

## SOME SILICA-SCALED CHRYSOPHYTES FROM THE TATRA MOUNTAINS, POLAND

JOLANTA PIĄTEK

**Abstract.** Four species of chrysophytes were identified from a peat bog and lakes in the Tatra Mts in Poland: *Mallomonas acaroides* Perty emend. L. Ivanov, *M. flora* K. Harris & D. E. Bradley, *Synura echinulata* Korshikov and *S. petersenii* Korshikov. *Mallomonas flora* and *Synura echinulata* are reported from Poland for the first time, and all of them for the first time from the Polish Tatra Mts. The species are described and illustrated with LM and SEM micrographs.

**Key words:** Chrysophytes, Synurophyceae, *Mallomonas*, *Synura*, Tatra Mountains, Poland

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### INTRODUCTION

During examination of water samples collected for a study of chrysophyte stomatocysts in the Tatra National Park, Poland, I sometimes also observed living cells, colonies and scales of chrysophytes. They were observed by light microscopy and/or scanning electron microscopy. Four species were identified. Two were observed by both LM and SEM, and the other two only by SEM. This paper describes and illustrates these chrysophytes, two of which are new to Poland (*Mallomonas flora* K. Harris & D. E. Bradley and *Synura echinulata* Korshikov), and all of which are new to the Polish Tatra Mts.

### MATERIALS AND METHODS

The material was collected from a peat bog adjoining Litworowy Staw Gąsienicowy lake (21 September 2005) and from Zadni Staw Gąsienicowy lake (23 September 2005), Czerwone Stawki Gąsienicowe lakes (east lake) (23 September 2005) and Przedni Staw Polski lake (4 July 2007), all situated in the Polish Tatra Mts. Water samples were collected from different microhabitats: bottom sediment, water squeezed from aquatic plants, and plankton. Phytoplankton was collected with a plankton net (10 or 20 mm mesh). The samples are preserved in a 30% water solution of formaldehyde

(formalin). Live samples were examined and identified by standard light and phase contrast microscopy (LM) and SEM. Slide preparations for LM were mounted in water and studied using a NIKON Eclipse 600 light microscope equipped with Nomarski phase contrast. The micrographs were taken with a NIKON DS-Fi1 camera. For SEM analysis each sample was pipetted onto clean cover glasses, air-dried and affixed to an aluminum stub with double-sided transparent tape. The stubs were sputter-coated with carbon using a CRESSINGTON sputter-coater and viewed with a Hitachi S-4700 scanning electron microscope. SEM micrographs were taken in the Laboratory of Field Emission Scanning Electron Microscopy and Microanalysis at the Institute of Geological Sciences of the Jagiellonian University.

The chemical and physical characteristics of the water (oxygen, silica, SiO<sub>2</sub>) were determined at the same time immediately after collection, with a Spectroquant® NOVA 60 (Merck). Water temperature (°C), conductivity (μS·cm<sup>-1</sup>) and pH were measured with a CC-102 conductivity meter (Elmetron IP67) and a CP-103 waterproof pH-meter (Elmetron IP67). These characteristics of the water from these locations are presented in Table 1.

All measurements of the cells and their scales are from slide preparations studied by LM and directly from LM and SEM micrographs. The descriptions of *Mallomonas* species follow the terminology of Kristiansen (2002), and the descriptions of *Synura* species follow

**Table 1.** Chemical and physical characteristics of the localities where chrysophytes were found (all stations in the Polish Tatra Mts).

Locality	Peat bog adjoining Litworowy Staw Gąsienicowy lake	Zadni Staw Gąsienicowy lake	Czerwone Stawki Gąsienicowe lakes (east lake)	Przedni Staw Polski lake
Date	21 Sept. 2005	23 Sept. 2005	23 Sept. 2005	4 July 2007
Temperature of water (°C)	8.0	6.4–7.0	8.9–9.0	12.5
pH	7.2	8.12	7.88	6.69
Conductivity ( $\mu\text{S}\cdot\text{cm}^{-1}$ )	10.0	13.0	15.0	22.5
Oxygen (O <sub>2</sub> ) mg/l	6.9	8.4	7.8	no data
Si mg/l	no data	0.045	0.059	no data
SiO <sub>2</sub> mg/l	no data	0.13	0.12	no data

the terminology of Kristiansen (1986) and Kristiansen and Preisig (2001), as summarized by Kristiansen and Preisig (2007).

## RESULTS AND DISCUSSION

SYNUROPHYCEAE R. A. Andersen

SYNURALES R. A. Andersen

MALLOMONADACEAE Diesing

*Mallomonas acaroides* Perty *emend.* L. Ivanov  
Fig. 1

LOCALITY: Zadni Staw Gąsienicowy lake, water squeezed from plants (23 September 2005).

SEM DESCRIPTION: All the scales are tripartite, composed of a dome, shield and flange, with a distinct V-rib separating the shield from the flange. Scales are 5.2–5.5  $\mu\text{m}$  long and 3.4–3.8  $\mu\text{m}$  wide.

