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# CHRYSOPHYCEAE STOMATOCYSTS FROM BUDZYŃ PEAT BOG (KRAKÓW-CZĘSTOCHOWA UPLAND, POLAND)

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**Abstract**: Chrysophycean stomatocysts from the small, very threatened peat bog near Budzyń (Kraków-Częstochowa Upland) were investigated using light and scanning electron microscopy. Twenty-eight different cyst morphotypes (unornamented stomatocysts, stomatocysts with hooked projections in the collar region, and stomatocysts ornamented with spines) were recorded and documented with drawings, photographs and descriptions following International Statospore Working Group (ISWG) guidelines. One stomatocyst, Stomatocyst 1 Cabała, is described as a new morphotype.

**Key words**: Chrysophyceae, stomatocysts, morphology, taxonomy, ecology, peat bog

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## INTRODUCTION

The ability to form siliceous resting stages (stomatocysts) is one of the most important reasons for the success of Chrysophyceae as efficient competitors in harsh conditions such as oligotrophy, low temperature and unpredictable climate (Wilkinson *et al*. 1997). Species-specific ornamentation and the development of visually distinct morphotypes in response to defined environmental factors allows Chrysophyceae stomatocysts to be used effectively as biological indicators in ecological and paleolimnological studies. They can also provide information for evaluating the effects of the spread of acid rain (Lewis & Grant 1980).

Chrysophycean stomatocysts have been reported rarely from Poland (Rybak 1986, 1987). Sometimes authors have provided brief information about cysts of Chrysophyceae co-occurring with diatoms, but without precise descriptions and photographic documentation (Wasylik 1965; Kaczmarska 1976; Przybyłowska-Lange 1976).

This study is part of a comprehensive examination of algae flora from the Budzyń peat bog, located about 12 km northwest of Kraków in southern Poland (Fig. 1A), covering about 0.5 ha. It is the last peat bog on the Kraków-Częstochowa Upland that still possesses rich algae flora. The peat bog is threatened; only *ca* 30% of its area is relatively little influenced by human activity (Fig. 1B). The plant cover of the undisturbed part is composed mainly of *Betula* sp., *Calluna vulgaris* L., *Carex* sp., *Drosera rotundifolia* L., *Eriophorum angustifolium* Honck., *Lycopodiella inundata* L., *Lycopodium clavatum* L., *Oxycoccus palustris* Pers., *Pedicularis palustris* L., *Salix rosmarinifolia* L. and *Sphagnum* spp. (Kozik 1996, 2000). Among the relatively numerous algae observed were interesting stomatocysts of Chrysophyceae not been previously reported from Poland and/or Europe. This paper aims to add to our knowledge of Chrysophyceae flora of peat bogs, one of the most interesting and unfortunately most threatened environments. It is the first study of chrysophycean stomatocysts from a peat bog in Poland using current taxonomic guidelines to describe them.

## MATERIAL AND METHODS

The material was collected in November 1999 from seven following sites (numbered 1–7) of a peat bog near Budzyń (Fig. 1B):

1 – the central part of the peat bog, with construction rubble on one side and a typical peat bog habitat with a carpet of *Sphagnum* spp. on the other (water temperature 1.4°C, pH 7.5, conductivity 74 μS, 82 mV);

2 – dominated by *Carex* sp., *Eriophorum* sp. *Oxycoccus palustris* and *Sphagnum* spp. (3.4°C, pH 7.3, 79 µS, 3 mV);

3, 4 & 5 – part of the peat bog free of rubble, overgrown mainly with *Betula* sp., *Eriophorum* sp., *Salix rosmarinifolia* and *Sphagnum* spp. (3.2–3.4°C, pH 7.3, 88 µS, 43 mV);

6 – ditch about 1 m deep, 15 m long and 1–3 m wide, with margins overgrown with *Bidens cernuus* L. and *Lemna minor* L. on the water surface (0.4°C, pH 7.8, 109 µS, 163 mV);

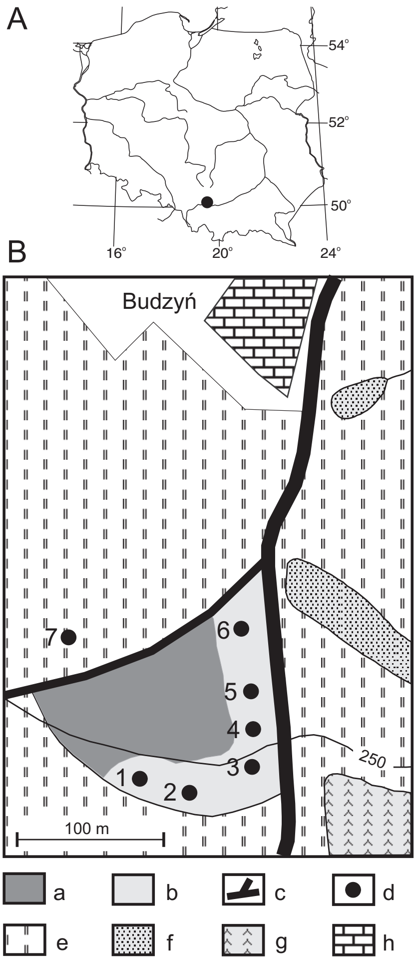



**Fig. 1**. Location of the study area in Poland (A) and investigated sites 1–7 on the peat bog near Budzyń (B). a – area covered with rubble, b – peat bog, c – field road, d – sites 1–7, e – grassy vegetation, f – ponds, g – pine forest, h – village.

7 – area *ca* 4 $m^2$ with typical peat bog community located outside the present limits of the peat bog (5.3°C, pH 7.3, 174 µS, 31 mV).

The material was collected into 120 ml plastic containers with the use of a water pump and a spoon from the water surface, beneath the surface, the bottom of peat bog cavities and a drainage ditch, or squeezed from *Sphagnum* spp. Samples were preserved in a solution of 4% formaldehyde. Each sample was treated with HCl and rinsed several times with distilled water, then boiled in concentrated $H_2O_2$ with a small amount of $ClO_3$ added at *ca* 15 min intervals, and rinsed several times with distilled water. Light microscope preparations were mounted in Naphrax® and examined with an Amplival microscope (Carl Zeiss, Jena) equipped with an Apochromat 100x oil immersion objective without phase contrast. Many stomatocysts were recorded and then selected for scanning electron microscopy. For SEM observations, cleaned material was air-dried on a cover glass. The cover glasses were mounted on stubs and coated with carbon and next with gold. Then the material was viewed with a PHILIPS XL30 ESEM microscope.

