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Trachelomonas spp. and Other Euglenophyceae Taxa in a Southeastern Virginia Lake

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ABSTRACT

Trachelomonas species from Lake Kilby, a reservoir lake in southeastern Virginia are described with supportive electron micrographs . The most abundant *Trachelomonas* species were *T. hispida* and *T. volvocina.* Other members of the Euglenophyceae occurring in this lake are identified.

INTRODUCTION

Within freshwater phytoplankton communities, representatives of the genus *Trachelomonas* Ehrenberg (phylum Euglenophyta, class Euglenophyceae) are often common and abundant. These microscopic, unicellular, and flagellated cells are encased in a lorica (test) whose characteristic surface morphology (among other factors), provides significant information for their identification. Representative *Trachelomonas* species that were identified in Lake Kilby, a relatively small reservoir lake in southeastern Virginia, are described with representative scanning electron microscope prints. A listing of other species within the Euglenophyceae category that were present in Lake Kilby are also given.

Lake Kilby is located in Suffolk, Virginia (76°38′W, 36°42′40″N) and its waters serve as a regional water supply source. Typical of other reservoirs established within an impounded watershed segment, the lake has an elongated and generally narrow basin, mostly shallow, with a maximum depth of approximately 6-7 meters, and a surface area of 90 ha (Norman, 1985). Seasonal stratification occurs in the deeper regions, with submerged tree stumps found throughout its more shallow sections. During periods of low water level, additional water from the Potomac aquifer will be pumped into the lake (Schafran and Scully, 1994). This pumping is most common beginning in September and continuing into late fall. When this occurs the oxygen level in the lake decreases, with the total phosphorus concentrations and alkalinity increasing. In addition, as a control measure to reduce the occurrence of algal blooms, copper sulfate is often added to the lake surface between March and November.

METHODS

Water samples (500 ml) were taken from the upper 1 meter depth at 4 stations that were placed along the length of the lake. Collections were made once in June and twice in July 1996. The samples were collected with a Kemmerer sampler and preserved with Lugol's solution. A modified Utermöhl method was followed where the water sample was passed through a series of settling and siphoning steps (3) to provide a 40 ml concentrate of the original water sample (Marshall and Alden, 1990). Fractions of this concentrate (based on the density of the plankton and suspended solids present) were placed in settling chambers and examined at both 315x and 500x magnification using a Zeiss (inverted) plankton microscope. Taxon concentrations were determined from this analysis. Representative water samples were then prepared for examination using a Cambridge Stereoscan model S-100 scanning electron microscope. This report

emphasizes only the euglenophycean species identified in the sample analysis. Water quality variables were determined by personnel from the City of Portsmouth. Identification references included Huber-Pestalozzi (1955), Conforti and Nudelman (1994), Couté and Iltis (1981), Couté and Thérézien (1985), and Wolowski (1998).

RESULTS

The year 1996 may be considered a "wet" year with the highest annual rainfall for this area recorded over the last decade at 65.8 inches, with a monthly mean of 5.49". Subsequently this resulted in approximately 56 million gallons of water pumped into the lake from the Potomac aquifer for 1996, which is considerably less than what would be added during a "dry" year, as occurred in 1997 when this region had 42.7 inches of rainfall and the amount of pumping reached 181 million gallons. For the two months (June-July 1996) when water samples were taken, the pH ranged from 5.7 to 6.2. The surface oxygen was from 3.1 to5.9 mg L^{-1}, orthophosphates 0.06 to 0.09 mg L^{-1}, nitrates 0.07 to 0.1 mg L^{-1}, and nitrites remained at 0.02 mg L^{-1} . The water's surface temperature ranged from 20.1 to 25.3 °C. The lake is considered eutrophic. During this period cell concentrations for the total *Trachelomonas* spp. at the four stations ranged from 2-183 x 10^3 cells L^{-1} in June and 29-108 x 10^3 cell L^{-1} in July. These concentrations for the *Euglena* spp. ranged from 2-11 x 10^3 cells L^{-1} in June and 2-15 x 10^3 cell L^{-1} in July, and for *Phacus* spp. ranged from 6-63 x 10^3 cells L^{-1} in June and 2-88 x 10^3 cell L^{-1} in July.

The genus Trachelomonas:

Following mainly Huber-Pestalozzi (1955): The genus *Trachelomonas* is represented by unicellular, free swimming cells, enclosed in a lorica, usually spherical, oval, or spindle shaped. The cell surface may be smooth, rough, pitted, and possess small or large size punctae. The cell surface may be with, or without spines; and when present the spines may vary in size, thickness, and location among different species. The flagellar pore may have an annular ring, or possess a collar that would vary in its shape, length, and the presence of spines. These cells are common in shallow lakes, ponds, and swamp waters.

