The silica-scaled chrysophytes of the Elbe Sandstone Region, Czech Republic

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Abstract: We investigated the silica-scaled chrysophyte flora (classes Chrysophyceae and Synurophyceae) in the Czech part of the unique Elbe sandstone region. We focused on such types of habitats that had not been studied in the region before – small ponds, forest pools and headwater streams. In 10 localities we found altogether 20 chrysophyte species. *Chrysodydimus synuroideus*, *Mallomonas multisetigera* and *M. striata* var. *serrata* were recorded from the Czech Republic for the first time. Moreover, another 4 species were first records for the Elbe sandstone region. Living chrysophytes were also observed in sediment samples, though they are generally believed to be planktonic.

Key words: Chrysophyceae, Elbe sandstones, Elbsandsteingebirge, silica-scaled chrysophytes, Synurophyceae

Introduction

The Bohemian Switzerland National Park and the Elbe Sandstone Protected Landscape Area are situated in the north of the Czech Republic at the German border. Together with the Saxon Switzerland National Park and the Saxon Switzerland Protected Landscape Area in Germany they comprise a unique sandstone landscape formation of European importance (Patzelt & Sojka 2003) called the Elbsandsteingebirge (Elbe Sandstone) region. Above all, this region is special for its geomorphology – sandstone rocks and deep gorges, formed by the Quaternary erosion of Cretaceous sediments. However, it is not respected only for its geodiversity - a lot of rare or endangered species of animals and plants can be found there (Patzelt & Sojka 2003).

The flora of silica-scaled chrysophytes is useful for assessment of the microbial distribution (Kristiansen 2000, Řezáčová & Neustupa 2007), biomonitoring with respect to pH, temperature and eutrophication (Roijackers & Kessels 1986, Siver 1995), and paleoecological reconstructions (Zeeb & Smol 2001).

In the Elbsandsteingebirge region, the silica-scaled flora was previously investigated by Nováková et al. (2004), who studied peat bogs. Subsequently, a new species *Mallomonas kalinae* Řezáčová was described from one peat-bog pool in the Elbe Sandstone Protected Landscape Area (Řezáčová 2006).

In the present study we focused on the silica-scaled chrysophytes from forest ponds, small pools and headwater streams. These habitats had not been previously studied in the Elbsandsteigebirge region.

Material and methods

The area of the Bohemian Switzerland National park is poor in water bodies because of high water permeability of the sandstone bedrock (Patzelt & Sojka 2003). Small ponds, natural pools and headwater (mostly ephemeral) streams were investigated. Altogether, 27 plankton and upper sediment samples from two ponds (locality: 1, 2) and two pools (locality: 3, 4; Fig. 1) were taken in different seasons during 2005–2007. A total of 161 samples from 15 streams were collected from different types of substrates between 2004 and 2006, (for details see Veselá & Johansen, accepted). However, only 6 selected samples with abundant silica-scaled chrysophytes or specific algal composition were chosen from all of the stream samplings for further TEM (transmission electron microscope) investigations. Conductivity and pH were measured using a Hanna Combo HI 98129 pH/EC/TDS tester/ thermometer. Fresh material was examined using a light microscope Olympus BX 51 with DIC. Samples

Fig. 1. Locations of sampling sites in the Elbe Sandstone region: (1) a pond in a forest on the Suchá Bělá Stream; (2) a pond at the road from Hřensko to Mezní Louka, always turbid and coloured by inorganic particles; (3) a pool directly above the previous site; (4) a pool in a forest close to the municipality of Mezní Louka; (5) the Dolnožlebský Stream, a lower reach above the municipality of Dolní Žleb; (6) the Písečná Rokle Stream, a lower reach above the confluence with the Kamenice Stream; (7) the Kachní Stream, an upper reach near the origin and a lower reach above the confluence with the Kamenice Stream; (8) the Hluboký Důl Stream, an upper reach near the origin; (9) the Mlýnská Rokle Stream, an upper reach near the origin; (10) the Studený Stream, a lower reach above the municipality of Studený near hill Studenec.

for TEM investigations were prepared in accordance with PICHRTOVÁ et al. (2007) and chrysophyte taxa were identified using a TEM JEOL 1011 microscope.

Results and Discussion

Conductivity values varied between 49–155 $\mu S.cm^{-1}$ and pH between 3.6–6.7 (Table 1). A total of 20 silica-scaled chrysophytes were identified in 10 localities including 2 Chrysophyceae and 18 Synurophyceae taxa (Table 2). The greatest species number was found in a forest pond at the end of the Suchá Bělá Stream, and in an ephemeral pool connected with the Kachní Stream. The silica-scaled chrysophytes were poorly represented in the other streams, in several sediment samples there were only *Synura* species and in one extremely acidic stream (the Mlýnská Rokle Stream) there was a large population of *Mallomonas ouradion* HARRIS et BRADLEY (Fig. 2g). NOVÁKOVÁ et al. (2004) have recorded 16 chrysophyte species in the region and in the present study we have confirmed a repeated occurrence of 14 of them.

