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DIATOMS NEW TO OHIO AND THE LAURENTIAN GREAT LAKES[1]

DAVID F. MILLIE[2] and REX L. LOWE, Department of Biological Sciences, Bowling Green State University, Bowling Green OH 43403

Abstract. Epiphytic diatoms *(Bacillariophyta)* were collected from three marshes along the southern shoreline of Lake Erie during the summer and fall of 1977. Geographical distributions of 24 taxa new to the state of Ohio are described, and 149 and 34 taxa are reported as new for Lake Erie and the Laurentian Great Lakes, respectively. We attribute the large number of taxa new to the lake to a lack of previous littoral diatom studies, sampling technique, and habitat diversity within the littoral zone.

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The western basin of Lake Erie has been the site of extensive phycological research since the turn of the century. Most studies, however, have dealt with the plankton community (Snow 1902, Tiffany 1934, Chandler 1940, 1942, 1944; Taft 1942, Chandler and Weeks 1945, Verduin 1954, Wujek 1967, Hohn 1969, Taft and Taft 1971, Munawar and Munawar 1976). In recent years, a few researchers have begun to concentrate upon the systematics and ecology of littoral algal communities (Bellis and McLarty 1967, Taft and Kishler 1968, Downing 1970, Kishler and Taft 1970, Fredrick 1975). All of these studies, however, have completely ignored the diatom component of the near shore flora. The paucity of literature concerning this component of the lake's littoral algae and the importance of attached algae within lentic systems (Allen 1971) warrant study in this area.

This is the first of several planned papers concerning the systematics and ecology of the littoral diatom flora within the western basin. Diatom taxa presented here were identified from epiphytic collections from three marshes along the southern shoreline. Chemical and physical data were also collected. This information, along with information concerning seasonal periodicity, community structure, and epiphyte-host interaction is given in the original thesis (Millie 1979).

A taxon is reported as new for Ohio, Lake Erie, or the Laurentian Great Lakes if no previous record of the taxon *in published literature* could be found. Photographs, where available, and geographical distributions are given for taxa newly reported for Ohio. The phylogenetic system presented follows that of Hustedt (1930) and Patrick and Reimer (1966, 1975). To retain standardization within Great Lakes literature, nomenclature of taxa follows that used by the Great Lakes Research Division, University of Michigan.

MATERIALS AND METHODS

Sampling locations were established within the Navarre Unit of the Ottawa Wildlife Refuge, Winous Point Shooting Club, and Moxley's Marsh (fig. 1). The Navarre Unit is composed of 585 acres under the auspices of the United States Fish and Wildlife Service, in the Ottawa Wildlife refuge, which is located at the confluence of the Toussaint River and Lake Erie, Carroll Township, Ottawa County. Winous Point Shooting Club is located at the western end of Sandusky Bay near the mouths of the Sandusky River and Muddy Creek, Ottawa and Erie Counties. This marsh, composed of approximately 5000 acres, has undergone extensive damage due to recent climatic conditions and wave action coupled with high water levels. Moxley's March, composed of approximately 900 acres, is located directly east of Martin Point, Erie County.

Typha angustifolia1 L., *Nymphaea tuberosa* Paine, and *Polygonum coccineum* Muhl. were selected as sub-

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[2]Present address: Dept. of Botany, Iowa State University, Ames IA 50011.