The stomatocysts were assigned numbers in accordance with International Statospore Working Group (ISWG) guidelines (Cronberg & Sandgren 1986), following Duff *et al.* (1995). For each morphotype the number of specimens present was indicated as × (single), ×× (very rare) or ××× (rare) on a modified Starmach's (1989) scale. Asterisks were used for forms new to Poland (*) and newly described (**).

## Results and Discussion

In the material from the peat bog in Budzyń, 28 stomatocyst morphotypes were recorded (Table 1). Twelve of them were viewed by SEM and LM, and 16 only by LM. Ten of those described by LM and SEM are unornamented stomatocysts (Figs 2–15, 18–29), one is ornamented with spines (Figs 16, 30 31) and one is ornamented with low, short ridges (Fig. 17). Nine of them are new to Poland and one is described here as a new morphotype, stomatocyst 1 Cabała (Figs 16, 30, 31).

In the material described the most frequently represented were stomatocyst 120 (Figs 4, 5, 18–20), stomatocyst 134 (Figs 11–13, 22–26), an unidentified stomatocyst (= type 160; Figs 14, 15, 27–29), and new stomatocyst 1 Cabała (Figs 16, 30, 31). The last was observed mainly in fresh material, while in HCl-treated material it was very infrequent. It is possible, then, that the fragile spines of stomatocyst 1 Cabała were destroyed during boiling in HCl.

Stomatocysts 1, 29, 120, 46 and 189 are typically common, cosmopolitan cysts (Brown *et al*. 1997). The full ecological preferences of the other recorded stomatocysts are undetermined so far.

Sixteen stomatocysts (Figs 32–65) observed only under LM, labelled as unidentified, occurred very infrequently and/or in small numbers (Table 1).

The recorded cysts are presented in groups based on their morphological characteristics, following Duff *et al*. (1995), beginning with unornamented stomatocysts, followed by stomatocysts ornamented with spines and then stomatocysts ornamented with ridges, circuli or a reticulum. Unidentified stomatocysts viewed only by LM are described at the end.

The micrographs and drawings of the material investigated are deposited in the Iconotheca of Algae (KRAM), W. Szafer Institute of Botany of the Polish Academy of Sciences, Kraków.

**Table 1.** Occurrence and frequency of stomatocysts at seven sites of the peat bog in Budzyń (1–7 as in Fig. 1B). × – single, ×× – very rare, ××× – rare.

| Stomatocyst/ site | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Stomatocyst 1 | | | | × | | | |
| Stomatocyst 29 | | | | | × | | |
| Stomatocyst 120 | | | | ××× | ××× | | ×× |
| Stomatocyst 46 | | | | | | | ×× |
| Stomatocyst 189 | | | | | | | ×× |
| Stomatocyst 49 | | | | × | | | |
| Stomatocyst 19 | | | | | | | × |
| Stomatocyst 181 | | ×× | | × | | | × |
| Stomatocyst 134 | | | ××× | ××× | ××× | | |
| Unidentified stomatocyst = Type 160 | ××× | ××× | | | | ×× | |
| Stomatocyst 1 Cabała | | | ××× | ××× | ×× | | ×× |
| Stomatocyst 133 forma B | | | | | | | × |
| Unidentified stomatocyst 1 | | × | | | | | |
| Unidentified stomatocyst 2 | | | | × | × | | × |
| Unidentified stomatocyst 3 | ×× | ×× | | | | | |
| Unidentified stomatocyst 4 | | | × | | | | |
| Unidentified stomatocyst 5 | | | | | | | × |
| Unidentified stomatocyst 6 | | ×× | | | | | |
| Unidentified stomatocyst 7 | × | | | | | | |
| Unidentified stomatocyst 8 | | | × | | | | |
| Unidentified stomatocyst 9 | | | | | | × | |
| Unidentified stomatocyst 10 | | | | | | | × |
| Unidentified stomatocyst 11 | | | | | | × | |
| Unidentified stomatocyst 12 | | | | | | | ×× |
| Unidentified stomatocyst 13 | × | | | | | | |
| Unidentified stomatocyst 14 | | | | | | | ×× |
| Unidentified stomatocyst 15 | × | | | | | | |
| Unidentified stomatocyst 16 | | | | × | | | |

1. STOMATOCYSTS DESCRIBED USING SEM AND LM

1a. Unornamented stomatocysts

***Stomatocyst 1**, Duff & Smol 1988 *emend*. Zeeb & Smol 1993 (Fig. 2)

BIOLOGICAL AFFINITY. This stomatocyst is probably the mature or immature form produced by a number of chrysophytes. At least two *Paraphysomonas* species have cysts of this type (Duff *et al*. 1995).

SEM DESCRIPTION. Stomatocyst spherical with smooth surface, 4.3–4.6 μm in diameter, without collar. Regular pore 0.3–0.4 μm in diameter.

LM DESCRIPTION. Stomatocyst 1 is distinguished from stomatocysts 29 and 46 on the basis of pore morphology, and from stomatocyst 9 on the basis of size (Duff *et al*. 1995).

ECOLOGY. Occurred singly in water squeezed from *Sphagnum* (site 4). More studies are likely to demonstrate that this cyst is widely distributed across broad ecological gradients (Duff *et al*. 1995).

***Stomatocyst 29**, Duff & Smol 1989 *emend*. Zeeb & Smol 1993 (Fig. 3)

BIOLOGICAL AFFINITY. This stomatocyst may be produced by more than one species (Duff *et al*. 1995).

SEM DESCRIPTION. A small, spherical stomatocyst a with smooth surface, 5.7–5.8 μm in diameter, collar absent. Pore shallow, concave, inner diameter 0.3–0.4 μm.

LM DESCRIPTION. Stomatocyst 29 can be distinguished from stomatocyst 1 and 46 by pore morphology, and from stomatocyst 120 by size only (Duff *et al*. 1995).

ECOLOGY. Occurred singly in water squeezed from *Sphagnum* and in sediment from the bottom of small depressions (site 5). This cyst may be produced by a cold-tolerant and eutrophic taxon (Duff *et al*. 1995).

***Stomatocyst 120**, Duff & Smol *in* Duff *et al*. 1992 *emend*. Zeeb & Smol 1993 (Figs 4, 5, 18–20)

BIOLOGICAL AFFINITY. This stomatocyst may be produced by more than one species, e.g., *Chrysosphaerella longispina* Lauteborn *emend.* K. H. Nicholls (Duff *et al*. 1995).

