

Proceedings of the Iowa Academy of Science

Volume 83 | Number

Article 5

1976

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Recommended Citation

Wee, James L.; Dodd, John D.; and Wujek, Daniele (1976) "Studies on Silica-Scaled Chrysophytes from Iowa," *Proceedings of the Iowa Academy of Science*: Vol. 83: No. 3 , Article 5.
Available at: <http://scholarworks.uni.edu/pias/vol83/iss3/5>

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Studies on Silica-Scaled Chrysophytes from Iowa

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WEE, JAMES L. AND JOHN D. DODD (Department of Botany and Plant Pathology, Iowa State University, Ames, Iowa 50011), DANIEL E. WUJEK (Department of Biology, Central Michigan University, Mt. Pleasant, Michigan 48859). Studies on silica-scaled chrysophytes from Iowa. Proc. Iowa Acad. Sci. 83(3):94-97, 1976.

References in the literature to the silica-scaled chrysophytes of Iowa are few and, since the advent of the electron microscope, identifications of taxa in this group are no longer considered valid without accompanying electron micrographs. Using scanning electron microscopy for critical identifications, eight taxa from three

genera of the Synuraceae are reported here including the first known report of the genus *Paraphysomonas* from Iowa. From the other two genera, *Mallomonas* and *Synura*, only one of the taxa in this paper, *Mallomonas pseudocoronata*, has been reported from Iowa previously. *Mallomonas acaroides* var. *striatula*, *M. tonsurata*, *M. tonsurata* var. *alpina*, *M. teilingii*, *M. pseudocoronata*, *Mallomonas* sp., *Synura petersenii*, and *Paraphysomonas imperforata* are the taxa reported.

Key Words: Iowa algae; scaled Chrysophytes; *Synura*; *Mallomonas*; *Paraphysomonas*

The silica-scaled chrysophytes are a group of algae which are one of the more frequently encountered groups of phytoplankton in the Chrysophyta yet published records from Iowa are few in number. Edmonson's (1906) report of *Mallomonas plossii* S.K. and *Synura uvella* Ehr. are perhaps the earliest. Prescott (1931) noted two species of *Synura*. Since then, no additional species of *Synura* have been reported (Starret and Patrick, 1952; Smith, 1962; DeLisle, Takahashi and Weeber, 1965). *Mallomonas pseudocoronata* Prescott was added by Kutkuhn in 1958.

Identification of scaled chrysophytes to species presently depends upon the morphology of the scales and bristles (if present) which cover the cell membrane. Korshikov (1929) was one of the first to apply this concept to chrysophycean taxonomy. Transmission electron micrographs (TEM) of scales from members of this group were first published in 1955 (Asmund, 1955; Fott, 1955; Manton, 1955). Since then identifications have not been considered valid without accompanying electron micrographs showing scale morphology. Only two workers have published scanning electron micrographs (SEM) of scaled chrysophytes (Kristiansen, 1971; Cronberg, 1972, 1973, 1975). This study was initiated to investigate and make a preliminary report of the scaled chrysophycean flora of Iowa using the SEM for critical identifications while introducing the literature of this group in an Iowa journal.

METHODS AND MATERIALS

Eight samples were examined from seven locations in five counties (Table 1). Three genera, *Synura* Ehrenberg, *Mallomonas* Perty and *Paraphysomonas* DeSaedeleer, were represented in the samples. Plankton tows were taken using a 171 meshes per inch plankton net. All samples were first observed under a light microscope to visibly select those having a suitable abundance of specimens. One sample was critical point dried, but for the purpose of scale identification this technique did not prove superior to air drying the samples directly on brass plates. Dried samples were coated with a thin layer of gold-palladium and examined in a Jeol 35 scanning electron microscope in the EM facility of the Department of Botany and Plant Pathology, ISU. Advice and assistance by Dr. Harry T. Horner, Jr., and Mr. Paul Elsner are gratefully acknowledged.

