

SILICA-SCALED CHRYSOPHYTES FROM INDIANA. II.

Daniel E. Wujek
Department of Biology
Central Michigan University
Mount Pleasant, Michigan 48859

and

Glenn A. Bechtel¹
Department of Biology
Mississippi State University
Mississippi State, Mississippi 39762

ABSTRACT: A total of 32 scaled chrysophytes (Synurophyceae: 19 *Mallomonas* spp. and 6 *Synura* spp.; Chrysophyceae: 3 *Chrysosphaerella* spp., 2 *Spiniferomonas* spp., and 2 *Paraphysomonas* spp.) were identified from water samples from Lake Monroe, Monroe County, Indiana, using TEM. Twenty-two taxa were new records from Indiana, including *Paraphysomonas runcinifera*, a species new to North America.

KEYWORDS: Lake Monroe, *Paraphysomonas runcinifera*, silica-scaled chrysophytes.

INTRODUCTION

The first published electron micrographs of silica-scaled chrysophytes from Indiana were those of Wujek and Swinehart (1995). All previous reports were based on light microscopy. Kristiansen (1979) demonstrated that electron microscopy is needed to confirm chrysophyte identifications. The chrysophyte flora of Michigan is becoming well studied using the electron microscope (see Wujek and Igoe, 1989, and the literature therein). In this study, we used transmission electron microscopy to examine the silica-scaled algal flora from Lake Monroe, Monroe County, Indiana.

MATERIALS AND METHODS

Lake Monroe is located in south-central Indiana; the lake lies predominately in Monroe County but also extends into Brown, Jackson, and Lawrence Counties. Whole water samples from Lake Monroe (Table 1) were collected and concentrated by settling. These samples were fixed in M3 (Standard Methods, 1989). For transmission electron microscopy (TEM), subsamples were placed on Formvar-coated, carbon-stabilized grids, air dried, and examined with a Philips 300 TEM.

¹Present address: 4050 East Haskell Lake Road, Harrison, Michigan 48625.

Table 1. Physicochemical collection data for silica-scaled chrysophytes from Lake Monroe, Indiana, in 1994.

Sample Number	Site	ID	Depth (m)	pH	Temp (°C)	Conductivity (µS/M)	Turbidity (NTU) ¹	Dis. Org. Carbon ²	Dis. Nitrates and Nitrites ²	Total Organic Carbon ²
4 May										
1	MNR20003	87353*	Surface	7.0	15.3	173	14.4	5	0.2	3.91
2	MNR20003	87354	1.5	7.0	15.3	174	14.8	6	0.2	4.67
3	MNR21004	87358	Surface	6.9	15.4	189	14.5	5	0.3	4.55
4	MNR21004	87359	1.5	6.0	13.2	188	25.4	6	0.2	4.74
5	MNR21004	87361	6	6.8	26.9	172	49.3	6	0.3	5.06
25 May										
6	MNR20047	97103	3	6.7	19.1	123	7.2	6	0.0	5.55
7	MNR20047	97105	6	6.5	16.5	123	14.3	6	0.1	5.39
7 June										
8	MNR21001	95052	Surface	—	—	—	—	—	—	—
8 June										
9	MNR21004	95179	6	6.8	24.8	161	21.0	5	0.0	6.01
10	MNR20047	95183	Surface	7.5	26.8	150	19.8	5	0.0	5.13
11	MNR20047	95189	1.5	6.7	26.8	151	—	6	0.0	5.35
28 June										
12	MNR20003	96465	3	7.6	26.6	143	17.6	3	0.0	3.78
3 August										
13	MNR20003	96116	3	7.5	26.5	162	19.2	5	0.1	5.6
16 August										
14	MNR20004	96208	Surface	6.8	24.0	181	26.7	10	0.0	7.3

¹ National Turbidity Units.² mg/L.