SEM DESCRIPTION. Stomatocysts spherical or slightly oblate, 7.2–8.8 μm in diameter (according to Duff *et al*. 1995, always less than 9 μm), collar absent, outer pore 1.4 μm in diameter, inner pore 0.4–0.5 μm in diameter.

LM DESCRIPTION. Similar to stomatocyst 29 (Zeeb & Smol 1993) but larger, and to stomatocyst 42 (Duff & Smol 1989) but smaller. According to Duff *et al*. (1995) they are also similar to stomatocysts 9 (Zeeb & Smol 1993) and 189 (Duff *et al*. 1995), but their pore structure is different.

It is similar to the cyst 9 μm in diameter illustrated by Kaczmarska (1976; Pl. 3, Fig. 8) from Eemian freshwater sediments of Imbramowice near Wrocław. In that paper only an LM photograph is given, without a description.

ECOLOGY. Occurred rarely in water squeezed from *Sphagnum* (site 4); in water squeezed from *Sphagnum* and in sediment from the bottom of small depressions (site 5); and in sediment from the bottom of depressions (site 7). This cyst has been found primarily in circumneutral to alkaline water, common in shallow lakes (Duff *et al*. 1995).

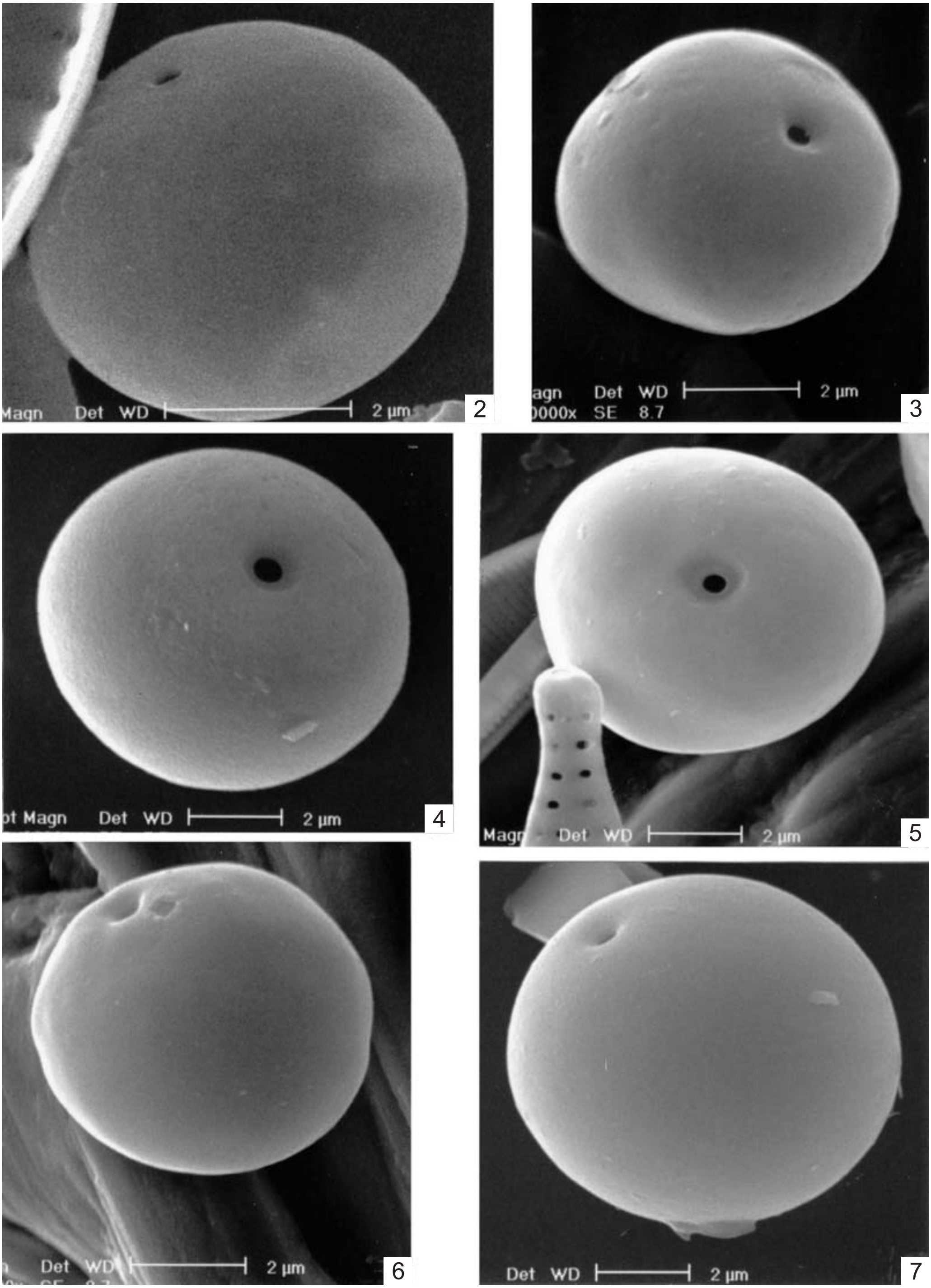
***Stomatocyst 46**, Duff & Smol 1991 (Fig. 6)

BIOLOGICAL AFFINITY. Unknown.

SEM DESCRIPTION. Stomatocysts spherical, 5.8 μm in diameter, collar absent, with a deep, conical pore, 0.5–0.6 μm in diameter.

LM DESCRIPTION. Stomatocyst 46 differs from stomatocysts 1 and 29 on the basis of pore morphology, and from stomatocyst 189 on the basis of size (Duff *et al*. 1995).

ECOLOGY. Occurred very rarely in water from surface and beneath it in peat bog depressions (site 7). According to Pienitz *et al.* (1992) this




**Figs 2–7**. 2 – Stomatocyst 1 (SEM); 3 – Stomatocyst 29 (SEM); 4 & 5 – Stomatocyst 120 (SEM); 6 – Stomatocyst 46 (SEM); 7 – Stomatocyst 189 (SEM).

morphotype is most probably produced by a species tolerant of high salinity.

***Stomatocyst 189**, Zeeb & Smol in Zeeb *et al.* 1996 (Fig. 7)

BIOLOGICAL AFFINITY. Unknown.

SEM DESCRIPTION. Stomatocysts spherical, 7.0–8.4 μm in diameter, collar absent, outer pore 1.3–1.4 μm in diameter, inner pore 0.5–0.7 in diameter.

LM DESCRIPTION. Stomatocyst 189 is distinguished from stomatocysts 9 and 120 on the basis of pore morphology, and from stomatocysts 46 and 150 on the basis of size (Duff *et al.* 1995).