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OBSERVATIONS AND DISCUSSIONS

Mallomonas

Mallomonas species are unicellular free-living, freshwater organisms having a membrane covered with siliceous scales, movable bristles, or immovable spines (Wujek and Hamilton, 1972). The cells appear to have only one flagellum, but currently are placed in the biflagellated Synuraceae because remnants of a second flagellum have been found with the aid of the TEM (Takahashi, 1975).

Mallomonas acaroides var. *striatula* Asmund (Fig. 1). A description and transmission electron micrographs of this taxon were first published from Danish collections (Asmund, 1959). The only report from North America is by Wujek and Hamilton (1973) from Michigan. Dimorphism of the bristles sets this variety apart from other varieties of this species. In our sample from Clear Lake (10 V 75) the helmet bristles were much more common than the serrate bristles. Temperature or other seasonably variable parameters may possibly be responsible for some of this morphological variation. It is also possible that such differences are inherited and that transition forms occur between taxa with one bristle type and taxa with more than one bristle type (Asmund, 1959; Kristiansen, 1971).

Mallomonas tonsurata Teiling emend. Krieger (Fig. 3). This widespread species was first described by Teiling (1912); while Krieger (1930) later gave a more detailed description. In the United States it has been reported from Minnesota (Meyer and Brook, 1969), North Carolina (Whitford and Schumaker, 1969), and Michigan (Wujek and Hamilton, 1973). Only Wujek and Hamilton have published a transmission electron micrograph in this country. Foreign reports of this taxon supported by TEM illustrations are from Sweden (Kristiansen, 1969), Japan (Takahashi, 1959), and Denmark (Asmund, 1959). Our sample was collected from Beck's canal (16 VII 75).

Mallomonas tonsurata var. *alpina* (Pascher and Ruttner) Krieger (Fig. 2). The disposition of this taxon is questionable at present. Asmund (1959) originally described it as a variety of *Mallomonas tonsurata* Teiling emend. Krieger. Later she elevated it to a species (Kristiansen, personal communication, 1976). We agree with Kristiansen (personal communication, 1976) that the two taxa are very much alike and that it is more reasonable to keep this taxon as a variety of *M. tonsurata*. Kristiansen (personal communication, 1976) informs us that Asmund has told him that *M. monograptus* Harris

SILICA-SCALED CHRYSOPHYTES

Table 1

Date	Site	Location	Taxa Observed
15 III 75	Big Wall Lake	Wright County Wall Lake Township Sec. 11 & 12 [T-90N, R-24W]	<i>M. Teilingii</i> <i>Mallomonas</i> sp. 1 <i>S. petersenii</i>
10 V 75	Clear Lake	Cerro Gordo County Clear Lake Township Sec. 20 [T-96N, R-22W]	<i>M. acaroides</i> var. <i>striatula</i>
24 VI 75	Big Spirit Lake at Miniwakon State Park	Dickinson County Spirit Lake Township Sec. 9 [T-100N, R-36W]	<i>M. tonsurata</i> var. <i>alpina</i>
30 VI 75	Freda Hafner Preserve owned by The Nature Conservancy in "The Kettle Hole"	Dickinson County Lakeville Township Sec. 33 SW 1/4 [T-99N, R-37W]	<i>P. imperforata</i>
4 VII 75 16 VII 75	Beck's Canal off of Emersons Bay West Lake Okoboji	Dickinson County Lakeville Township Sec. 25 [T-99N, R-37W]	<i>M. tonsurata</i> var. <i>alpina</i> <i>M. pseudocoronata</i> <i>M. tonsurata</i>
11 X 75	Private Farm Pond next to road, entrance to Ledges Wildlife Management Station	Boone County Worth Township Sec. 21 [T-83N, R-26W]	<i>M. pseudocoronata</i>
23 X 75	Little Wall Lake	Hamilton County Ellsworth Township Sec. 16 [T-86N, R-24W]	<i>M. pseudocoronata</i>

and Bradley is identical to *M. tonsurata* var. *alpina*. *M. tonsurata* var. *alpina* has been reported from the United States as *M. monograptus* Harris and Bradley by Asmund and Takahashi (1969) and Wujek and Hamilton (1972). Our specimens were collected from Beck's canal (4 VII 75) and Big Spirit Lake (24 VI 75).