Synura echinulata KORSHIKOV (Fig. 2h) occurred in our samples most frequently. This species is widely distributed and prefers neutral to slightly acidic waters (KRISTIANSEN & PREISIG 2007). These findings are in good agreement with the observed physical-chemical parameters of the study area (Table 1).

The only one scale of *Mallomonas multisetigera* DÜRRSCHMIDT (Fig. 2f) was found in the sediment sample from the ephemeral Písečná Rokle Stream. It is the first record of this species for the Czech Republic. It has a cosmopolitan distribution (KRISTIANSEN & PREISIG 2007) and has been reported as more common in acidic waters (SIVER 2001).

Also *Chrysodydimus synuroideus* PROWSE

Table 1. Chemical parameters of the sampling sites. The values for sites 1-4 are averages from seven different samplings.

Locality	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
pH	5.8	5.9	6.0	5.0	6.3	5.2	6.0	4.7	3.6	6.7
conductivity ($\mu S.cm^{-1}$)	64	144	49	59	155	148	118	78	82	109

Table 2. List of silica-scaled chrysophyte taxa from the Elbsandsteingebirge region. First records for the Czech Republic are marked with an asterisk, first records for the region with double asterisk (for localities see Fig. 1).

Locality	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Chrysophyceae										
Chrysosphaerella brevispina Korshikov**	+		+							
Paraphysomonas vestita (Stokes) De Saedleer	+				+		+			
Synurophyceae										
Chrysodidymus synuroideus Prowse*							+			
Mallomonas adamas Harris et Bradley	+									
M. annulata (Bradley) Harris**							+			
M. calceolus Bradley							+			
M. flora Harris et Bradley**							+			
M. matvienkoae Asmund et Kristiansen**	+									
M. multisetigera Dürrschmidt*						+				
M. ouradion Harris et Bradley									+	
M. papillosa Harris et Bradley	+						+			
M. pillula Harris f. *pillula*				+			+			
M. pumilio Harris et Bradley var. *pumilio*	+									
M. schwemmlei Glenk	+									
M. striata var. *serrata* Harris et Bradley*				+						
M. tonsurata Teiling	+									
Synura echinulata Korshikov	+	+	+	+			+			
S. petersenii Korshikov			+	+			+			
S. sphagnicola (Korshikov) Korshikov			+	+						
S. spinosa Korshikov	+									
Synura spp.								+	+	+

(Fig. 2b) was found in the Czech Republic for the first time. *Chrysodydimus* forms characteristically moving two-celled colonies. The different way of movements distinguishes *Chrysodydimus* from the genus *Synura* which can sometimes also consist of two cells only (Nicholls & Gerrath 1985). We recorded two scales of *C. synuroideus* in the sediment sample from the locality Kachní Stream. It is considered to be an acidophilic or acidobiontic species (Siver 2001) with a cosmopolitan but scattered distribution (Kristiansen & Preisig 2007).

The variety *Mallomonas striata* var. *serrata* Harris & Bradley (Fig. 2i) belongs to the first records for the Czech Republic, too. We observed it in pond at the end of the Suchá Bělá Stream. The main distinctive feature of *M. striata* varieties is the bristle type that is necessary for