ECOLOGY. Occurred very rarely in water from surface and beneath it in peat bog depressions (site 7). This cyst is strongly associated with oligotrophic and alkaline lakes, and may be produced by a cold-tolerant species (Duff *et al.* 1995).

**Stomatocyst 49**, Duff & Smol 1991 *emend.* Zeeb & Smol 1993 (Fig. 8)

BIOLOGICAL AFFINITY. This stomatocyst closely resembles the mature stomatocyst of *Chrysosphaerella longispina* Lauterborn (Duff *et al.* 1995).

SEM DESCRIPTION. Stomatocysts spherical to slightly oblate, 8.1–8.2 μm in diameter, smooth, with concave pore: outer pore 1.7 μm in diameter, inner pore 0.75 μm in diameter, collar absent.

LM DESCRIPTION. Stomatocyst 49 is distinguished from stomatocysts 42 and 120 on the basis of pore morphology (Duff *et al.* 1995).

ECOLOGY. Occurred singly in water squeezed from *Sphagnum* (site 4). *Chrysosphaerella longispina* is a widely distributed taxon, found primarily in acidic and circumneutral waters, with an estimated optimum pH of 5.4–6.3. The morphotype has been found in both acidic and alkaline locations (Duff *et al.* 1995).

***Stomatocyst 19**, Duff & Smol 1988 (Fig. 9)

BIOLOGICAL AFFINITY. This stomatocyst may be produced by several *Epipyxis* Ehrenb. species, notably *Epipyxis tubulosa* (Mack) D. K. Hilliard & Asmund (Duff *et al.* 1995).

SEM DESCRIPTION. Stomatocysts smooth, oval, length 8.5–8.7 μm, width 7.5–7.6 μm, smooth, with a regular or shallow concave pore 0.8 μm in diameter, collar absent.

LM DESCRIPTION. Stomatocyst 19 is distinguished from stomatocyst 118 by its lack of a collar (Duff *et al.* 1995).

ECOLOGY. Occurred singly in water from surface and beneath it in peat bog depressions (site 7). This stomatocyst has been found at several arctic and alpine sites, suggesting that it is produced by a cold-tolerant taxon. It has been observed across a wide range of pH, in both lakes and ponds (Duff *et al.* 1995).

***Stomatocyst 181**, Brown & Smol in Brown *et al.* 1994 (Figs 10 & 21)

BIOLOGICAL AFFINITY. Unknown.

SEM DESCRIPTION. Stomatocyst spherical, 6.4–6.5 μm in diameter, with smooth surface. Collar conical, with a broadly rounded apex, collar base 3 μm in diameter, apical diameter 1.6–1.7 μm. Pore regular, 0.3–0.4 μm in diameter.

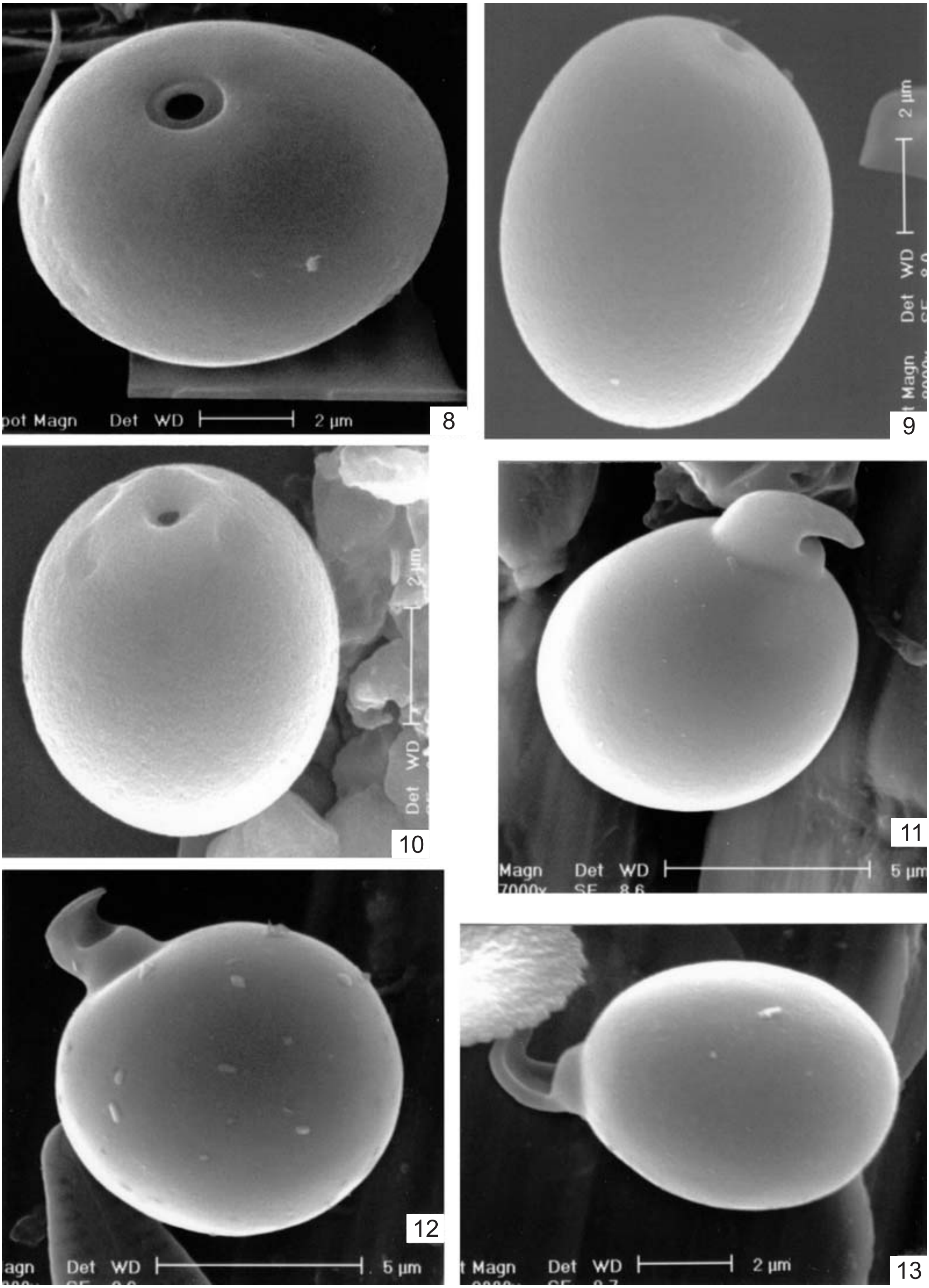
LM DESCRIPTION. Stomatocyst 181 is distinguished from stomatocysts 146 and 156 on the basis of collar morphology (Duff *et al.* 1995).