Mallomonas pseudocoronata Prescott (Fig. 4). Prescott (1944) described this species from Wisconsin. The micrographs of Asmund and Hilliard (1961) were confirmed by Prescott and are closely similar to ours. Wujek and Hamilton (1972) reported this species from Lake Michigan. Our samples were collected from Beck's canal (16 VII 75), Little Wall Lake (23 X 75), and a private pond near Ledges State Park (11 X 75). This species was observed in more of our samples (3) than any other taxon.

Mallomonas teilingii Conrad (Fig. 5). The characteristic cell shape of this species was first described by Conrad (1933). Electron micrographs have been published from Rumania (Peterfi, 1966) and Denmark (Asmund, 1956). Identifications from light microscopy have been made in England (Harris, 1953) and North Carolina (Whitford and Schumaker, 1969). Only one cell was observed in our sample, but its scales match closely those illustrated by Peterfi (1966) and Asmund (1956). The electron micrograph of our specimen, collected from Big Wall Lake (15 III 75), appears to be the first one of this taxon published in the U.S.

Mallomonas Sp. 1 (Fig. 6). This taxon was observed with the SEM and with phase contrast microscopy of burned mounts (in Hyrax). The single cell seen under the SEM was intact and micrographs were taken of the whole organism as well as of the individual scales. Illustrations of an organism with similar scale morphology could not be found in the available literature. It is

possible that this organism may be in the genus *Mallomonopsis* Matvienko (1941), but since no flagella were seen a true differentiation cannot be discerned. This alga was collected from Big Wall Lake (15 III 75).