Trachelomonas acanthophora Stokes

Lorica spindle-form, having an ellipsoidal central area with ends extended. The anterior end contains a tubular collar, ending terminally with the rim of the collar possessing a ring of spines (6-8) diverted outwardly. The collar length is around 18 microns. The caudal end is more narrow, but slightly conical, tubular, with the terminus containing a ring of spines (5-6) diverted outwardly. The surface of the central body contains punctae, with thick pointed spines (3-5 microns long). Spines also on the caudal extension, with some but fewer spines on the lower part of the collar. Variability in shape and size of central cell body. Similar to *T. Dastuguei* Balech. See Huber-Pestalozzi (1955). Approximately 37-65 X 20-25 microns in size, yellow brown in color. Figure 1.

Trachelomonas acanthostoma Stokes emend. DeFlandre

Represented by a sub-spherical or broadly ellipsoidal lorica, having a smooth surface, containing fine punctae. May be without a collar, or with a low collar, with the flagellar pore surrounded by 1 or 2 rings of short spines. 26-31 x 22-27 microns

in size. See Huber-Pestalozzi (1955) and Wolowski (1998). Color reddish brown. Figure 2.

Trachelomonas alisoviana Skvortzov

Spherical to slightly ellipsoidal lorica, with the entire surface pitted, and having a flagellar pore surrounded by a distinct and raised annular rim. Flagellar pore is 1.5- 2.0 microns. Size 15-20 microns. See Couté and Thérézien (1985). Figure 3.

Trachelomonas armata v. *Steinii* Lemmermann emend. Deflandre

Possesses an egg-shaped lorica, with a fairly smooth surface, containing minute punctae. The posterior end is slightly broader. The collar is represented by a low elevated rim containing a circle of spines. The spines are concentrated at both ends of the cell. Small straight spines (2 microns) at the anterior end. A cluster of long, curved, thick spines (8-12 microns) are at the posterior end. Similar to *T. armata* v. *longispina* (Playf.) Deflandre illustrated in Prescott 1956), and *T. armata* v. *longa* Deflandre. Also see Huber-Pestalozzi (1955), Couté and Thérézien (1985). Size, 35-40 x 25-30 microns. Yellow brown in color. Figure 4.

Trachelomonas globularis v. Boyeri (Palmer) Conrad

The lorica has a spherical shape, with short conical-shaped spines scattered over the surface, which are inter-spaced by punctae. Golden brown in color. Size 9-14 microns. See Huber-Pestalozzi (1955). Figure 5.

Trachelomonas hispida (Perty) Stein

The lorica is ellipsoidal, with short spines and punctae over the entire surface of the cell. The collar is either absent, or it is only slightly developed. A very common species. Light brown to reddish brown in color. 19-25 x 15-19 microns in size. See Huber-Pestalozzi (1955). Figure 6.

Trachelomonas hispida v. *coronata* Lemmermann

Possesses an elongated ellipsoidal shape lorica, with a surface covered with short spines. There is a slight development of a collar, with the collar rim encircled by row of short spines. 22-30 x 8-15 microns in size. A common species, with variable ranges in size. Dark brown in color. Refer to Couté and Iltis (1981), Huber-Pestalozzi (1955), and Wolowski (1998). Figure 7.

Trachelomonas intermedia Dangeard

Has a lorica that is sub-spherical to broad ellipsoidal in shape, with a collar having a low, but distinct rim, but is not raised. The cell surface is rough, dense, and contains punctae. The cell is dark brown in color. 15-22 microns. (See Couté and Thérézien, p.114, Plate 11, figs.1-3, 1985; Huber-Pestalozzi, 1955).

Trachelomonas Raciborskii Woloszynska

Lorica ellipsoid in shape, with no developed collar. Distinct, sparsely distributed spines, not dense, mostly concentrated at polar ends of cell. Surface area contains punctae. Size 30-34 x 25-28 microns. Dark brown in color. See Couté and Thérézien (1985), Huber-Pestalozzi (1955). Figure 8.

Trachelomonas similis Swirenko

Ellipsoidal shaped lorica, coarse rough surface, with punctae scattered over surface, but no spines. Possesses a thick, coarse collar, extending (4-6 microns), bent from the vertical. Golden brown in color. 24-29 x 16-20 microns in size. See Wolowski (1998). Figure 9.

Trachelomonas superba Swirenko emend. Deflandre

Lorica ellipsoidal, with small punctae over surface. Different length conical-shaped spines over the surface, being longer at the polar ends. Possesses a low collar encircled by ring of spines. Reddish brown in color. Size 30-36 x 23-28 microns. See Couté and Thérézien (1985). Figure 10.