NOTES. The scales of *M. acaroides* were found only in the preparations studied by SEM. No living or preserved cells were observed by light microscopy. *Mallomonas acaroides* is very similar to *Mallomonas crassisquama* (Asmund) Fott. They have similar development of the secondary ornamentation of the shield. The most important difference between these two species is the presence of spines on the posterior scales of *M. crassisquama* and the absence of such spines in *M. acaroides*. In the present material from Zadni Staw Gąsienicowy lake I observed many scales, and all of them be-

longed to the same species. Due to the absence of domeless scales and spined scales they were identified as *M. acaroides*.

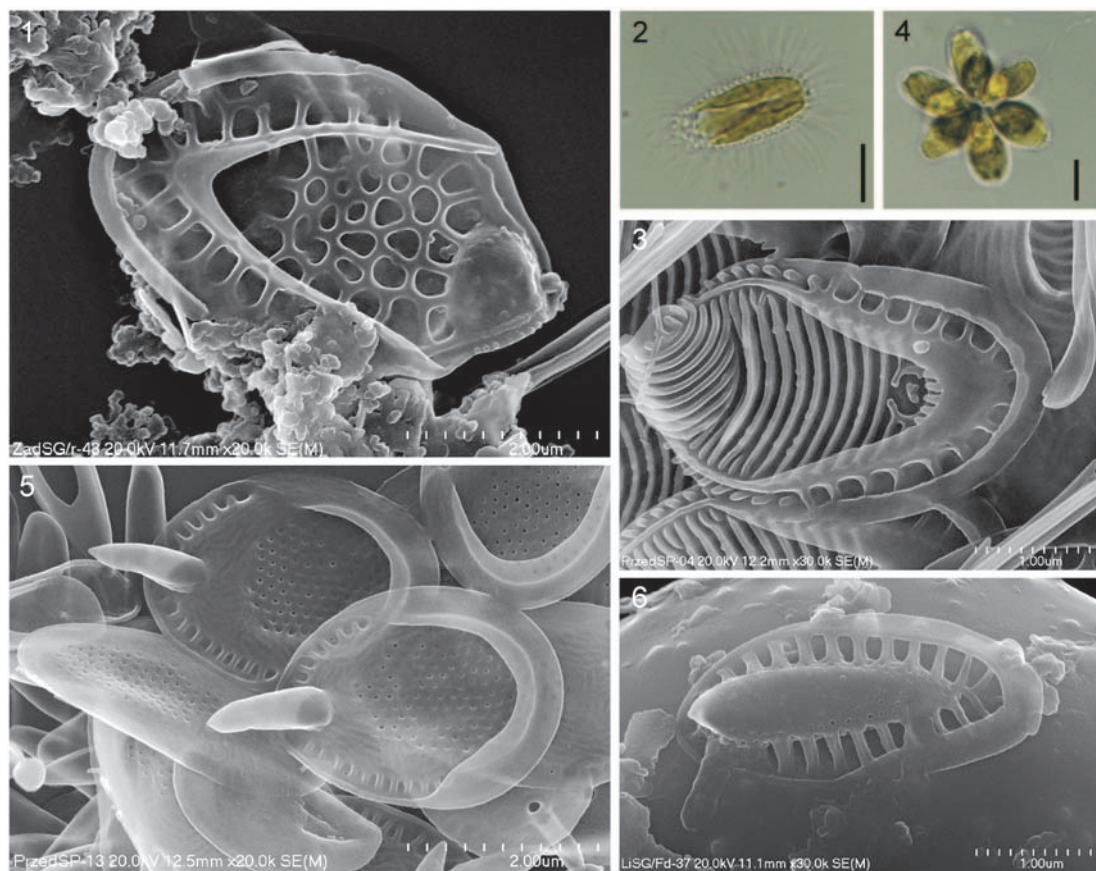
*Mallomonas acaroides* is widely distributed around the world, mainly in the temperate zone (Kristiansen & Preisig 2007). Many reports of this chrysophyte are based on LM observations and are therefore of doubtful value. *Mallomonas acaroides* has been reported from Poland several times (Siemińska & Wołowski 2003), but these records have not been supported by light and electron micrographs. *Mallomonas acaroides* is new to the Polish Tatra Mts; previously only *M. acaroides* fo. *tatica* Wołoszyńska was reported from there (Wołoszyńska 1939), but the identity of this form is unknown. It has been reported from the Czech Republic (Němcová *et al.* 2003).

*Mallomonas flora* K. Harris & D. E. Bradley  
Figs 2 & 3

LOCALITY: Przedni Staw Polski lake, on bottom (4 July 2007).

LM DESCRIPTION: The cells are ovoid, 21.1–27.0  $\mu\text{m}$  long and 8.8–11.0  $\mu\text{m}$  wide. The bristles are 8.0–12.0  $\mu\text{m}$  long.