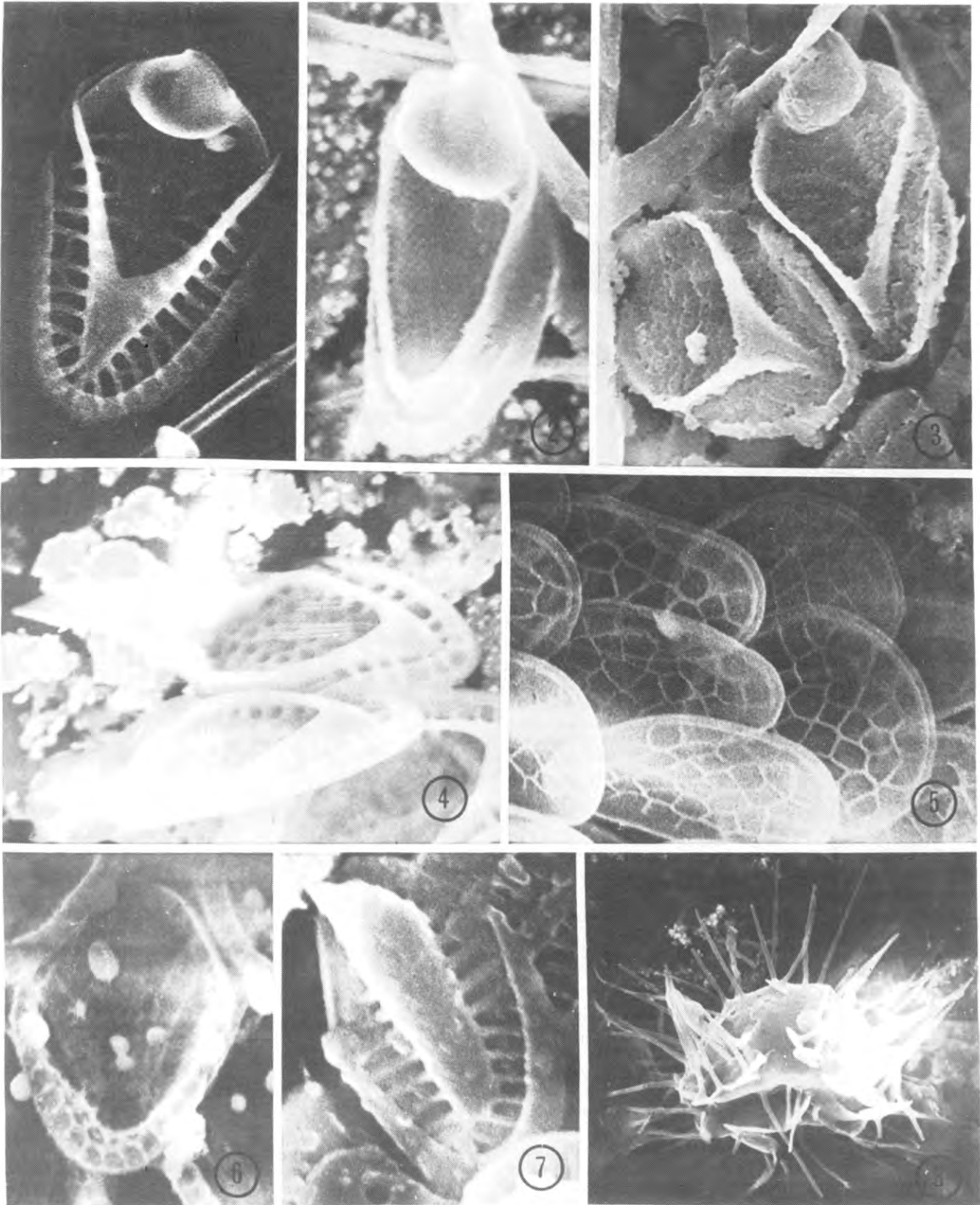
Synura

Synura cells are united radially to form spherical to oblong colonies. The individual cells are pyriform and biflagellate (Wujek and Hamilton, 1972). The siliceous scales have short spines or apiculations (Prescott, 1962). The scales of members of this genus generally are smaller and less thickly silicified than those of *Mallomonas*.

Synura petersenii Korshikov (Fig. 7). This species is probably the most commonly reported scaled chrysophyte. In the United States it has been reported from Michigan (Wujek and Hamilton, 1972), North Carolina (Petersen and Hansen, 1956), and Washington (Munch, 1972). It has been reported from several locations in Europe and Japan. Cronberg (1972) published scanning electron micrographs of material collected in Sweden. Our samples were taken from Beck's canal (4 VII 75) and Big Wall Lake (15 III 75). It is interesting to note that although the former sample was taken during midsummer and the latter late winter, colonies were present in bloom proportions in both samples.

Paraphysomonas

This seemingly rare genus is found in both freshwater and marine habitats. Individuals are unicellular, lack chloroplasts and have heterokont flagellation (Thomsen, 1975). Specific differences are



based on morphology of the silica scales, many of which possess conspicuous spines, and an identification is not considered valid without an electron micrograph. To date eight species have been described.

Paraphysomonas imperforata Lucas (Fig. 8). This species was described by Lucas (1967) from cultures. A survey of the genus by Thomsen (1975), using specimens from natural waters, gives a much wider size range for the scales of this species than Lucas originally stated and, therefore, essentially eliminates size range differences between this species and *Paraphysomonas vestita* (Stokes) DeSaedeleer. This leaves the shape of the spine tips as the only consistent difference between these species (Thomsen, 1975). However, Thomsen noted that *P. imperforata* may be present with all the spines broken off. Our specimens were collected from the Kettle Hole in the Freda Hafner preserve (30 VI 75).

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Figures 1-8. Scanning electron micrographs of chrysophyte scales collected in Iowa.

- Figure 1. *Mallomonas acaroides* var. *striatula*. 11,000 X.
- Figure 2. *Mallomonas tonsurata* var. *alpina*. 16,000 X.
- Figure 3. *Mallomonas tonsurata* var. *tonsurata*. 9,400 X.
- Figure 4. *Mallomonas pseudocoronata* var. *pseudocoronata*. 7,200 X.
- Figure 5. *Mallomonas teilingii* var. *teilingii*. 7,200 X.
- Figure 6. *Mallomonas* sp. 1. 7,800 X.
- Figure 7. *Synura petersenii* var. *petersenii*. 18,000 X.
- Figure 8. *Paraphysomonas imperforata* var. *imperforata*. 4,000 X.