Trachelomonas volvocina Ehrenberg

Lorica globular, spherical shaped, with a surface that is generally smooth, lacking spines. The collar is either lacking, or the collar is slightly developed. With no collar, flagellar pore is surrounded by slightly raised annular region. Very common. Diameter 7-28 microns, reddish brown to dark brown color. See Huber-Pestalozzi (1955). Figure 11.

Another taxon, listed as *Trachelomonas* sp., was noted only once in a July sample, but it could not be identified to species. It is spherical in shape, possessing a definite pole to pole pattern of raised ribs, having a longitudinal type pattern, somewhat similar to *T. Stokesiana* Palmer (Huber-Pestalozzi, 1955), but with greater conformity in the pattern of rib development. Dark brown in color, cell diameter 18-25 microns.

Other Euglenophyceae:

Thirty-three euglenophycean species were recorded for Lake Kilby from these samples (Table 1). These included 13 *Trachelomonas*, 10 *Phacus*, 9 *Euglena*, and 1 *Lepocinclis* sp. The more abundant and common representatives within these genera were *Euglena deses*, *E. mutabilis*, *Phacus caudatus*, *P. longicauda*, *P. monilatus*, *P. suecicus*, *Trachelomonas hispida*, *T. hispida* v. *coronata*, and *T. volvocina*. *Phacus monilatus* produced an extensive bloom in July, with cell concentrations at 74.6×10^3 l^{-1}. The other members of these groups were not abundant and were only intermittently found at the different stations during the months of collection. These results compare closely with species reported by Woodson and Seaburg (1968) in Lake Chesdin, another reservoir lake in Virginia. They reported 42 species, including 17 *Trachelomonas*, 11 *Phacus*, 10 *Euglena*, and 4 *Lepocinclis* in a year-long study. In addition, Marshall and Burchardt (1998) also found the Euglenophyceae well-represented in the tidal-freshwater region of the James River (Virginia), where they identified 2 *Trachelomonas*, 4 *Phacus*, 7 *Euglena*, and 2 *Strombomonas* species.

SUMMARY

Lake Kilby is a shallow, reservoir lake, that is subject to seasonal manipulation regarding water that is removed for regional usage and that which is pumped into the lake from a sub-surface aquifer. In addition to precipitation, normal surface flow and drainage enters its watershed and the lake. This includes the passage of water from surrounding swamps. A total of 33 euglenophycean species were identified in Lake Kilby during a sampling period in June and July 1996. These species include a diverse representation of taxa within the genera of *Euglena*, *Phacus*, and *Trachelomonas*. From this group, twelve *Trachelomonas* species are described in detail. The most common species within this category were *T. hispida*, *T. hispida* v. *coronata*, and *T. volvocina*. The other *Trachelomonas* species were less abundant, and not consistently recorded at all the sampling sites. Several species were rare. The genus *Phacus* was well-represented, with *P. monilatus* attaining bloom concentrations, whereas, *Euglena* spp. were less abundant. The examination of the *Trachelomonas* cells with scanning

electron microscopy noted some range of variation in the outer cell morphology and dimensions of several species. Such phenotypic variations may be expected due to the different sets of daily or monthly environmental factors that would influence the development of these assemblages.

ACKNOWLEDGEMENT

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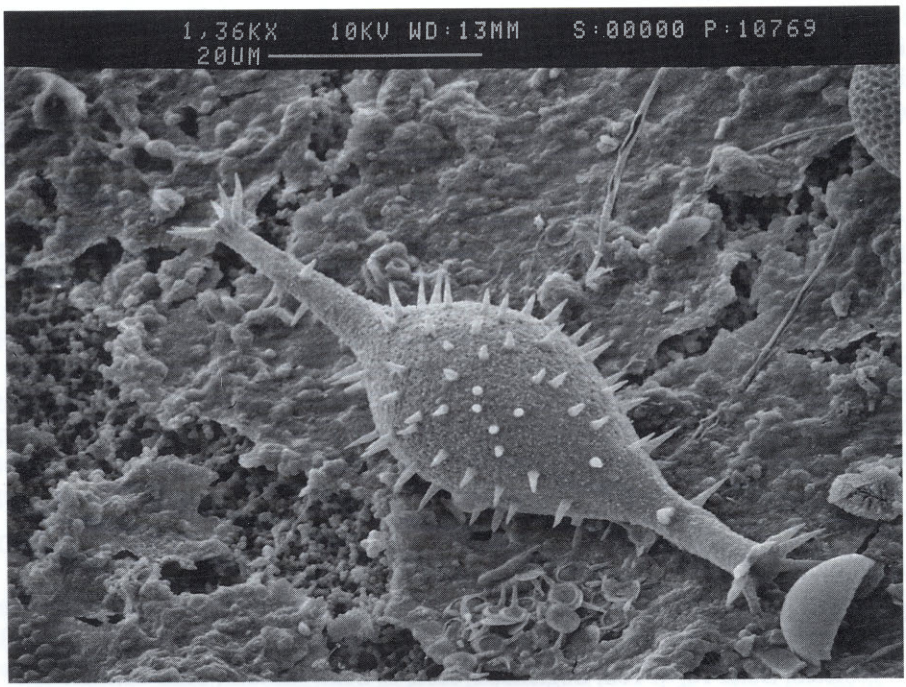