ECOLOGY. Occurred very rarely in water from surface, beneath surface and the bottom of peat bog depressions (site 2); singly in water squeezed from *Sphagnum* (site 4); and singly in water from surface of peat bog depressions (site 7). The ecological distribution of this cyst is undetermined (Duff *et al.* 1995).

***Stomatocyst 134**, Duff & Smol in Duff *et al.* 1992 (Figs 11–13, 22–26)

BIOLOGICAL AFFINITY. Unknown.

SEM DESCRIPTION. Stomatocysts spherical, oval, obovate or ovate, 5.5–8.0 μm long, 6.5–7.0 μm wide, with conical collar 1–2 μm in diameter, 1–2 μm high, with characteristic hooked projection 2.0–3.5 μm long.




**Figs 8–13**. 8 – Stomatocyst 49 (SEM); 9 – Stomatocyst 19 (SEM); 10 – Stomatocyst 181 (SEM); 11, 12 & 13 – Stomatocyst 134 (SEM).

LM DESCRIPTION. This stomatocyst is identified by the collar shape and projection (Duff *et al*. 1995).

ECOLOGY. Occurred rarely in water squeezed from *Sphagnum* (sites 3 & 4); in water squeezed from *Sphagnum* and in sediment from the bottom of depressions (site 5). Stomatocysts 134 may be produced by a littoral species, tolerant of cold water (Duff *et al*. 1995).

**Unidentified stomatocyst = *Type 160**, Adam 1980 (Figs 14, 15, 27–29)

BIOLOGICAL AFFINITY. Unknown.

SEM DESCRIPTION. Stomatocysts oval, 8.2–10.0 μm long, 7.8–8.7 μm wide, with characteristic projection of varied length (usually 3–5 μm) at anterior pole and with ring-like collar below.

LM DESCRIPTION. The collar shape and projection identify this stomatocyst. It is distinguished from stomatocysts 135 and 187 on the basis of the collar complex.

It is very similar to one of the stomatocysts described by Przybyłowska-Lange (1976; Pl. 8), collected from the Polish Baltic coast (Lake Druzno) from late Glacial and Holocene sediments.

ECOLOGY. Occurred rarely in water squeezed from *Sphagnum* (site 1); in water from surface, beneath surface and the bottom of the depressions (site 2); and very rarely in water from surface, beneath surface and the bottom of the drainage ditch (site 6).

1b. Stomatocysts ornamented with spines

****Stomatocyst 1**, Cabała (this paper) (Figs 16, 30, 31)

NEGATIVE NUMBER. J. Cabała, negative Bot. 5, Fig. 16 – Iconotype (deposited in the Iconotheca of Algae (KRAM) in the Department of Phycology of the W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków).

BIOLOGICAL AFFINITY. Unknown.

SEM DESCRIPTION. Stomatocysts spherical, 11.0–12.5 μm in diameter, covered with 3–5 spines 6–10(–11) μm long (usually 6–8 μm) evenly distributed over the surface. Spines slightly wider at base, straight, usually not bifurcated at ends, distributed over their surface. Collar with flat planar annulus *ca* 3 μm wide, 1.0–1.5 μm long.

LM DESCRIPTION. Similar in shape, size and surface structure to stomatocyst 62, Duff & Smol 1991 and stomatocyst 80, Hansen 2001. Unlike stomatocyst 62 it may have more than three, usually straight spines and stomatocyst 80, Hansen has larger and obconical collar. Similar to stomatocysts 64, 114, 115 and 218 (Duff *et al*. 1995) but two or three times larger. The recorded stomatocysts have spines distributed over their surface (spines of stomatocysts 64, 114, 115 and 218 are located at or near equato).

TYPE LOCALITY. Peat bog near Budzyń, on *Sphagnum* spp., Nov. 1999, *leg. Jolanta Cabała*.

ECOLOGY. Occurred rarely in water squeezed from *Sphagnum* (sites 3 & 4); very rarely in water squeezed from *Sphagnum* and in sediment from the bottom of depressions (site 5); and in water from surface and beneath it in depressions (site 7). It has been found in waters of pH 7.1–7.5. The full ecological preferences of this cyst are undetermined so far.

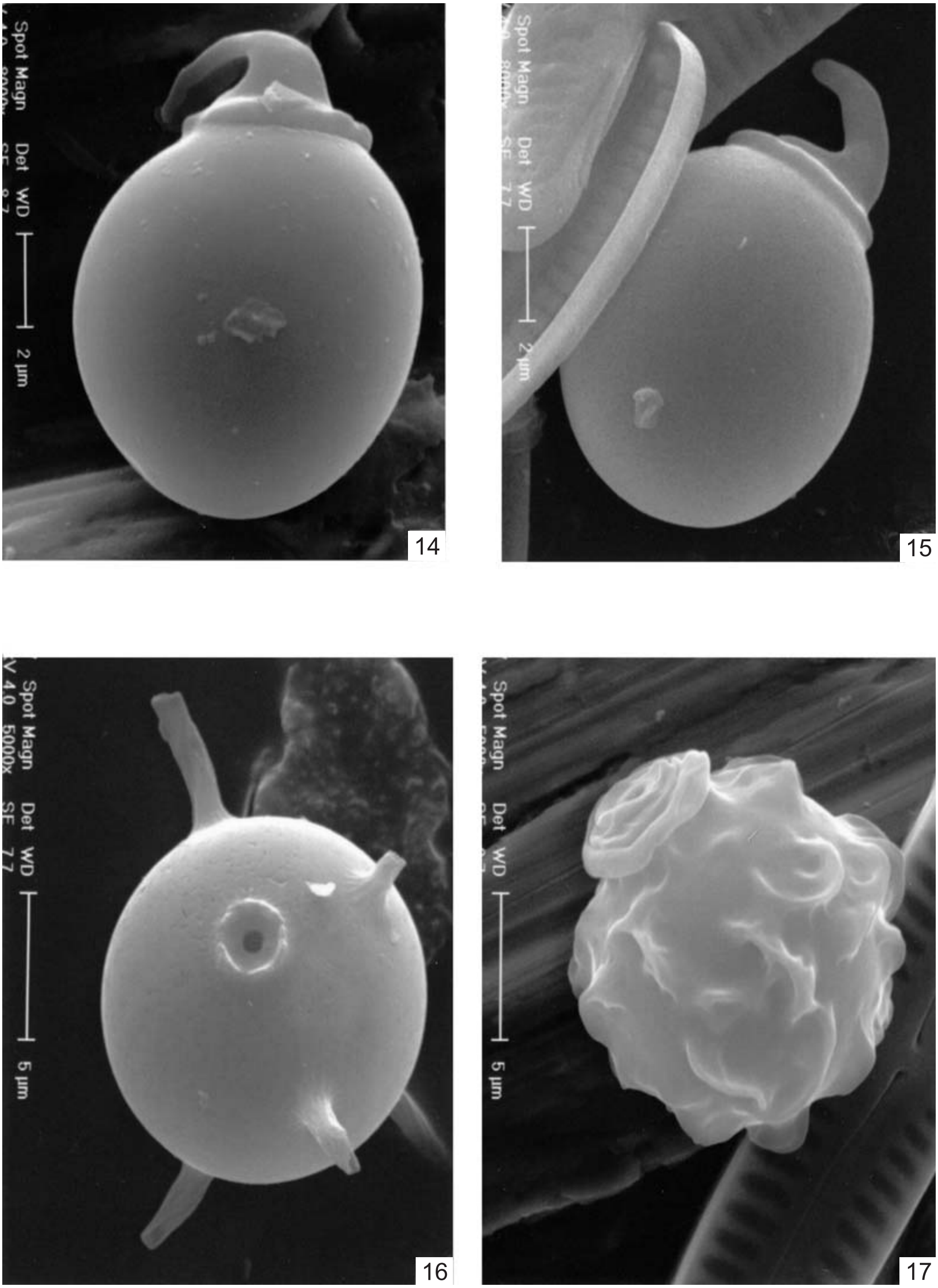
1c. Stomatocysts ornamented with ridges, circuli or a reticulum

