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Cysts of Chrysophyceae from King George Island (South Shetland Islands, Antarctica)

ABSTRACT: This paper reports the preliminary results from the studies on the scanning electron microscopical studies on chrysophycean cysts collected in ponds and streams of King George Island (South Shetlands). The cysts play an important role as the survival developmental stages. Fifteen morphotypes are described, six of which are new for science. Particular attention has been paid to the anatomy of the pore, collar structure and to the ornamentation of the cyst surface.

Key words: Antarctica, King George Island, ponds, streams, cysts of Chrysophyceae.

Introduction

The chrysophycean cysts presented in this paper were found in materials collected during the Polish Antarctic Expedition in 1992/93 to the *Henryk Arctowski* Station on King George Island.

Chrysophycean algae are an important and diverse group of primarily freshwater phytoplankton, which are characterized by the endogenous formation of siliceous cysts or stomatocysts (also called statospores or statocysts – Duff, Zeeb and Smol 1995). Cyst morphology is highly variable, but they all possess a single exit pore that may be surrounded by a collar of various structure. The cyst wall may be covered with a whole variety of different ornamentation elements, although many species produce unornamented cysts that are exceedingly difficult to classify.

Cyst morphology is considered to be generally species-specific, allowing for some developmental variation (Cronberg 1980, 1986, Sandgren 1983, 1989, Skogstad 1984, Duff, Zeeb and Smol 1995). Nygaard (1956) proposed the classification of morphotypes by introducing the artificial “genus” *cysta* followed by a descriptive name as a means to classify unidentified cysts.

Most of the literature deals with the chrysophycean cysts from the Northern Hemisphere (Cronberg 1986, 1988, 1989; Sandgren 1989; Skogstad and Raymond 1989; Duff, Zeeb and Smol 1995). In the Antarctic region (Southern Hemisphere) data concern mainly the marine species (Krebs 1983, Gersonde 1986, Takahashi, Watanabe and Satoh 1986, Gersonde and Wefer 1987, Garrison and Buck 1989, Bartsch 1989, Scharek 1991, Zieliński 1993). For obtaining a complete picture of the flora of algae the description of cysts is absolutely essential, particularly in a severe polar climate where the cysts play an important role as the survival developmental stages. The cysts, as microfossils, are also valuable for paleoecological studies (Sandgren 1989).

At the present stage of chrysophycean studies it is possible to link only a small percentage of the cyst morphotypes with the algal taxa that produce them.

It is therefore of great importance to intensify and further continue the studies on the Antarctic Chrysophyceae.

Materials and methods

Samples of algae were collected in austral summer of 1992/93 from the transient ponds and streams on the moraines of the Ecology Glacier. The study area is located within the Site of Special Interest (SSSI) No. 8, in the vicinity of the *Henryk Arctowski* Station on the western shores of Admiralty Bay (King George Island). The sampled ponds are scattered between the glacier and the oldest contemporary moraine hills.

Samples were preserved in a solution of 4% formaldehyde. In the laboratory, after examination under a light microscope, the samples showing the presence of chrysophycean cysts were selected for the scanning electron microscopy (SEM). Sample preparation for SEM consisted of soaking them in 30% hydrogen peroxide at 85–95°C for 12–24 hrs in a water bath, followed by several changes of distilled water. The aqueous suspension of cleaned cysts were air dried on glass-covered specimen stubs and sputter coated with gold. The specimens were observed and photographed on a Jeol – 35 or a Philips LX 30 scanning electron microscope.

The terminology and description format of cyst morphotypes is adopted from Duff, Zeeb and Smol (1995), following International Statospore Working Group (ISWG) guidelines (Cronberg and Sandgren 1986).

Results and discussion

Fifteen chrysophycean cysts were found and characterized on the basis of their morphological features. Six cysts are new for science.

Following an artificial classification of Nygaard (1956), the cysts which could not be linked with any species were considered as morphotypes and given arbitrary names.

Cyst I (Plate 1, Fig. 1). — This cyst is spherical with a smooth surface (cyst diameter 4.24 μm). The collar is conical with a broadly rounded apex (collar base diameter 1.76 μm ; apical diameter 0.96 μm ; collar height 0.48 μm). The collar is irregular in its outline and it has at least one fold. The pore is regular (diameter 0.16 μm).