SEM DESCRIPTION: The scales are tripartite, composed of a dome, shield and flange, with a strongly curved V-rib separating the shield from the flange. The scales have a characteristic flower-like pattern on the posterior side of the shield, well visible in Fig. 3. The scales are elongate, 3.5–3.9



**Figs 1–6.** 1 – Body scale of *Mallomonas acaroides* Perty emend. L. Ivanov; 2 – Whole cell with scales and bristles of *Mallomonas flora* K. Harris & D. E. Bradley; 3 – Body scale with distinct flower-like pattern of *Mallomonas flora* K. Harris & D. E. Bradley; 4 – Colony of *Synura echinulata* Korshikov; 5 – Body scales with characteristic labyrinthic apical pattern of *Synura echinulata* Korshikov; 6 – Body scale with characteristic central ridge of *Synura petersenii* Korshikov. Scale bars for LM (Figs 2 & 4) = 10  $\mu\text{m}$ .

$\mu\text{m}$  long and 2.1–2.4  $\mu\text{m}$  broad. They have 9–11 curved, transverse ribs on the shield and 8 ribs on the flange, and the anterior submarginal ribs have about 8 external struts. The dome is ornamented with very curved ribs. The serrate bristles are 8.0–12.5  $\mu\text{m}$  long and 0.3–0.4  $\mu\text{m}$  wide.

**NOTES.** *Mallomonas flora* is widely distributed around the world (Kristiansen & Preisig 2007), and considered to be acidobiontic or acidophilic (Němcová *et al.* 2001). *M. flora* is reported here for the first time from Poland. It has been reported from the Czech Republic (Němcová *et al.* 2001, 2003).

#### *SYNURACEAE* Lemmerm.

#### *Synura echinulata* Korshikov Figs 4 & 5

**LOCALITIES:** Peat bog adjoining Litworowy Staw Gąsienicowy lake, on bottom (21 September 2005), Czerwone Stawki Gąsienicowe lakes (east lake), on bottom (23 September 2005), and Przedni Staw Polski lake, on bottom (4 July 2007).

**LM DESCRIPTION:** The colonies are spherical, 37.5–47.5  $\mu\text{m}$  in diameter, and composed of numerous cells 8.7–11.5  $\mu\text{m}$  wide and 20.0–23.7  $\mu\text{m}$  long.

**SEM DESCRIPTION:** The scales have a laby-

rinthic apical pattern 2.9–3.0  $\mu\text{m}$  long and 2  $\mu\text{m}$  wide, with linear, narrower, delicate and closely spaced bars ornamenting the front part of the scale. The basal plate of the scale is ornamented with irregularly scattered holes. The scale has an apical spine 2  $\mu\text{m}$  long and 0.4  $\mu\text{m}$  wide. The tip of the spines narrows to a small tooth.

NOTES. *Synura echinulata* is widely distributed around the world (Kristiansen & Preisig 2007), occurring in oligotrophic and eutrophic waters (Barreto *et al.* 2000), and very tolerant of low pH (Němcová *et al.* 2001). *Synura echinulata* is reported here for the first time from Poland. It has been reported from the Czech Republic (Němcová *et al.* 2001, 2003).

*Synura petersenii* Korshikov Fig. 6

LOCALITY: peat bog adjoining Litworowy Staw Gaśienicowy, on bottom (21 September 2005).

SEM DESCRIPTION: The scales are 3.2  $\mu\text{m}$  long and 1.6  $\mu\text{m}$  wide, with a central ridge 2.4  $\mu\text{m}$  long and 0.6  $\mu\text{m}$  wide, and rim 2.4  $\mu\text{m}$  long and 0.3  $\mu\text{m}$  wide.

NOTES. *Synura petersenii* is a cosmopolitan species with a very wide ecological amplitude, reported from all six continents (Kristiansen & Preisig 2007). In Poland it was recorded from the Vistula River in the Warsaw area (Klimowicz 1981, without SEM or TEM) and from a fishpond in Szczerbaków village in the Wyżyna Małopolska upland (Piątek 2007). *Synura petersenii* is reported here for the first time from the Polish Tatra Mts. It has been reported from the Czech Republic (Němcová *et al.* 2001, 2003).

DISCUSSION

Two species (*Mallomonas flora*, *Synura echinulata*) were observed as freely living cells or colonies by LM, and as scales or cells in material prepared for SEM. *Mallomonas acaroides* and *Synura petersenii* have not been observed as live specimens, only as scales observed by SEM, so there is no information about cells, colonies, chloroplasts or flagella. However, taxonomy in the genus *Mallo-*

*monas* and *Synura* is based mostly on silica scale ultrastructure (Kristiansen & Preisig 2007), so it was possible to identify these species.

Although these chrysophytes are widely distributed around the world (Kristiansen & Preisig 2007) they are rarely recorded in Poland or are new to this country. *Synura echinulata* and *Mallomonas flora* are recorded from Poland for the first time. *Mallomonas acaroides* is described and illustrated using SEM micrographs from Polish materials for the first time. *Synura petersenii* is reliably reported from Poland for only the second time. Knowledge of chrysophytes in Poland is still incomplete; the sole previous report of chrysophytes based on SEM studies is from Piątek (2007). Many more species may be found in Poland, as they are commonly observed all over the world. The four presented here, like many other chrysophytes, are common in the neighboring Czech Republic (Němcová *et al.* 2001, 2003).

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