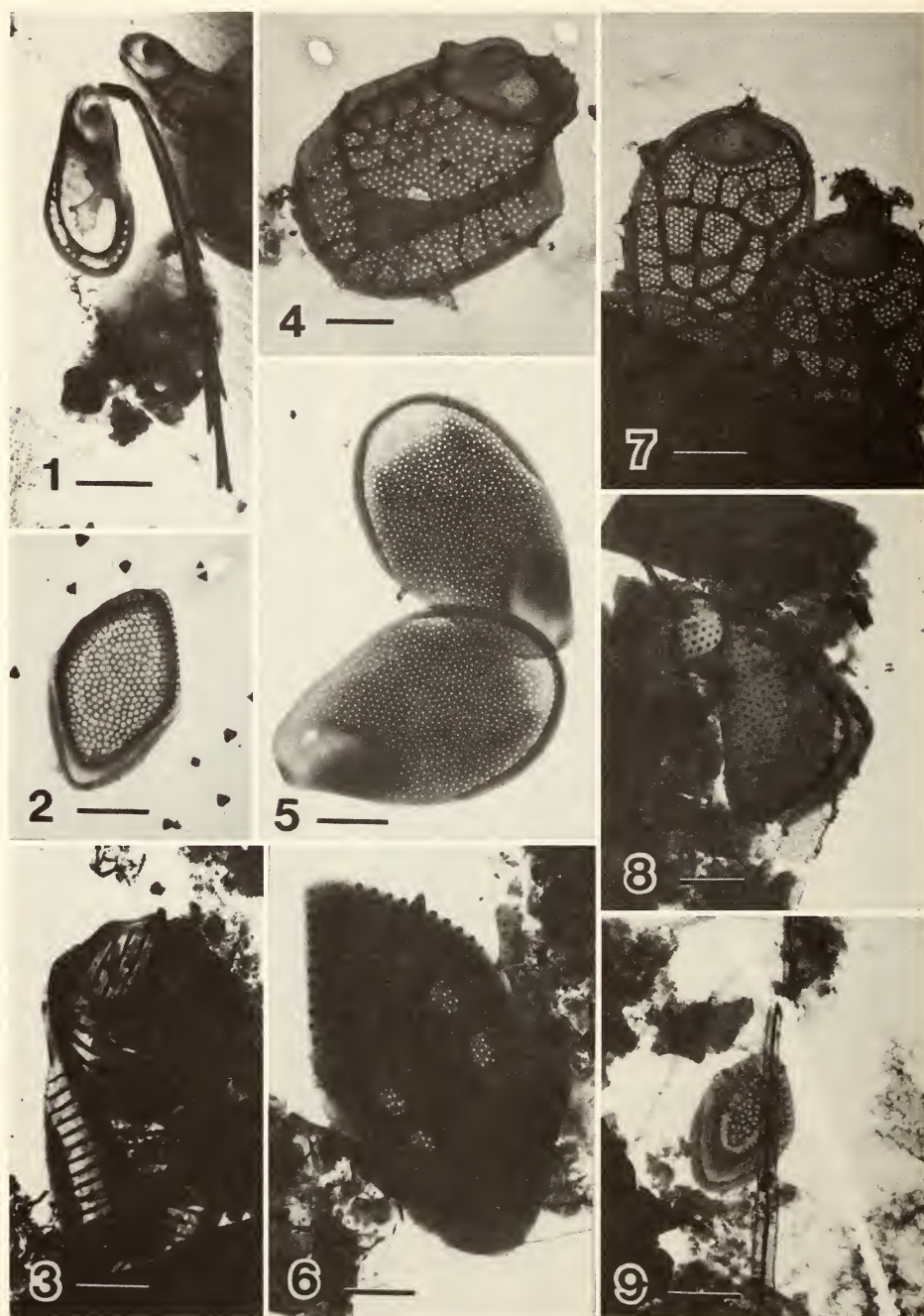
* Sample number of the Louisville District Army Corp of Engineers, Louisville, Kentucky.