Cyst I resembles the cyst listed as No. 181 (page 35, Fig. 16A) in Duff, Zeeb and Smol (1995). Cyst I is 40% smaller than the cyst 181, and its collar height is almost half of that on the cyst 181.

Distribution of the cyst No. 181: British Columbia, Canada (Zeeb 1994), California, U.S.A. (Zeeb *et al.* in Duff, Zeeb and Smol 1995), Greenland (Brown, Douglas and Smol 1994), and North-west Territories, Canada (Duff and Smol, *unpubl.* in Duff, Zeeb and Smol 1995).

Cyst II (Plate 1, Fig. 2). — This cyst is ovate with a truncated apex and thickly perforated ornamentation (diameter 6.8 \times 8.3 μm). The collar is conical (base diameter 3.6 μm ; apical diameter 1.3 μm). The outer collar margin is regular, but the inner collar margin is steeply sloping. The pore is regular (diameter 0.7 μm).

Cyst II is similar to the cyst No. 202 (Fig. 23B, page 40 in Duff, Zeeb and Smol 1995). This type of cyst is produced by *Mallomonas hamata* Asmund, and *M. heterospina* Lund (Cronberg 1989).

Cyst III (Plate 1, Figs 3, 4). — This cyst is spherical (diameter 7.65 μm). The collar is cylindrical with a widely rounded apex and a sloping inner margin (base diameter 3.9–4.1 μm ; collar height 1.1 μm). There is a notch-like indentation in the collar (Fig. 4, arrow). On both our SEM specimens (Figs 3, 4), the pore is obscured by a roughly spherical, convex plug (diameter 1.7 μm). The cyst surface ranges from irregular to low reticulum with lacunae.

Cyst III appears to be identical with the cyst listed as No. 241 (Fig. 126A–B, page 127 in Duff, Zeeb and Smol 1995). The notch-like indentation in the collar is in our specimen (Fig. 4) much less apparent than that in the cyst No. 241.

Distribution of the cyst No. 241: North-west Territories, Canada (Duff, Zeeb and Smol 1995); Poland (Rybak 1986 in Duff, Zeeb and Smol 1995).

Cyst IV (Plate 2, Fig. 1). — This cyst is spherical to slightly oblate (diameter 5.25–5.67 μm). The wall surface is smooth, but ornamented with irregularly and widely scattered conula (base diameter 0.3–0.5 μm ; height 0.3–0.4 μm). In our SEM specimen the collar is absent.

Cyst IV has the shape and ornamentation closely resembling the cyst No. 139 (Fig. 67A, page 77) in Duff, Zeeb and Smol 1995.

Distribution of the cyst No. 139: Ellesmere Island, North-west Territories, Canada (Duff, Zeeb and Smol 1995).

Cyst V (Plate 2, Fig. 2). — This cyst is spherical (diameter 3.52 μm). The collar is cylindrical (base diameter 2.13 μm ; apical diameter 1.28 μm) with planar sloping annulus surrounding the regular pore (diameter 0.57 μm). The ornamentation consists of regularly spaced, circular indentations (diameter 0.7–0.85 μm).

Cyst V does not correspond to any of the cysts listed in Duff, Zeeb and Smol (1995).

New morphotype: *cysta concava*.

Cyst VI (Plate 2, Fig. 3). — This cyst is spherical to oval (diameter $8.6 \times 7.97 \mu\text{m}$). The collar is cylindrical (base diameter $2.8 \mu\text{m}$; height $1.2 \mu\text{m}$), and was slightly damaged in our preparation. The ornamentation is of mixed type. The cyst surface is irregularly pitted and/or irregularly reticulated.

Cyst VI does not correspond to any of the cysts listed in Duff, Zeeb and Smol (1995).

New morphotype: *cysta microrecessa*.

Cyst VII (Plate 2, Fig. 4). — This cyst is spherical to oblate (diameter $6.0 \times 6.6 \mu\text{m}$). The collar is conical (base diameter $2.4 \mu\text{m}$; apical diameter $1.87 \mu\text{m}$; collar height $0.87 \mu\text{m}$). The pore is regular (diameter $0.37 \mu\text{m}$).

Cyst VII does not correspond to any of the cysts listed in Duff, Zeeb and Smol (1995).

New morphotype: *cysta globosa*.

Cyst VIII (Plate 3, Fig. 1). — This cyst is spherical (diameter $6.3 \mu\text{m}$). The wall surface is slightly rough, and ornamented with widely scattered conula (base diameter $0.35\text{--}0.47 \mu\text{m}$; height $0.35 \mu\text{m}$) as cyst IV.