**Stomatocyst 133 forma B**, Duff & Smol 1994 (Fig. 17)

BIOLOGICAL AFFINITY. This stomatocyst is possibly produced by *Ochromonas* species (Duff *et al*. 1995).

SEM DESCRIPTION. Stomatocysts spherical, 12.3–13.0 μm in diameter, ornamented with short echinate spines to lunate ridges of different lengths randomly oriented, with a complex collar. Regular pore 1.1 μm in diameter. Primary collar 2.3–2.6 μm, secondary collar 5.9 μm in diameter.

LM DESCRIPTION. This stomatocyst can be recognized by its fairly wide, complex collar and by its ornamentation. If the ridges cannot be distin-




**Figs 14–17**. 14 & 15 – Unidentified stomatocyst = Type 160 (SEM); 16 – Stomatocyst 1 Cabała (SEM); 17 – Stomatocyst 133, Forma B (SEM).

guished from spines, stomatocyst 133 forma B can be confused with stomatocyst 185 forma B (Duff *et al*. 1995).

ECOLOGY. Occurred singly in water from beneath surface in peat bog depressions (site 7). The ecological distribution of this cyst is undetermined (Duff *et al.* 1995).

2. STOMATOCYSTS DESCRIBED USING LM ONLY

**Unidentified stomatocyst 1**, Cabała (this paper) (Fig. 32)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts unornamented, spherical, 17.5 μm in diameter, collar absent, pore 3.3 μm in diameter. Similar to stomatocysts 15 (Zeeb & Smol 1993), 42 (Duff & Smol 1989), 120 (Duff *et al*. 1992) and 150 (Zeeb & Smol 1993). Stomatocyst 120 is smaller (diameter less than 9 μm), whereas stomatocysts 15 and 150 possess different pore structure (Duff *et al*. 1995). Detailed determination is impossible without SEM confirmation.

ECOLOGY. Occurred singly in water from bottom of peat bog depressions (site 2).

**Unidentified stomatocyst 2**, Cabała (this paper) (Figs 33 & 34)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts unornamented, spherical, 4–5 μm in diameter (always less than 5 μm), collar 0.75 μm in diameter, 0.75 μm high. Similar to stomatocyst 50 (Duff & Smol 1991) in size, shape and surface structure, but the collar of unidentified stomatocyst 2 is higher and wider. Similar to stomatocyst 52 (Duff *et al.* 1995) but detailed determination is impossible without SEM confirmation. Similar also to stomatocysts 234 (Duff *et al.* 1995), 127 (Duff *et al.* 1992) and 197 (Duff *et al*. 1995), whose diameters are more than 5 μm.

ECOLOGY. Occurred very rarely in water squeezed from *Sphagnum* (sites 4 & 5); and in water from the bottom of depressions (site 7).

**Unidentified stomatocyst 3**, Cabała (this paper) (Figs 35–37)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts unornamented, spherical or oval, 7–8 μm in diameter. Collar cylindrical, 1 μm high, *ca* 2 μm in diameter, always wider than its height. Similar to stomatocysts 152 (Zeeb & Smol 1993) and 234 (Duff *et al*. 1995) but detailed determination is impossible without SEM confirmation.

ECOLOGY. Occurred very rarely in water squeezed from *Sphagnum* (site 1); and in water from the bottom of depressions (site 2).

**Unidentified stomatocyst 4**, Cabała (this paper) (Figs 38–40)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts unornamented, spherical, 9.7–11.0 μm in diameter, collar 3.0–4.2 μm in diameter.

ECOLOGY. Occurred singly in water squeezed from *Sphagnum* (site 3).

**Unidentified stomatocyst 5**, Cabała (this paper) (Fig. 41)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts unornamented, ovoid, smooth, 11 μm long, 9 μm wide, with three characteristic rings surrounding the pore at the anterior pole. Rings 3–8 μm in diameter.