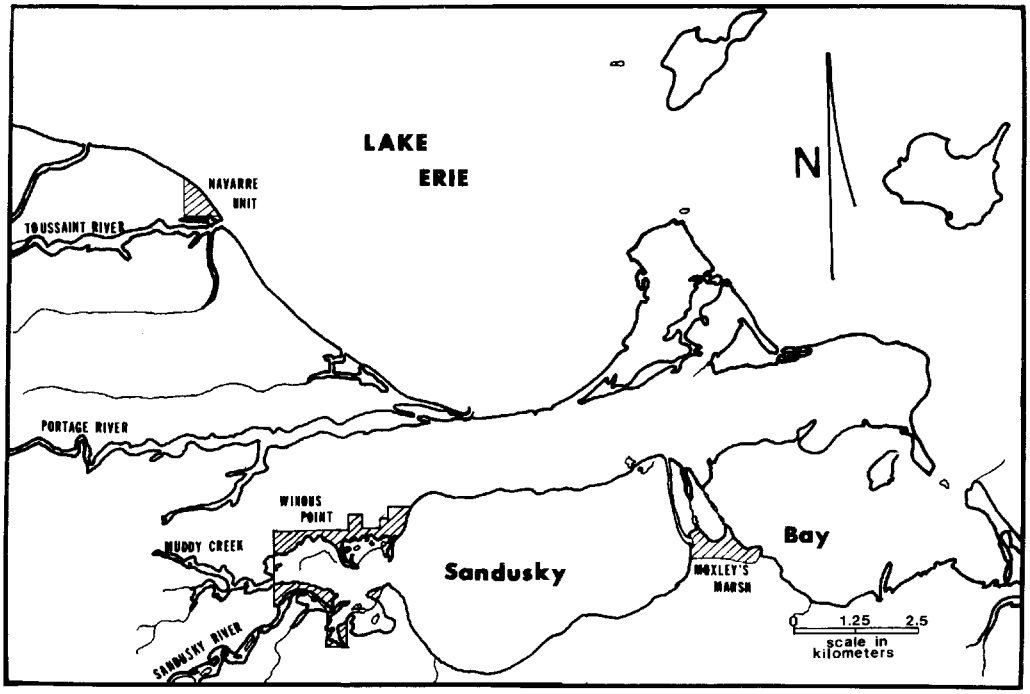


FIGURE 1. Location of the three Lake Erie marshes utilized for sampling epiphytic communities.

strates for epiphytic collections due to commoness in all marshes. Because of its similarity to macrophytic tissue, wooden dowel rod was chosen as an artificial substrate. Epiphytes were collected every three weeks from 10 June 1977 to 7 October 1977. Stems of *T. angustifolia* L. and *P. coccineum* Muhl. and the petiole of *N. tuberosa* Paine were sampled approximately 15 cm below the surface of the water to reduce the effects of wave action on epiphytic growth. A 10 cm tube (internal diameter 1.75 cm) was used to prevent the loss of a large majority of loosely attached algae. The aerial portion of the macrophyte was cut and the tube slid over the cut stem or petiole. The bottom portion of the macrophyte was cut and the tube sealed. Dowel rod was sampled in a similar manner, and samples were taken in triplicate whenever possible. Diatoms were removed from the substrates by careful scraping and cleaned by standard methods. We prepared permanent slides for light microscopy with Hyrax mounting medium (I.R.I. 65) and determined diatom relative abundance through horizontal transects of the coverslips with a 100X apochromatic oil immersion objective (1.32 N.A.). Five hundred diatom valves, rather than complete frustules, were counted per slide as certain taxa possess a differing propensity to separate in the cleaning process (Canburn *et al* 1978). Since substrates at each site were usually sampled in triplicate, the vector from which relative abundance was generated was usually based upon 1500 valves.

Relative abundances of taxa are reported as rare if always less than 1% of the community or uncommon if they rearch a relative abundance between 1% and 5% of the community at times. Representative specimens are availabe for examination in the senior author's herbarium and are available upon request.

RESULTS

We identified 252 diatom taxa encompassing 38 genera, 12 families, and 8 orders. Twenty-five taxa are reported as new for the state of Ohio (table 1), and 149 taxa

TABLE 1

Diatom taxa reported as new for Ohio.

TAXON	SAMPLING LOCATION*
Achnanthes lanceolata var. *apiculata* Patr	N.U., M.M.
Caloneis clevei (Lagst.) Cl. var. *clevei*	M.M.
Cymbella hauckii V. H. var. *hauckii*	N.U.
Cymbella minuta var. *pseudogracilis* (Choln.) Reim.	N.U.
Cymbella minuta var. *silesiaca* (Rabh.) Reim.	N.U., M.M.
Cymbella prostrata var. *auerswaldii* (Rabh.) Reim.	N.U.
Eunotia arcus var. *bidens* Grun.	N.U.
Epithemia adnata var. *proboscidea* (Kütz.) Patr.	N.U., W.P., M.M.

TABLE 1 *Continued.*

TAXON	SAMPLING LOCATION*
Gomphonema affine var. *elongatum* (Mayer) Millie & Lowe	N.U., W.P., M.M.
Gyrosigma obscurem W. Sm.) Griff & Henfr. var. *obscurem*	N.U.
Navicula menisculoides Hust. var. *menisculoides*	N.U., W.P.
Navicula scutelloides W. Sm. var. *scutelloides*	N.U.
Navicula splendicula Van Landingham var. *splendicula*	N.U., M.M.
Navicula vaucheriae Petersen var. *vaucheriae*	N.U., W.P., M.M.
Neidium affine var. *capitata* Mölder	N.U.
Pinnularia acrosphaeria W. Sm. var. *acrosphaeria*	N.U.
Plagiotropis lepidoptera var. *proboscidea* (Cl.) Reim.	N.U., W.P., M.M.
Nitzschia amphioxoides Hust. var. *amphioxoides*	W.P., M.M.
Nitzschia frustulum var. *perminuta* Grun.	N.U., W.P., M.M.
Nitzschia graciloides Hust. var. *graciloides*	N.U., W.P.
Nitzschia longissima var. *reversa* Grun.	N.U., W.P., M.M.
Nitzschia philippinarum Hust. var. *philippinarum*	N.U., W.P.
Nitzschia pusila (Kütz.) Grun. emend. Lange-Bertalot var. *pusilla*	N.U., M.M.
Nitzschia tarda Hust. var. *tarda*	N.U., W.P.
Surirella iowensis Lowe var. *iowensis*	M.M.