OBSERVATIONS AND DISCUSSION

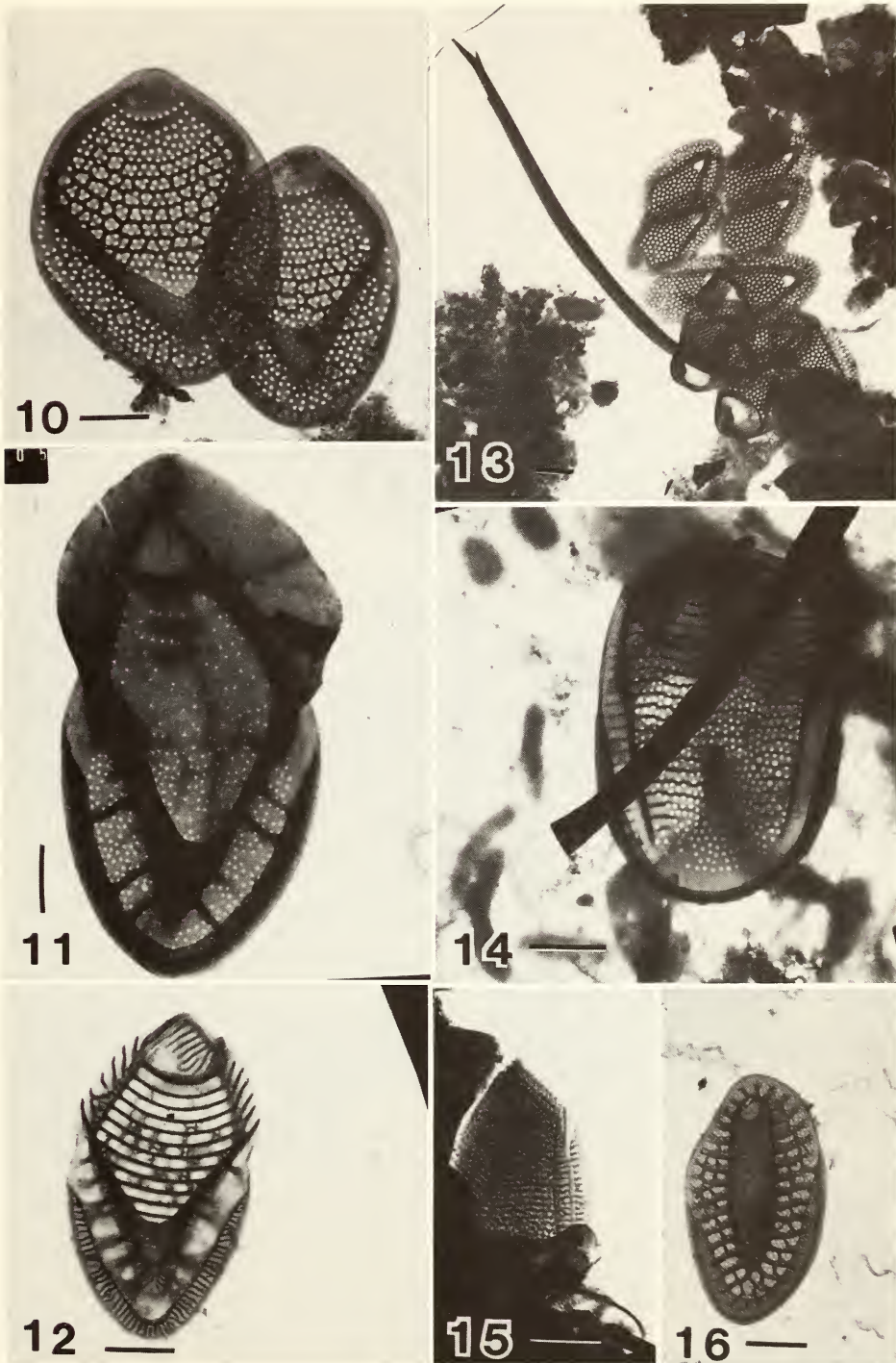
The taxa identified from Monroe Lake are listed in Table 2. Physiochemical parameters are listed for each sample in Table 1. Taxa reported for the first time from Indiana are marked with an asterisk. A total of 32 silica-scaled chrysophyte taxa from the genera *Mallomonas* (19 taxa), *Synura* (6 taxa), *Chrysosphaerella* (3 taxa), *Spiniferomonas* (2 taxa), and *Paraphysomonas* (2 taxa) were observed (Figures 1-23; only species not previously reported from Indiana based on electron microscopy are illustrated). Because the collections were all made during the summer, we suspect that reports of additional species

Table 2. Survey of the occurrence of silica-scaled chrysophytes in Lake Monroe, Indiana. See Table 1 for descriptions of sample sites and dates. Open circles indicate that both isolated scales and complete cells were observed. An asterisk is a new report for Indiana based on electron microscopy.