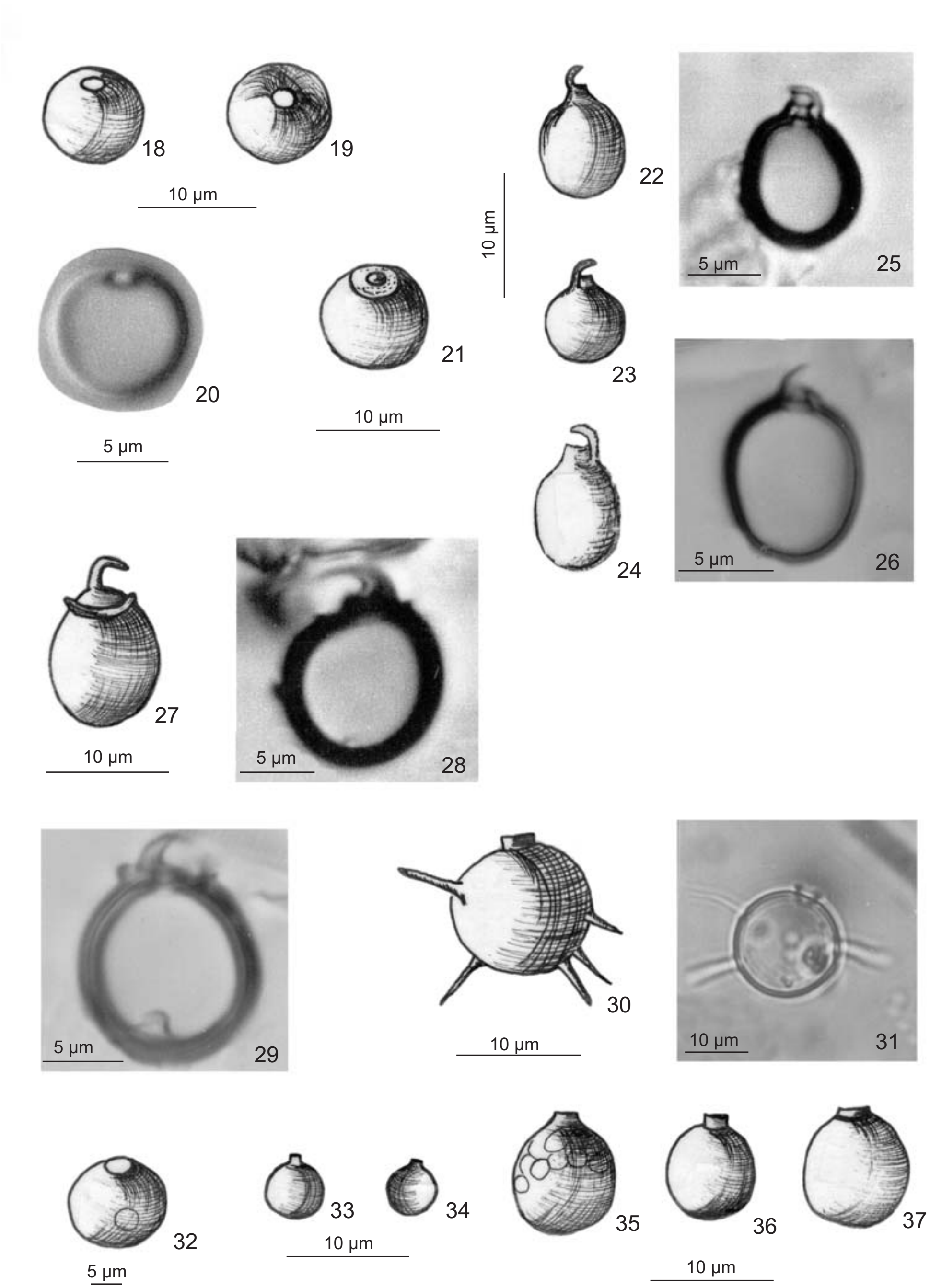
ECOLOGY. Occurred singly in water from surface of peat bog depressions (site 7).

**Unidentified stomatocyst 6**, Cabała (this paper) (Figs 42 & 43)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts unornamented, ovate, smooth, 9.5–10.0 μm long, 8.0–8.5 μm wide, without collar but with characteristic, *ca* 6 μm long, slightly hooked projection close to pore. Pore irregular at margins.

ECOLOGY. Occurred very rarely in water from the bottom of peat bog depressions (site 2).




**Figs 18–37**. 18 & 19 – Stomatocyst 120; 20 – Stomatocyst 120 (LM); 21 – Stomatocyst 181; 22–24 – Stomatocyst 134; 25 & 26 – Stomatocyst 134 (LM); 27 – Unidentified stomatocyst = Type 160; 28 & 29 – Unidentified stomatocyst = Type 160 (LM); 30 – Stomatocyst 1 Cabała; 31 – Stomatocyst 1 Cabała (LM); 32 – Unidentified stomatocyst 1; 33 & 34 – Unidentified stomatocyst 2; 35–37 – Unidentified stomatocyst 3.

**Unidentified stomatocyst 7**, Cabała (this paper) (Figs 44–47)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts unornamented, spherical and smooth, 9–11 μm in diameter, most probably without collar. Two characteristic projections, 2.5 μm long, usually slightly hooked and located close to pore. Similar to stomatocyst 248 (Wilkinson *et al*. 1997) but larger.

ECOLOGY. Occurred singly in water squeezed from *Sphagnum* (site 1).

**Unidentified stomatocyst 8**, Cabała (this paper) (Figs 48 & 49)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts unornamented, spherical, smooth, 6.5–7.0 μm in diameter, probably without collar. At the pore are two projections, 4.5 μm long, hooked at mid-length at almost a right angle.

ECOLOGY. Occurred singly in water squeezed from *Sphagnum* (site 3).

**Unidentified stomatocyst 9**, Cabała (this paper) (Fig. 50)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts unornamented, oval, smooth, 7–8 μm long, 7.5 μm wide, collar about 1 μm high.

ECOLOGY. Occurred singly in water from surface and beneath it in drainage ditch (site 6).

**Unidentified stomatocyst 10**, Cabała (this paper) (Fig. 51)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts spherical, 10.5 μm in diameter, surface entirely covered by blunt projections. Collar not visible, thus its complete identification is not possible. Similar to cyst IV (Mrozińska *et al*. 1998) but twice as large. Similar to stomatocyst 139 (Duff *et al*. 1992) but detailed identification without SEM is impossible.

ECOLOGY. Occurred singly in water from surface and beneath it in peat bog depressions (site 7).

**Unidentified stomatocyst 11**, Cabała (this paper) (Figs 52–55)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts spherical, 7–8 μm in diameter, surface probably covered entirely by blunt spines. Collar raised but not always regularly indented at margins as in typical forms. Detailed identification without SEM is impossible.

ECOLOGY. Occurred singly in water from surface and beneath it in drainage ditch (site 6).

**Unidentified stomatocyst 12**, Cabała (this paper) (Figs 56 & 57)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts spherical, 12.5–13.5 μm in diameter. Three to six short spines up to 3 μm long at posterior pole. Collar *ca* 1 μm high and 2.5 μm in diameter. Similar to stomatocyst 217 (Duff & Smol 1994) but two or three times larger.

ECOLOGY. Occurred very rarely in water squeezed from *Sphagnum* (site 7).

**Unidentified stomatocyst 13**, Cabała (this paper) (Figs 58 & 59)

BIOLOGICAL AFFINITY. Unknown.