*Sampling locations at which taxa were observed are referenced as N.U. (Navarre Unit of the Ottawa Wildlife Refuge), W.P. (Winous Point Shooting Club), and M.M. (Moxley's Marsh).

are new reports for Lake Erie (table 3). Thirty-four taxa, reported as new for the Laurentian Great Lakes, are presented in table 2 (after Stoermer and Kreis 1978). Of all taxa observed, 35% were present in all three marshes; 13% of all taxa were endemic to the sampling sites within the Navarre Unit. Each marsh was characterized by a distinct community structure. Eleven and 9% of the taxa were limited specifically to the sampling sites within Winous Point and Moxley's Marsh, respectively. The following systematic section cites critical references and provides additional information of diatoms new to Ohio.

TABLE 2

Diatom taxa reported as new for the Laurentian Great Lakes.

FAMILY
Fragilariaceae
Synedra netronoides Hohn & Hellerm. var. *netronoides*
Naviculariaceae
Gyrosigma macrum (W. Sm.) Griff & Henfr. var. *macrum*
G. obscurem (W. Sm.) Griff & Henfr. var. *obscurem*
Neidium affine var. *capitata* Mölder
N. hankensis Skv. var. *hankensis*
Navicula cincta var. *rostrata* Reim
N. cryptocephala var. *exilis* (Kütz.) Grun.
N. cuspidata var. *ambigua* (Ehr.) Cl.
N. halophila f. *tenurostris* Hurst.
N. hustedtii Krasske var. *hustedtii*
N. paucivisitata Patr. var. *paucivisitata*
N. seminulum var. *hustedtii* Patr.
N. tenera Hust. var. *tenera*
N. vaucheriae Petersen var. *vaucheriae*
Pinnularia abaugensis var. *rostrata* (Patr.) Patr.
Gomphonemaceae
Gomphonema affine Kütz. var. affine
G. affine var. *elongatum* (Mayer) Millie & Lowe
Epithemiaceae
Epithemia adnata var. *proboscidea* (Kütz.) Patr.
Nitzschiaceae
Nitzschia adapta Hust. var. *adapta*
N. amphioxoides Hust. var. *amphioxoides*
N. bremensis Hust. var. *bremensis*
N. debilis (Ar.) Grun. var. *debilis*
N. levidensis (W. Sm.) Grun. var. *levidensis*
N. microcephala Grun. var. *microcephala*
N. parvula var. *terricola* Lund.
N. philippanarum Hust. var. *philippanarum*
N. pusilla (Kütz.) Grun emend. Lange-Bertalot var. *pusilla*
N. spiculum Hust. var. *spiculum*
N. stricta Hust. var. *stricta*
N. subcapitellata Hust. var. *subcapitellata*
N. subrostroides Choln. var. *subrostroides*
Surirellaceae
Surirella iowensis Lowe var. *iowensis*
S. suecica Grun. var. suecica