Cyst VIII has the shape and ornamentation closely resembling the cyst 139 (Fig. 67A, page 77) in Duff, Zeeb and Smol (1995).

Cyst IX (Plate 3, Fig. 2). — This cyst is oblate (diameter $4.5 \times 5.6 \mu\text{m}$). The collar is cylindrical (base diameter $3.2 \mu\text{m}$; height $0.5 \mu\text{m}$). The pore appears to be obscured by a convex plug. The cyst surface is ornamented with irregular reticulum.

Cyst IX has a similar collar to that in the cyst 112 (Fig. 35A–B, page 49–50) in Duff, Zeeb and Smol (1995). This type of cyst is produced by *Ochromonas globosa* Skuja (Nygaard 1956).

Cyst X (Plate 3, Fig. 3). — This cyst is spherical to angular (diameter $5.87 \times 6.37 \mu\text{m}$). The collar is long and cylindrical (base diameter $1 \mu\text{m}$; height $1 \mu\text{m}$). The apex is conically broaden (diameter $0.8\text{--}1.25 \mu\text{m}$), and covered with small verrucae. The cyst wall is ornamented with spines (base diameter $0.25\text{--}0.5 \mu\text{m}$; height $0.6\text{--}1.47 \mu\text{m}$), and processes ranging from baculate with flattened table-like top, to wing-like branched projections.

Cyst X appears to have a unique structure and ornamentation. It does not correspond to any of the cysts listed in Duff, Zeeb and Smol (1995).

New morphotype: *cysta spinifera*.

Cyst XI (Plate 3, Fig. 4). — This cyst is oval to obovate (diameter $5 \times 6.2 \mu\text{m}$). The collar is low and cylindrical (base diameter $1.4 \mu\text{m}$; apex diameter $0.7 \mu\text{m}$).