FIGURE 1. *Trachelomonas acanthophora* Stokes

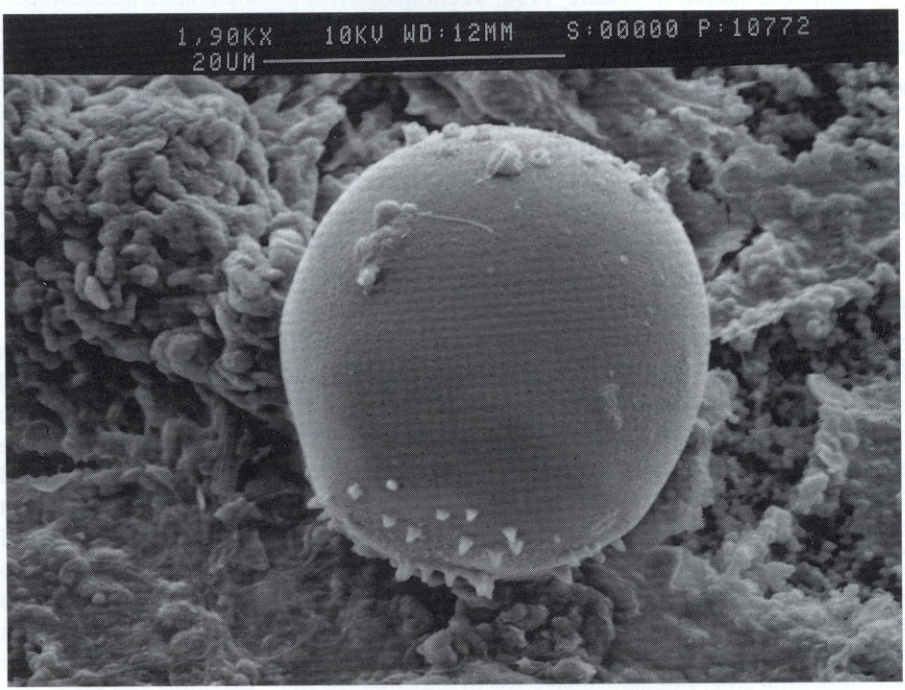

FIGURE 2. *Trachelomonas acanthostoma* Stokes emend. Deflandre

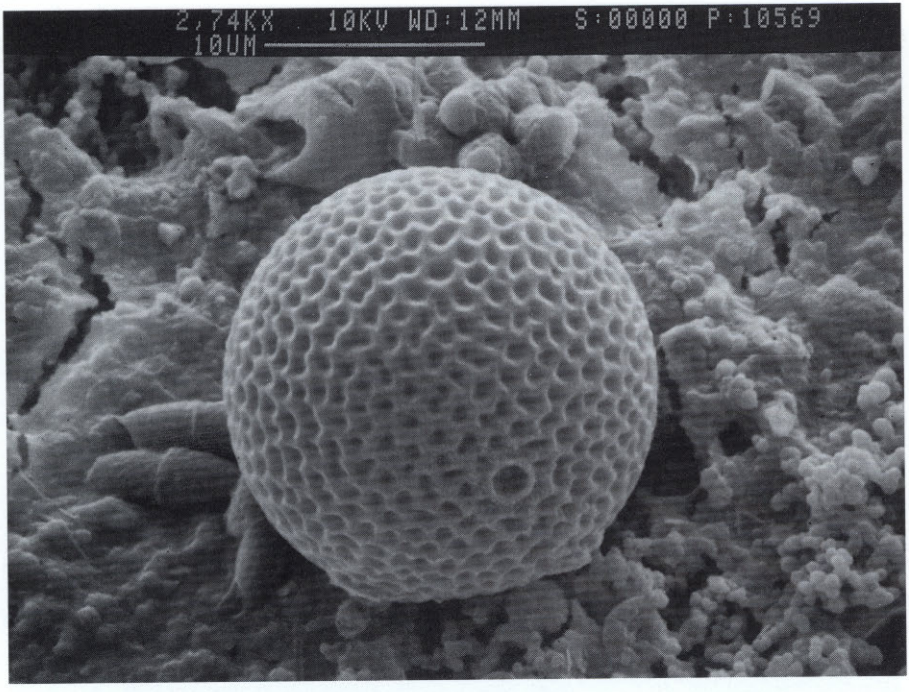

FIGURE 3. *Trachelomonas alisoviana* Skvortzov

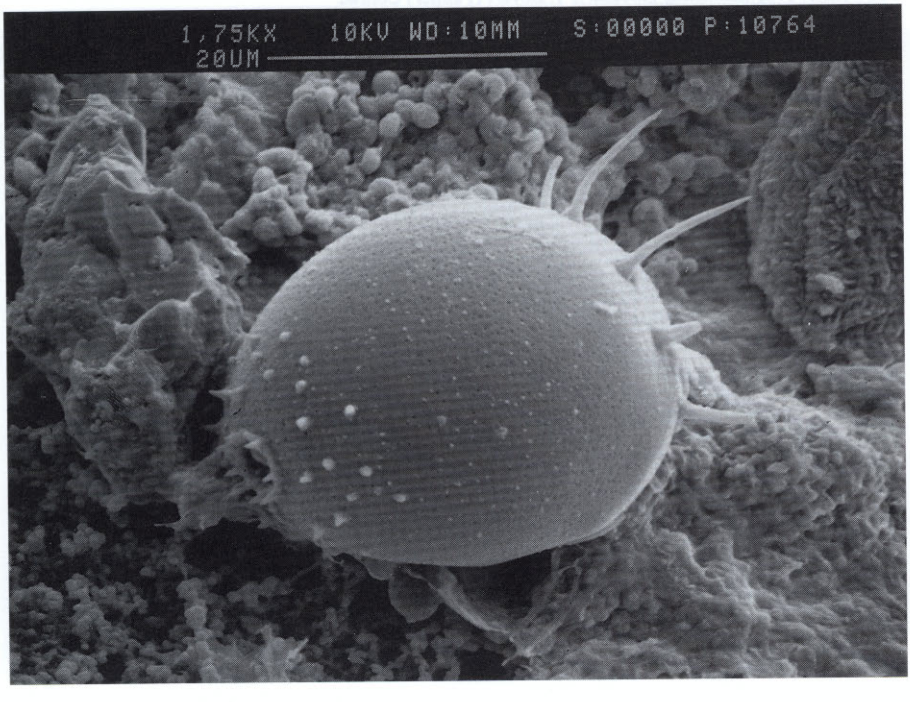

FIGURE 4. *Trachelomonas armata* v. *Steinii* Lemmermann emend. Deflandre

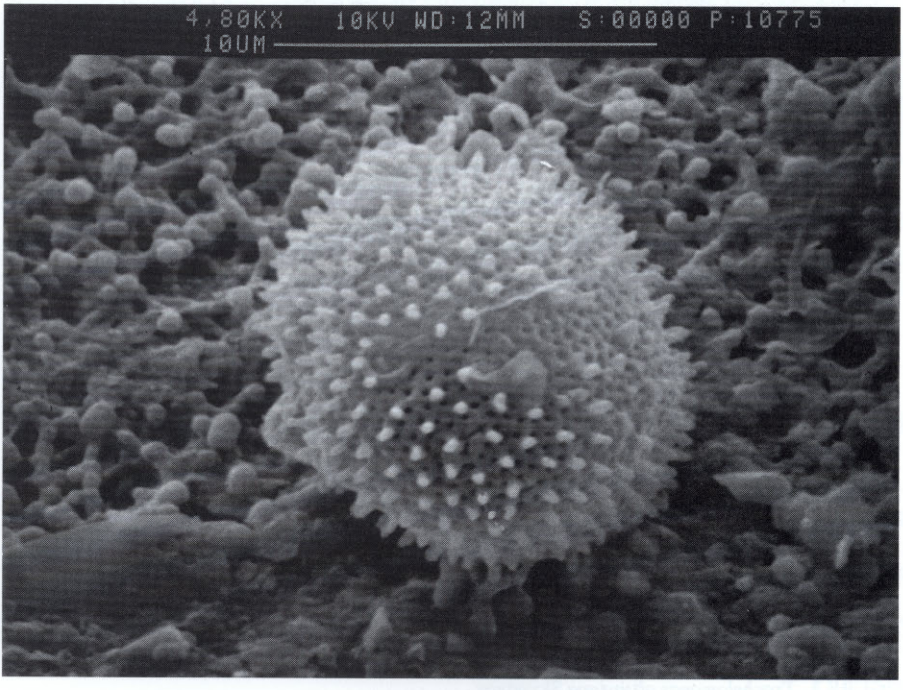

FIGURE 5. *Trachelomonas globularis* v. *Boyeri* (Palmer) Conrad