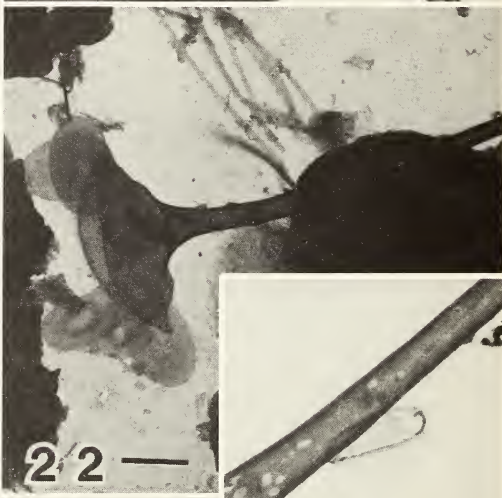
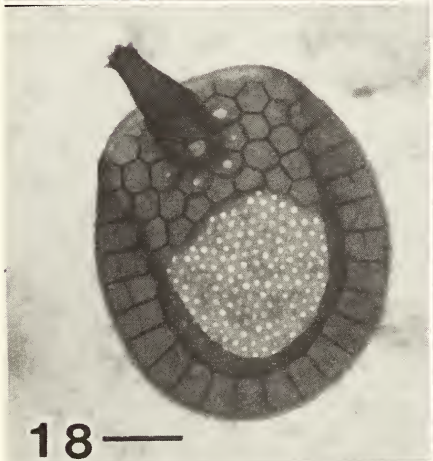
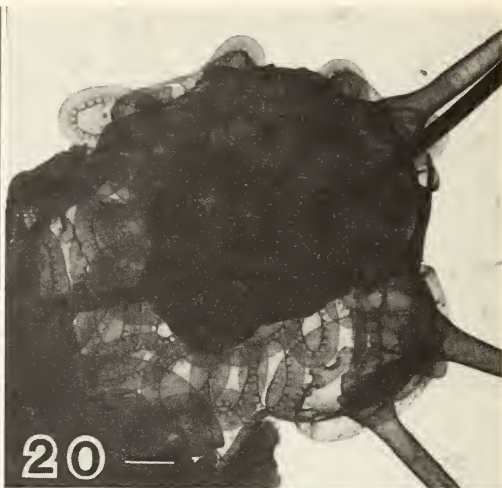
Taxon	Sample Number													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of Taxa/Collection	10	19	21	13	8	17	7	4	15	6	8	10	6	6
Synurophyceae														
Mallomonas														
<i>M. acaroides</i>	●	●	●											
* <i>M. akrokomos</i>			○			○			○			●		●
* <i>M. annulata</i>		●	●											
* <i>M. asmundiae</i>			●											
<i>M. caudata</i>		●	●	●	●	●	●		●	●		●		
* <i>M. crassisquama</i>	○	○	○	●	●	●	●	●	●	●	●	●	●	
* <i>M. hamata</i>		○				●								
* <i>M. heterospina</i>				●		●			●	●	●			
* <i>M. lychenensis</i>		●												
<i>M. mangofera</i> f. <i>mangofera</i>				●		●			●					
* <i>M. mangofera</i> f. <i>foveata</i>						●					●	●		
<i>M. papillosa</i> var. <i>papillosa</i>		●	●											
* <i>M. pillula</i> var. <i>valdiviana</i>			●											
* <i>M. portae-ferreae</i>		●	○									●		
* <i>M. pseudocoronata</i>									●	●				
* <i>M. striata</i> var. <i>serrata</i>			●											
* <i>M. tonsurata</i>	○	●	○	●	●	●	●	●		○	●		●	●
* <i>M. transsylvanica</i>	○	●	●	●	●	●			●					
* <i>M. sp. 1</i>												●		
Synura														
<i>S. curtispina</i>	●	●	●	●	●	●			●				●	●
<i>S. echinulata</i>	○	●	●	●	○	○	○		●	●	●	●		
<i>S. petersenii</i> f. <i>petersenii</i>	○	●	○	●	●	○	●		●	●	●			
* <i>S. petersenii</i> f. <i>kufferathi</i>				●										
* <i>S. spinosa</i>		●							●				●	●
* <i>S. uvella</i>			○				○							
Chrysophyceae														
Chrysosphaerella														
* <i>C. annulata</i>									●			●		
<i>C. brevispina</i>	●	●	●			●			●					
* <i>C. coronacircumspina</i>		○	●			●			●		●	●		
Paraphysomonas														
* <i>P. runcinifera</i>		●												
<i>P. vestita</i>	●	●	●	●		●	●	●	●			●	●	●
Spiniferomonas														
* <i>S. bourrellyi</i>			●	●		●								
* <i>S. trioralis</i>	○	○	○	●	●	●		○			○		●	●



Figures 1-9. 1. *Mallomonas akrokomos*. 2. *M. annulata*. 3. *M. asmundiae*. 4. *M. crassiquama*. 5. *M. hamata*. 6. *M. lichenensis*. 7. *M. heterospina*. 8. *M. mangofera* var. *foveata*. 9. *M. pillula* var. *valdiviana*. Scale bars = 1 μ m.