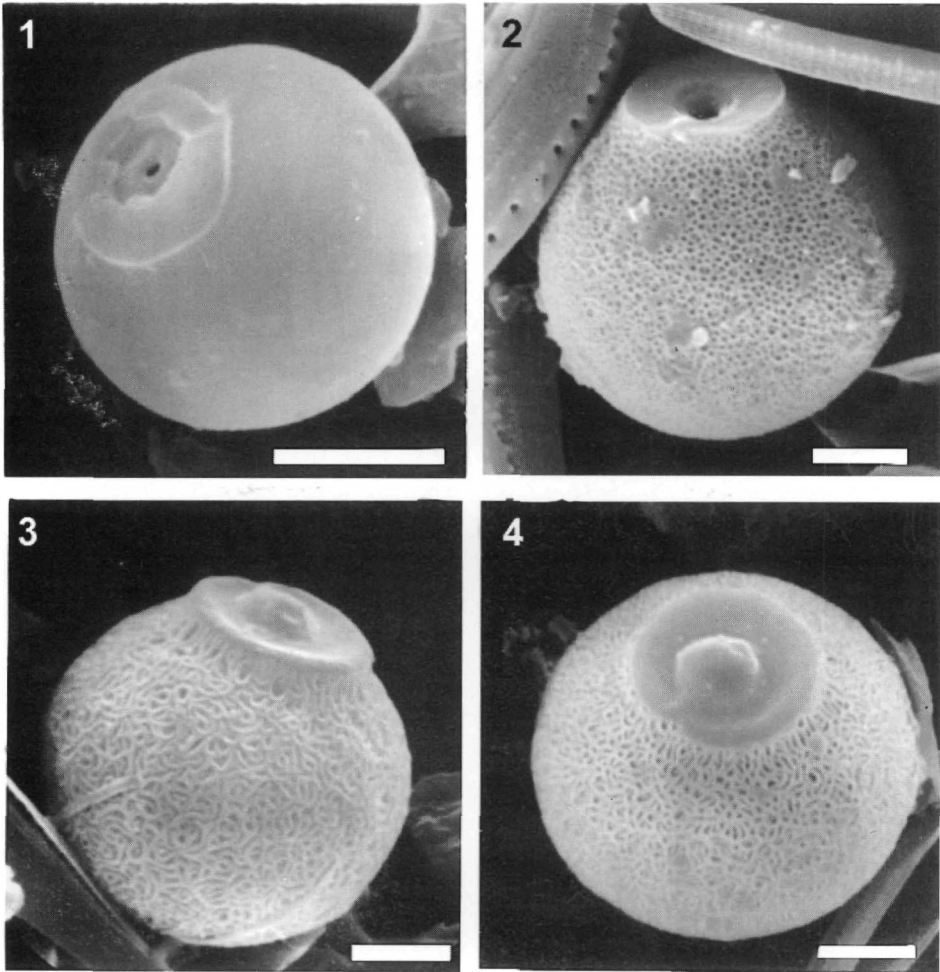


Fig. 1. Cyst I is similar to the cyst 181 in Duff, Zeeb and Smol (1995). Fig. 2. Cyst II is similar to the cyst 202 in Duff, Zeeb and Smol (1995). This type of the cyst is produced by cf. *Mallomonas hamata*, and *M. heterospina*. Figs. 3, 4. Cyst III is similar to the cyst 241 in Duff, Zeeb and Smol (1995).

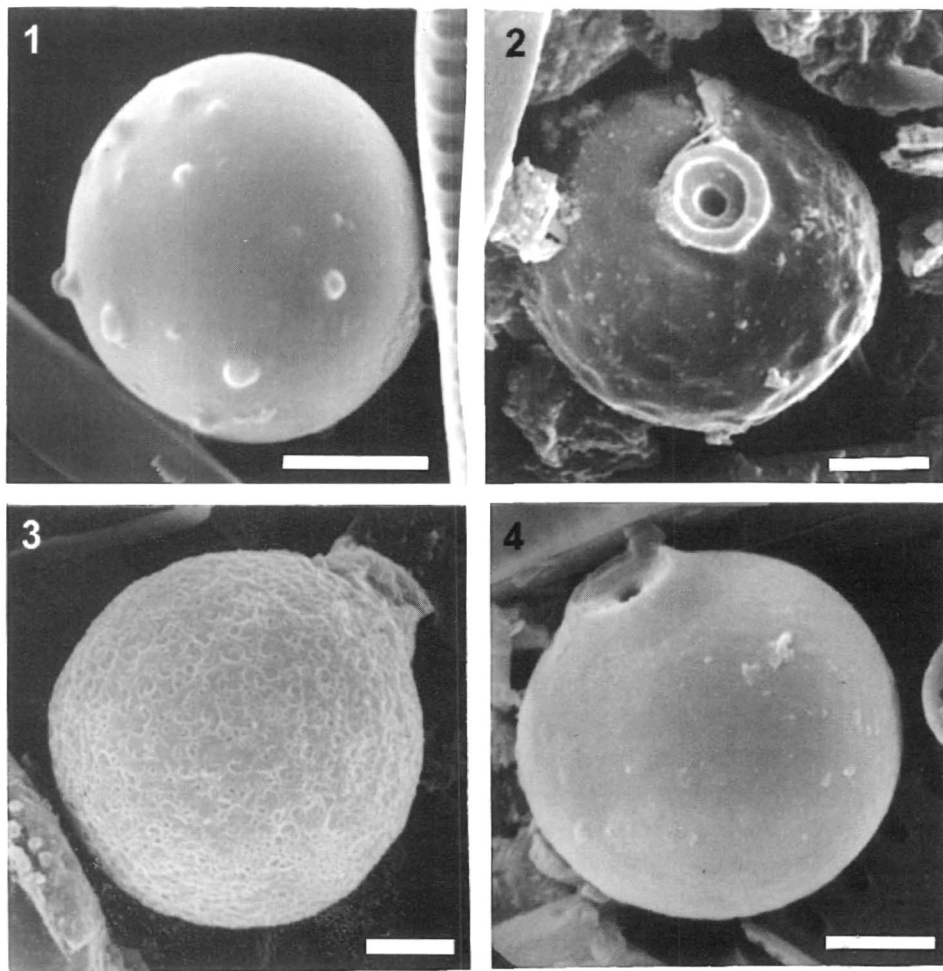


Fig. 1. Cyst IV is similar to the cyst 139 in Duff, Zeeb and Smol (1995). Fig. 2. Cyst V = *cysta concava*. Fig. 3. Cyst VI = *cysta microrecessa*. Fig. 4. Cyst VII = *cysta globosa*.

