KRISTIANSEN 2002).

CZ records: (ŘEZÁČOVÁ et al. 2004).

***Mallomonas retifera* DÜRRSCHMIDT** (Fig. 10)

Both body and apical scales are asymmetric. Two well defined transverse ribs are placed anteriorly on the shield of the body scales (KRISTIANSEN 2002).

Distribution: scattered (BARETTO 2005), rare, found only several times (KRISTIANSEN 2002).

CZ records: (ŘEZÁČOVÁ et al. 2004).

The chrysophyte flora has already been studied in this region. The previous investigations (NEUSTUPA et al. 2001) included localities the Matějovský Pond and the Babín Pond, which were studied this time again. NEUSTUPA et al. (2001) had carried out sampling at the end of May, whereas our samples were collected in April. That corresponds with our observed species composition which is more typical of vernal phytoplankton than the one presented by NEUSTUPA et al. (2001). A classic example is

Synura petersenii, the most abundant species in our study. This frequent species belongs to the group of taxa that disappear relatively soon after ice-out (SIVER 1995). NEUSTUPA et al. (2001) found *Synura petersenii* only in one locality. On the other hand, *Synura echinulata* and *Mallomonas caudata* were present in the Matějovský Pond during both investigations. Both species are known to tolerate a wide range of temperature (SIVER 1995). Besides *Synura echinulata* and *S. petersenii*, two common species: *S. spinosa* (Fig. 11) and *S. uvella* (Fig. 12) occurred in the Matějovský Pond. The largest number of species was also identified in the Matějovský Pond and after it in the Šabrava Brook (localities 3, 4, 5). Two rare species: *M. prora* and *M. retifera* also occurred there, which had previously been found in South Bohemia (ŘEZÁČOVÁ et al. 2004). Furthermore, these localities were rich in other phytoplankton, especially in desmids, diatoms (mostly *Asterionella*, *Aulacoseira*), euglenophytes and dinophytes. Interestingly, only two chrysophyte species occurred in the Babín Pond (locality 2), which is located near the Matějovský Pond. Here, the genus *Uroglena* was quite dominant.

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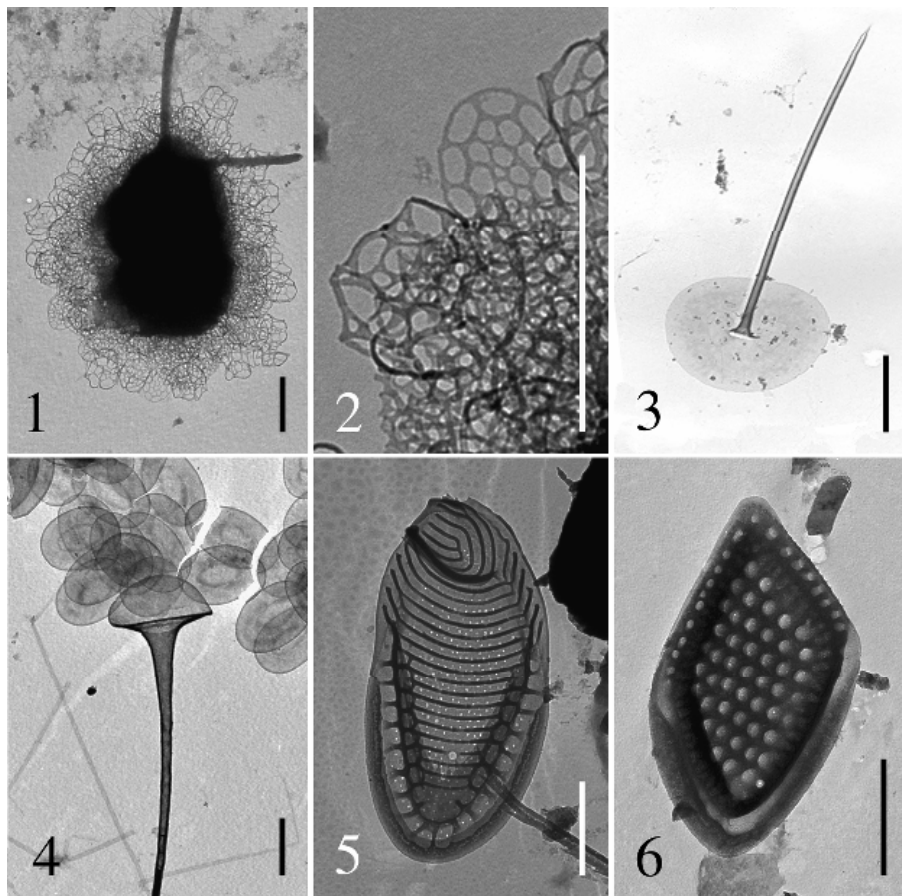
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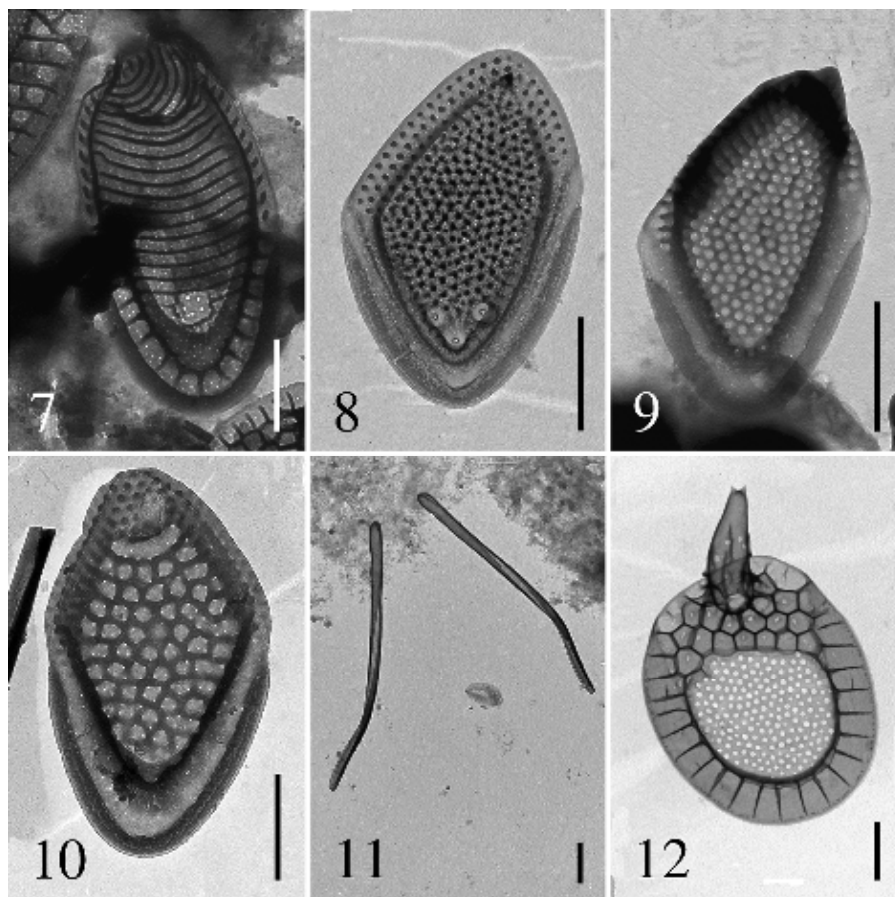
Table 2. List of species with their occurrence in the investigated localities. Dominant taxa in bold.