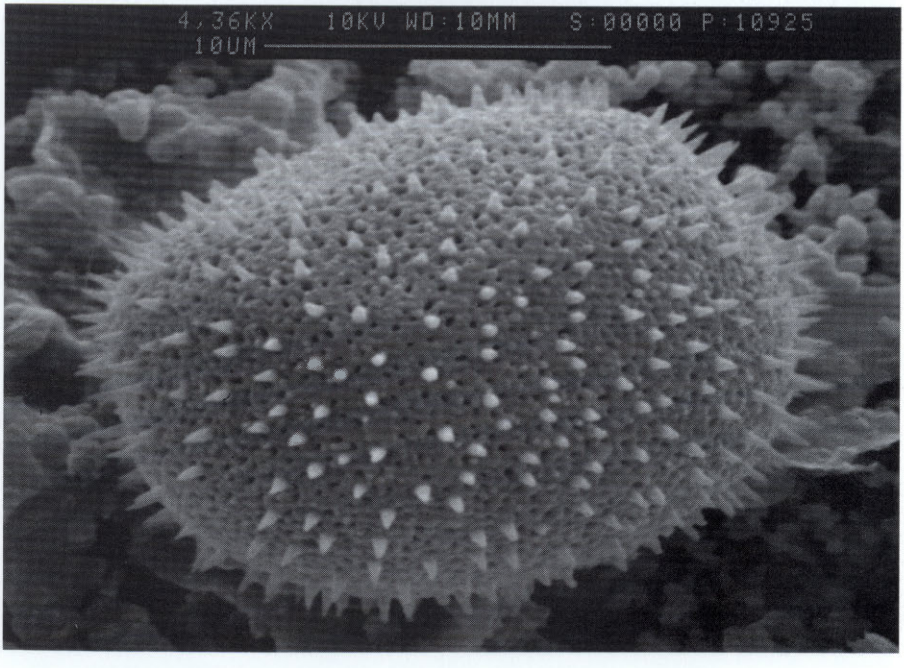

FIGURE 6. *Trachelomonas hispida* (Perty) Stein

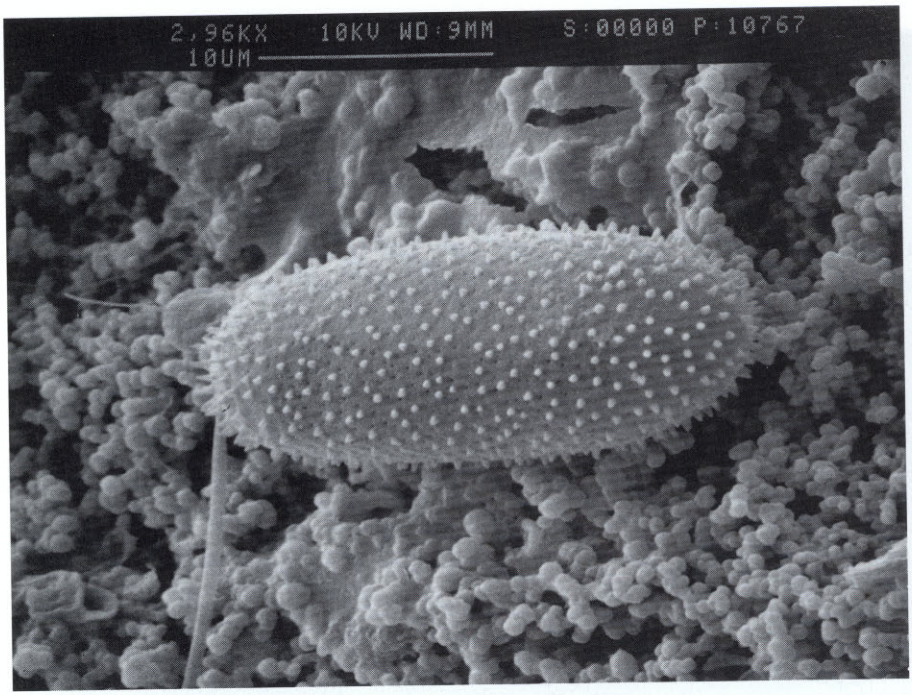

FIGURE 7. *Trachelomonas hispida* v. *coronata* Lemmermann

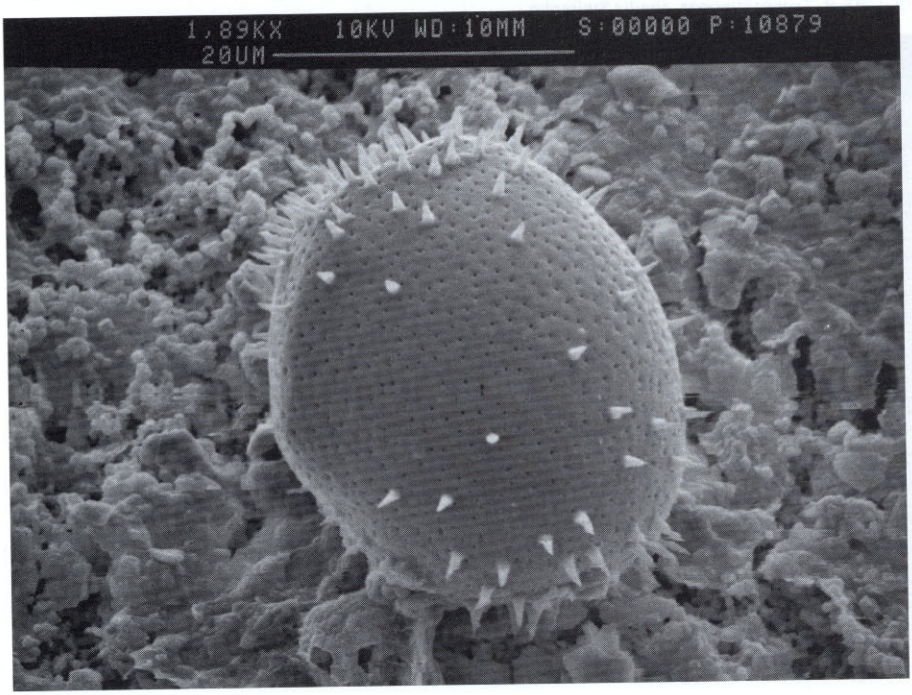

FIGURE 8. *Trachelomonas Raciborskii Woloszynska*

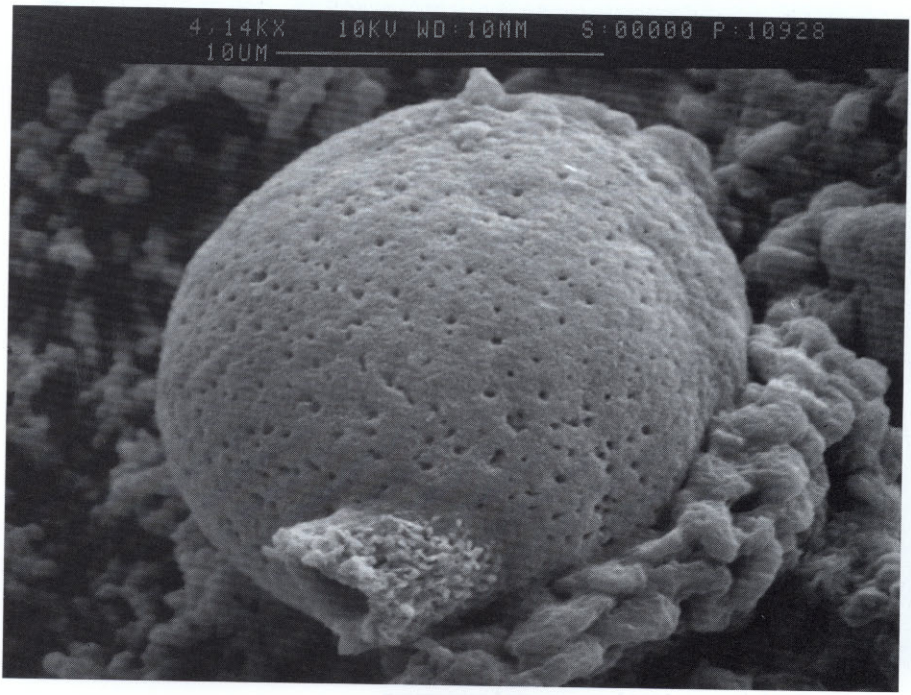

FIGURE 9. *Trachelomonas similis* Swirenko

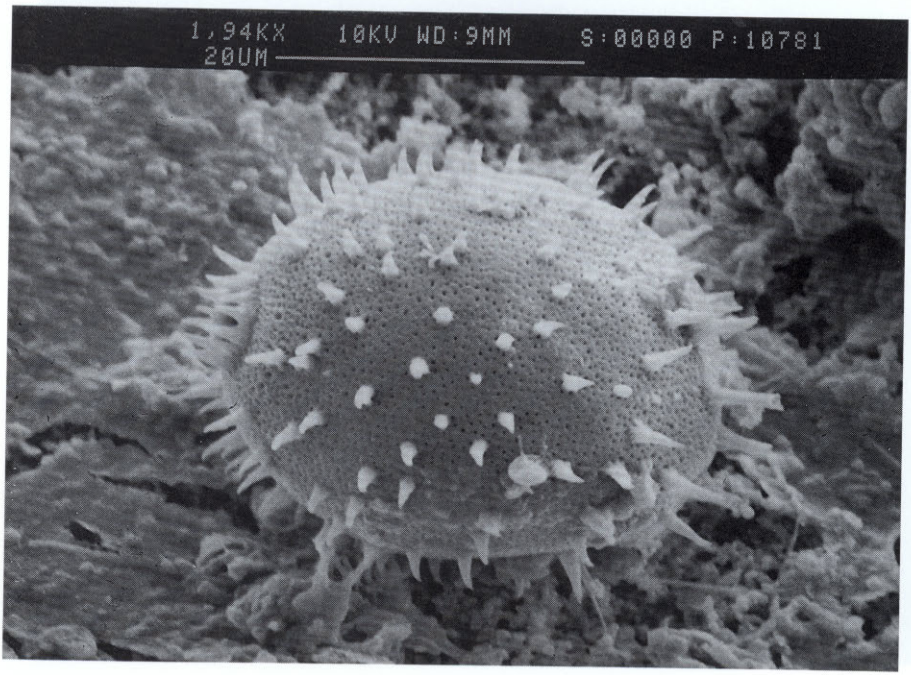