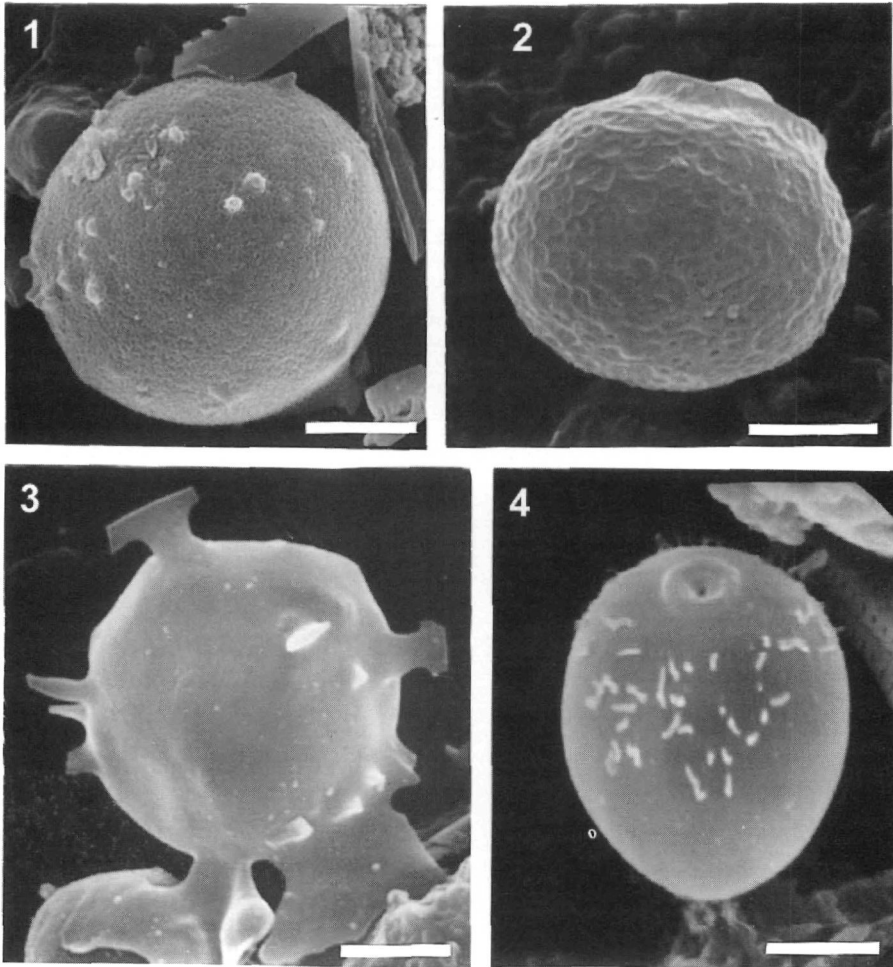


Fig. 1. Cyst VIII is similar to the cyst 139 in Duff, Zeeb and Smol (1995). Fig. 2. Cyst IX is similar to the cyst 112. This type of the cyst is produced by *Ochromonas globosa*. Fig. 3. Cyst X = *cysta spinifera*. Fig. 4. Cyst XI = *cysta amphora*.