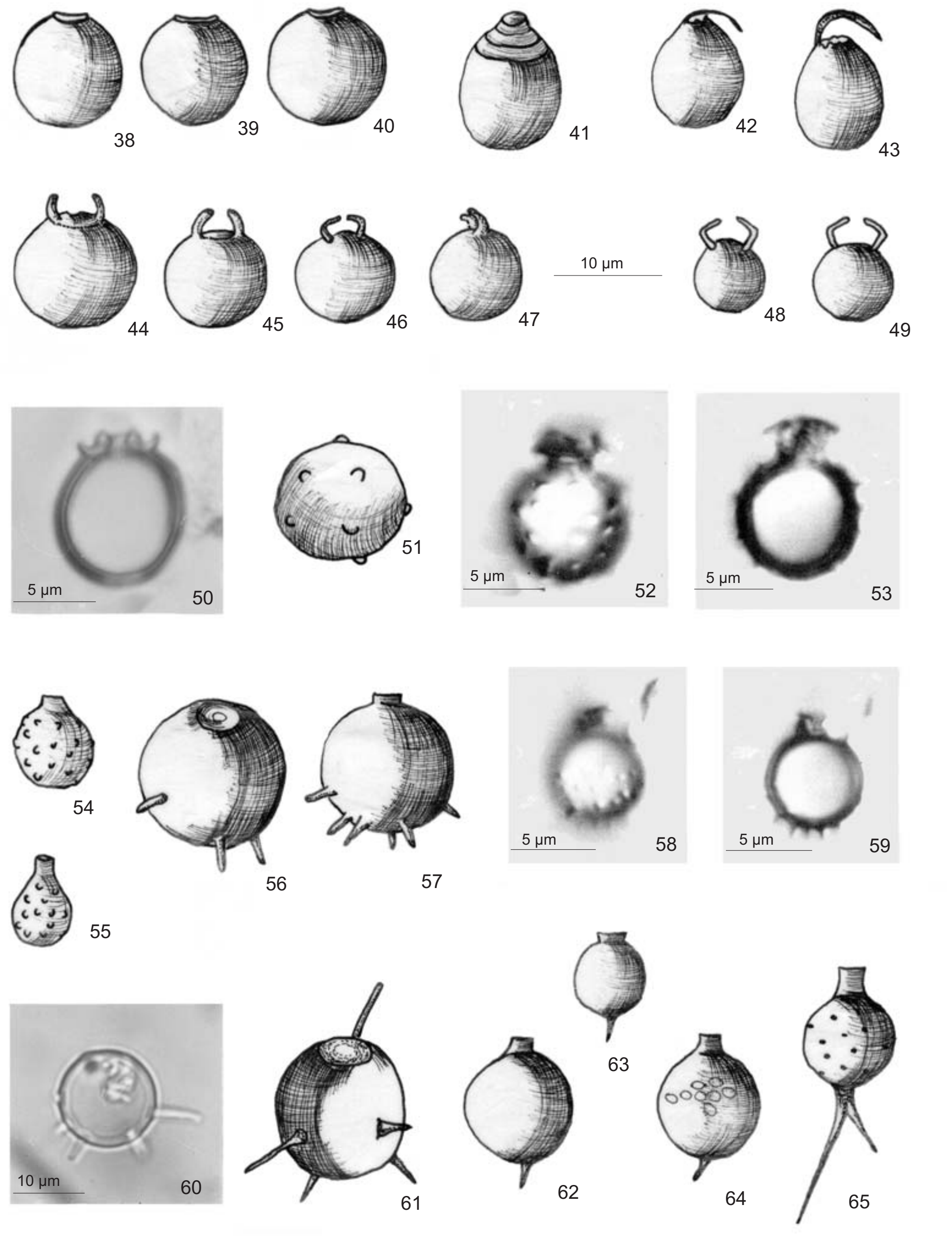
LM DESCRIPTION. Stomatocysts spherical, *ca* 6 μm in diameter, covered with short spines at posterior pole, with collar 1.6 μm high. Similar to stomatocyst 185 forma A (Brown *et al*. 1994) but detailed determination is impossible without SEM observations.

ECOLOGY. Occurred singly in water squeezed from *Sphagnum* (site 1).

**Unidentified stomatocyst 14**, Cabała (this paper) (Figs 60 & 61)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts spherical, 12.5–12.7 μm in diameter, surface entirely




**Figs 38–65**. 38–40 – Unidentified stomatocyst 4; 41 – Unidentified stomatocyst 5; 42 & 43 – Unidentified stomatocyst 6; 44–47 – Unidentified stomatocyst 7; 48 & 49 – Unidentified stomatocyst 8; 50 – Unidentified stomatocyst 9 (LM); 51 – Unidentified stomatocyst 10; 52 & 53 – Unidentified stomatocyst 11 (LM); 54 & 55 – Unidentified stomatocyst 11; 56 & 57 – Unidentified stomatocyst 12; 58 & 59 – Unidentified stomatocyst 13 (LM); 60 – Unidentified stomatocyst 14 (LM); 61 – Unidentified stomatocyst 14; 62–64 – Unidentified stomatocyst 15; 65 – Unidentified stomatocyst 16. Scale bar = 10 µm for all drawings.

covered by spines 3–6 μm long. Spines slightly wider at base, usually 4–5 in number, pore *ca* 4.5 μm in diameter, collar absent.

ECOLOGY. Occurred very rarely in water squeezed from *Sphagnum* (site 7).

**Unidentified stomatocyst 15**, Cabała (this paper) (Figs 62–64)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts spherical, smooth, 7–10 μm in diameter. Collar slightly conical, 1.0–1.5 μm high, 2 μm in diameter, with slightly hooked projection 2.0–2.5 μm long at posterior pole. Similar to Type 213 (Adam & Mahood 1980) but SEM confirmation was unavailable.

ECOLOGY. Occurred singly in water squeezed from *Sphagnum* (site 1).

**Unidentified stomatocyst 16**, Cabała (this paper) (Fig. 65)

BIOLOGICAL AFFINITY. Unknown.

LM DESCRIPTION. Stomatocysts spherical, *ca* 8.5 μm in diameter, with bifurcated projection *ca* 13 μm long at posterior pole. Collar 2.5 μm long, 2 μm wide. Very similar to '*Cyst furcata, Trachelomonas furcata* Dołgoff' described by Rybak (1986) from bottom sediments of Jezioro Kortowskie lake.

ECOLOGY. Occurred singly in water squeezed from *Sphagnum* (site 4).

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