FIGURE 10. *Trachelomonas superba* Swirenko emend. Deflandre

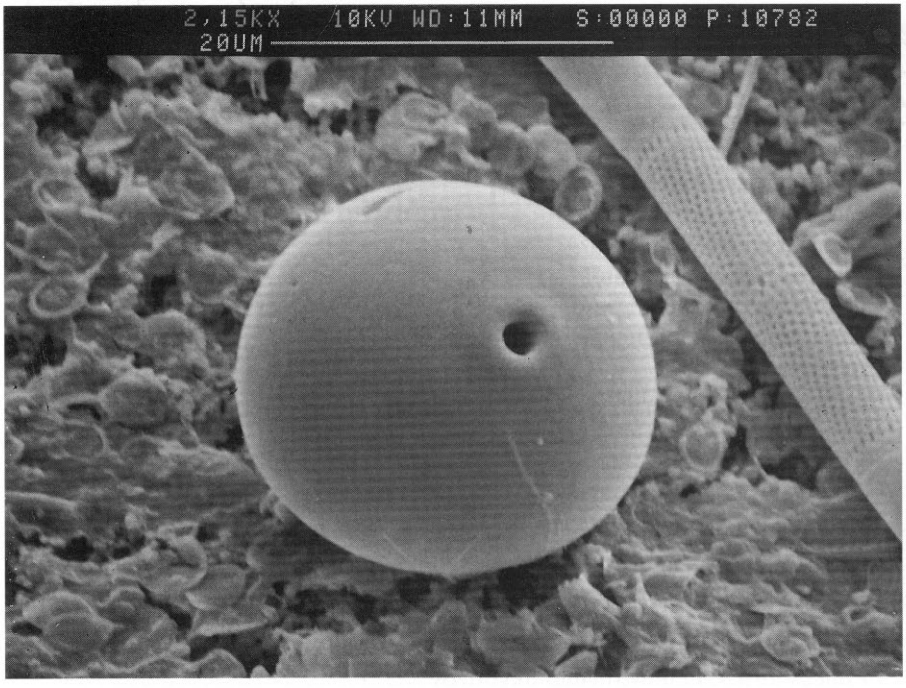

FIGURE 11. *Trachelomonas volvocina Ehrenberg*

TABLE 1. Species within the Euglenophyceae observed in Lake Kilby, June and July 1996.

Euglena acus Ehrenberg
Euglena caudata Hübner
Euglena deses Ehrenberg
Euglena Ehrenbergii Klebs
Euglena mutabilis Schmitz
Euglena oxyuris Schmarda
Euglena proxima Dangeard
Euglena spirogyra Ehrenberg
Euglena sp.
Lepocinclis ovum (Ehrenberg) Lemmermann
Phacus acuminatus Stokes
Phacus caudatus Hübner
Phacus helicoides Pochman
Phacus Lemmermannii (Swirenko) Skvortzov
Phacus longicauda (Ehrenberg) Dujardin
Phacus monilatus Stokes
Phacus obicularis Hübner
Phacus suecicus Lemmermann
Phacus tortus (Lemmermann) Skvortzov
Phacus undulatus (Skvortzov)
Trachelomonas acanthophora Stokes
Trachelomonas acanthostoma Stokes emend. Deflandre
Trachelomonas alisoviana Skvortzov
Trachelomonas armata v. *Steinii* Lemmermann emend. Deflandre
Trachelomonas globularis v. *Boyeri* (Palmer) Conrad
Trachelomonas hispida (Perty) Stein
Trachelomonas hispida v. *coronata* Lemmermann
Trachelomonas intermedia Dangeard
Trachelomonas raciborskii Woloszynska
Trachelomonas similis Swirenko
Trachelomonas sp.
Trachelomonas superba Swirenko emend. Deflandre
Trachelomonas volvocina Ehrenberg