Figures 10-16. 10. *Mallomonas portae-ferreae*. 11. *M. pseudocoronata*. 12. *M. striata* var. *serrata*. 13. *M. tonsurata*. 14. *M. transsylvanica*. 15. *M. sp. 1*. 16. *Synura petersenii* f. *kufferathi*. Scale bars = 1 μm .



Figures 17-23 (opposite page). **17.** *Synura spinosa*. **18.** *S. uvella*. **19.** *Chrysosphaerella annulata*. **20.** *C. coronacircumspina*. **21.** *Paraphysomonas runcinifera*. **22.** *S. bourrellyi*. **23.** *S. trioralis*. Scale bars = 1 μm .

in this region will be forthcoming. One species, *Paraphysomonas runcinifera* (Figure 21), is new to North America.

The number of scale-bearing chrysophyte taxa observed per sample ranged from 6 to 21. Species richness was greatest at lower water temperatures (Table 1). The most frequent *Mallomonas* species in the study were *M. crassisquama* (86%) and *M. tonsurata* (86%), *M. caudata* (64%), and *M. transsylvanica* (50%). Common species from other genera were *Synura echinulata* (79%), *S. petersenii* f. *petersenii* (71%), *S. curtispina* (64%), *Paraphysomonas vestita* (79%), and *Spiniferomonas trioralis* (71%). Species observed only once included *Mallomonas annulata*, *M. asmundiae*, *M. lychenensis*, *M. pillula* var. *valdiviana*, and *Paraphysomonas runcinifera*. Not surprisingly, the highest diversities were observed in those samples having the greatest dissolved nitrates + nitrites (Table 1).

The range in temperature (13.2° to 26.9° C) and the time of year may have resulted in elements of both the late spring and summer floras being collected. Species that were common in this study, such as *Mallomonas akrokomos* and *M. transsylvanica*, have often been found under the ice in more northern regions (Siver, 1991; Cronberg and Kristiansen, 1980). On the other hand, taxa such as *M. crassisquama*, *M. tonsurata*, and *Synura curtispina*, are more commonly found during the summer (Siver, 1991), supporting the idea that our collections contain elements of both the summer and winter floras.

The pH ranged from 6.5 to 7.6. Many of the species observed during this study, including *Mallomonas hamata*, *M. mangofera* var. *foveata*, *M. transsylvanica*, *Synura echinulata*, and *Spiniferomonas alata*, have been previously reported as common in acidic habitats (Siver, 1988, 1989, 1991). Our observations support these earlier findings.

In conclusion, as has been demonstrated in other regions of the upper Midwest, Indiana contains a diverse flora of scaled chrysophytes. Lake Monroe's chrysophyte diversity was greater than that of the ten different Indiana water bodies previously reported by Wujek and Swinehart (1995). We believe that further collections and observations from other geographic areas in Indiana will yield additional species. Including the species reported in this paper, the scaled chrysophyte flora of Indiana now has 37 known taxa.

ACKNOWLEDGMENTS

The authors wish thank Dr. F.K. Daily (Butler University) for literature assistance, P.R. Elsner for preparing the carbon-coated grids, CMU Graphics Production for assistance in the preparation of the photographic plates, and Dr. Jørgen Kristiansen for commenting on several of our identifications. The Louisville Dis-

trict of the Army Corp of Engineers provided the phytoplankton samples and physiochemical data.

LITERATURE CITED

- Cronberg, G. and J. Kristiansen. 1980. Synuraceae and other Chrysophyceae from central Småland, Sweden. Bot. Notiser 133: 595-618.
- Kristiansen, J. 1979. Problems in classification and identification of Synuraceae (Chrysophyceae). Schweiz. Z. Hydrol. 40: 310-319.
- Siver, P.A. 1988. Distribution of scaled chrysophytes in 17 Adirondack (New York) lakes with special reference to pH. Can. J. Bot. 66: 1391-1403.
- _____. 1989. The distribution of scaled chrysophytes along a pH gradient. Can. J. Bot. 67: 2120-2130.
- _____. 1991. The biology of *Mallomonas*: Morphology, taxonomy and ecology. Kluwer, The Netherlands, 230 pp.
- Standard Methods for the Examination of Water and Wastewater. 1989. American Public Health Association, Washington, D.C.
- Wujek, D.E. and M.J. Igoe. 1989. Studies on Michigan Chrysophyceae. VII. Beih. Nova Hedwigia 95: 269-280.
- _____. and A.L. Swinehart. 1995. Studies on silica-scaled chrysophytes from northern Indiana. Michigan Bot. 34: 59-66.