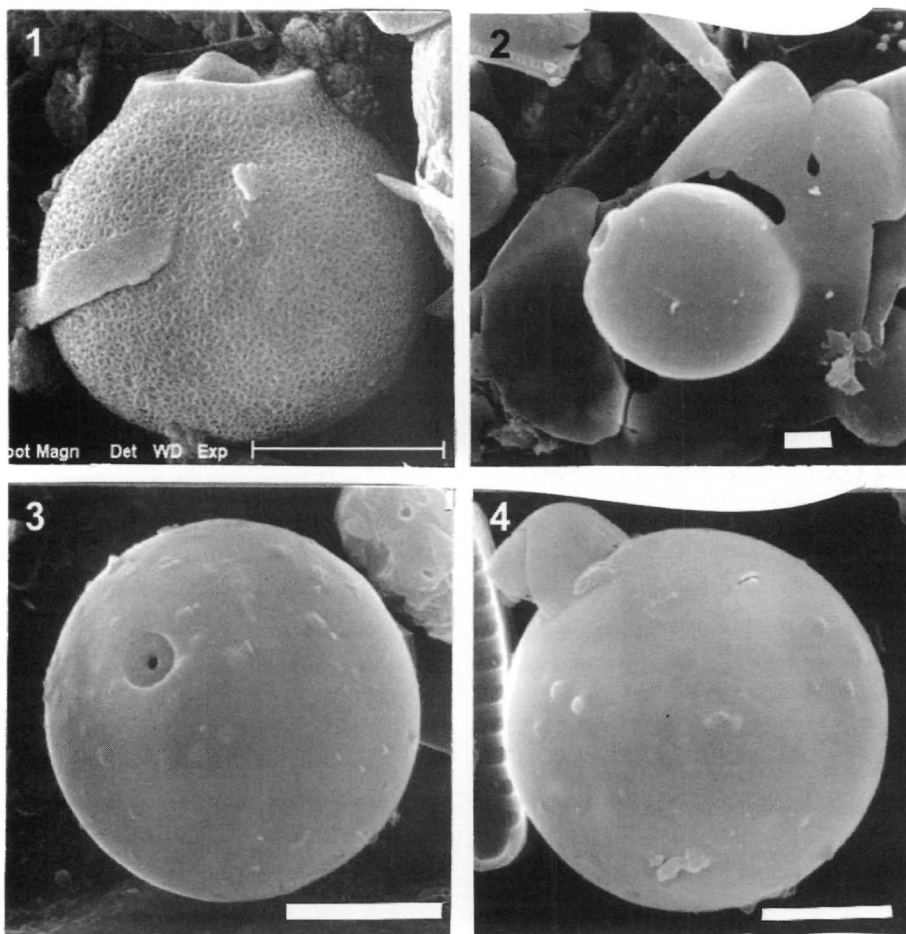


Fig. 1. Cyst XII = *cysta truncata*. Fig. 2. Cyst XIII. This type of the cyst is produced by *Hydrurus foetidus*. Fig. 3. Cyst XIV. This type of the cyst is produced by *Chrysosphaerella longispina*. Fig. 4. Cyst XV. This type of the cyst is produced by *Dinobryon cylindricum*.

[All Figs SEM photographs, scale bar equals 2 μm , except Fig. 1 on Pl. 4 where scale bar equals 5 μm].

The inner collar margin is steeply sloping. The pore is very small (diameter 0.17 μm). The cyst wall lacks ornamentation.

Cyst XI does not correspond to any of the cysts listed in Duff, Zeeb and Smol (1995).

New morphotype: *cysta amphora*.

Cyst XII (Plate 4, Fig. 1). — This cyst is ovate and apically truncated (diameter 8.75 \times 10.36 μm). The collar is very wide (base diameter 5.7 μm ; height 0.89 μm). The pore is obscured by a conical plug. The cyst wall is ornamented with irregular low reticulum.

Cyst XII does not correspond to any of the cysts listed in Duff, Zeeb and Smol (1995).

New morphotype: *cysta truncata*.

Cyst XIII (Plate 4, Fig. 2). — This cyst is oval (diameter 9.0 \times 9.6 μm). The collar is conical (base diameter 3 μm ; apical diameter 1.3 μm). The cyst wall surface is smooth, but at the posterior end of the cyst there is an extremely large (exceeding the size of the cyst) branched, gelatinous projection.

Cyst XIII is produced by *Hydrurus foetidus* (Villars) Trevison.

Cyst XIV (Plate 4, Fig. 3). — This unornamented, smooth surfaced cyst is spherical (diameter 4.86 μm), with a planar pseudoannulus (diameter 0.72 μm). The pore is extremely small (diameter 0.135 μm). There is no collar development.

Cyst XIV is produced by *Chrysosphaerella longispina* Lauterborn in Sandgren 1989.

Cyst XV (Plate 4, Fig. 4). — This cyst is smooth and spherical (diameter 5.77 μm). The collar is widely conical (base diameter 1.7 μm ; apical diameter 0.63 μm) with a hooked apex. The cyst wall surface is ornamented with a very few verrucae.

Cyst XV is produced by *Dinobryon cylindricum* Imbof (Donaldson and Stein 1984). Sandgren (1989) described the cyst of *Dinobryon* covered with verrucae. Our SEM specimen has only few regular verrucae.

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Streszczenie

Praca przedstawia wstępne wyniki badań dotyczących cyst Chrysophyceae ze środowisk słodkowodnych z Wyspy Króla Jerzego (Południowe Sztetlandy), analizowanych w skaningowym mikroskopie elektronowym. Obecność tych cyst świadczy o bogactwie flory rozwijającej się w ekstremalnych warunkach klimatycznych. Wyróżniono 6 nowych dla nauki morfotypów.