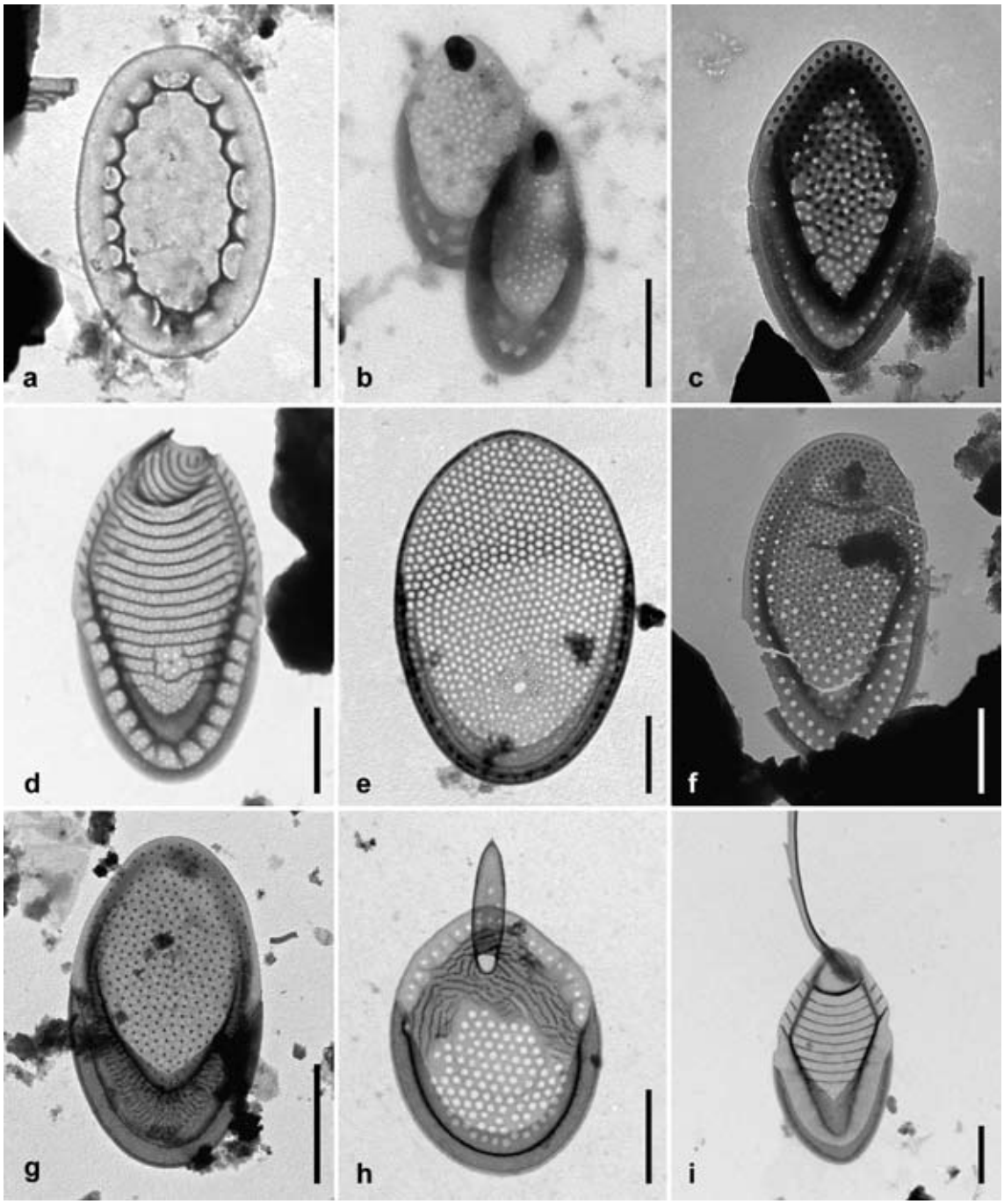

Fig. 2. Silica scales of reported species: (a) *Chrysosphaerella brevispina*; (b) *Chrysodidymus synuroideus*; (c) *Mallomonas annulata*; (d) *M. flora*; (e) *M. matvienkoae*; (f) *M. multisetigera*; (g) *M. ouradion*; (h) *Synura echinulata*; (i) *Mallomonas striata* var. *serrata.* Scale bars 1 μm.

their determination (KRISTIANSEN 2002). However, the differences between the varieties in the scale shape alone have already been discussed (NEUSTUPA & NĚMCOVÁ 2007). *Mallomonas striata* var. *serrata* occurs in lower temperatures and neutral pH (ROIJACKER & KESSELS 1986) and has a cosmopolitan distribution (KRISTIANSEN & PREISIG 2007).

Our findings contributed to the knowledge of the chrysophyte flora of the Elbsandsteingebirge region and of the distribution of the silica-scaled chrysophytes. Biogeography of microorganisms is in a focus of researchers with respect to the hypothesis whether protist species have a restricted distribution or whether they are cosmopolitan and ubiquitous (e.g. FINLAY & CLARKE 1999, KRISTIANSEN & LIND 2005, FOISSNER 2008).

The occurrence of the silica-scaled

chrysophytes associated with soft surface sediments in pools within small streams demonstrated that these organisms appear to be not only euplanktonic, though they are generally believed to be (Kristiansen 1986, Sandgren 1988). In accordance with our findings, diverse benthic chrysophyte assemblages have already been recorded (see Zeeb & Smol 2001).

Furthermore, in many stream samples we observed numerous chrysophycean cysts (resting spores). They are produced at the end of the occurrence period (Kristiansen 2002). In the investigated localities the cyst formation is probably connected with the desiccation of the streams during summer as the principal stress factor.

In conclusion, we reported seven silica-scaled chrysophytes new for the region including three first reports for the Czech Republic. In addition, we suggested that also habitats unusual for chrysophyte algae, such as sediments or small streams, may possess diverse chrysophyte flora.

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