Taxon	Number of locality									
	1	2	3	4	5	6	7	8	9	10
<i>Chryso-sphaerella brevispina</i>	x		x		x	x		x	x	
<i>Paraphysomonas butcheri</i>				x						
<i>P. imperforata</i>			x		x	x				
<i>P. vestita</i>	x		x	x	x			x		
<i>Spiniferomonas bourrellyi</i>			x							
<i>S. trioralis</i>			x							
<i>Mallomonas akrokomos</i>			x	x	x	x				
<i>M. alata</i> f. <i>alata</i>	x				x		x			x
<i>M. areolata</i>			x							
<i>M. annulata</i>	x		x	x	x	x			x	
<i>M. calceolus</i>	x			x						
<i>M. caudata</i>			x		x					x
<i>M. costata</i>				x						
<i>M. crassisquama</i>	x		x		x	x			x	

Cont. Table 2										
<i>M. cratis</i>					x					
<i>M. elongata</i>									x	
<i>M. eoa</i>								x		
<i>M. flora</i>					x					
<i>M. heterospina</i>	x		x		x	x				
<i>M. mangofera</i> f. <i>foveata</i>						x				
<i>M. oviformis</i>						x				
<i>M. papillosa</i>					x	x				
<i>M. prora</i>					x					
<i>M. pumilio</i> var. <i>pumilio</i>					x	x				
<i>M. pumilio</i> var. <i>munda</i>					x					
<i>M. punctifera</i>	x								x	
<i>M. retifera</i>									x	
<i>M. schwemmleri</i>	x									x
<i>M. striata</i>					x	x				
<i>M. tonsurata</i>				x	x	x	x	x		x
<i>M. transsylvanica</i>				x	x	x				
<i>M. trummensis</i>									x	x
<i>Synura echinulata</i>		x	x	x	x					
<i>S. petersenii</i>	x	x	x	x	x	x	x	x	x	x
<i>S. spinosa</i>			x	x	x	x				
<i>S. uvella</i>	x		x						x	
Total taxa	11	2	17	18	23	12	2	5	4	3



Figs 1-6. 1 *Paraphysomona butcheri*: 1 whole cell, 2 scales; 3 *P. imperforata*; 4 *Spiniferomonas bourrellyi*: scales and spines; 5 *Mallomonas cratis*: scale; 6 *M. eoa*: body scale. Scale bars 1 µm.



Figs 7-12. 7 *Mallomonas flora*: scale with flower pattern; 8 *M. mangofera* f. *foveata*: body scale; 9 *M. prora*; 10 *M. retifera*; 11 *Synura spinosa*: tubular scales; 12 *S. uvella*: body scale. Scale bars 1 μm .