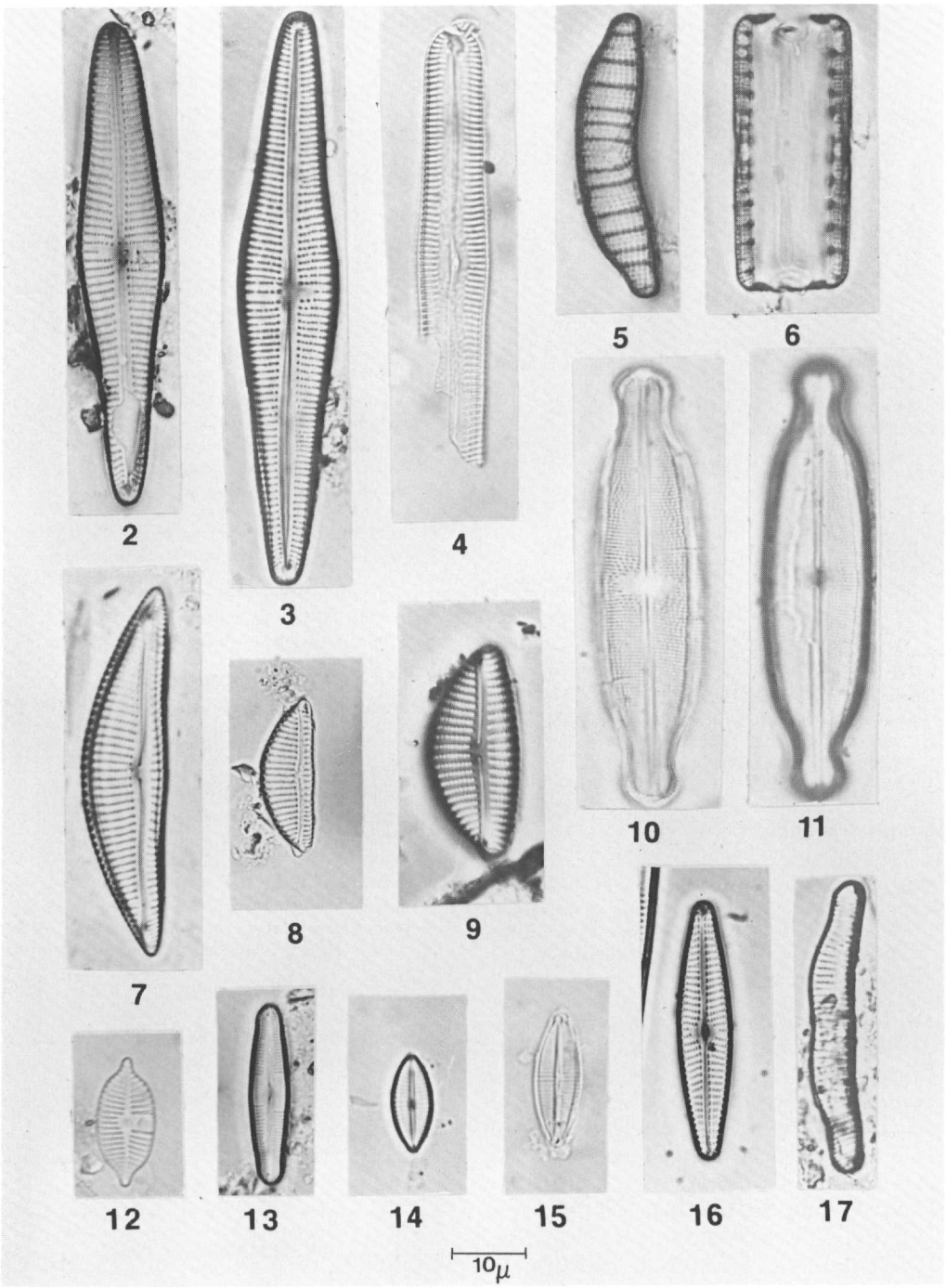
SYSTEMATIC SECTION

Eunotiaceae

Eunotia Ehr.

Eunotia arcus var. *bidens* Grun. Fig. 17

Critical reference: Patrick and Reimer (1966). Page 213; Pl. 13, Fig. 12



FIGURES 2-17. 2-3. *Gomphonema affine* var. *elongatum* (Mayer) Millie and Lowe comb. nov. 3. auxospore. 4. *Pinnularia acrosphaeria* W. Sm. 5-6. *Epithemia adnata* var. *proboscidea* Kütz.) Patr. Fig. 6. girdle view. 7. *Cymbella minuta* var. *pseudogracilis* (Choln.) Reim. 8. *Cymbella minuta* var. *silesiaca* (Rabh.) Reim. 9. *Cymbella prostrata* var. *auerswaldii* (Rabh.) Reim. 10-11. *Neidium affine* var. *capitata* Mölder Same specimen at two levels of focus. 12. *Achnanthes lanceolata* var. *apiculata* Patr. Rapheless valve. 13. *Caloneis clevei* (Lagst.) Cl. 14. *Navicula vaucheriae* Petersen. 15. *Navicula menisculoides* Hust. 16. *Navicula splendicula* Van Landingham. 17. *Eunotia arcus* var. *bidens* Grun.

One valve of this taxon was observed epiphytic on *P. coccineum* at the Navarre Unit on 2 July 1977.

Achnanthaceae

Achnanthes Bory

Achnanthes lanceolata var *apiculata* Patr. Fig. 12

Critical reference: Patrick and Reimer (1966). Page 270; Pl. 18, Fig. 24-25.

A few specimens were observed from the Navarre Unit on 6 September and from Moxley's Marsh on 2 July 1977.

Naviculaceae

Gyrosigma Hass.

Gyrosigma obscurem (W. Sm.) Griff & Henfr. var. *obscurem*

Critical reference: Patrick and Reimer (1966). Page 323; Pl. 24, Fig. 7.

One valve was observed epiphytic upon *N. tuberosa* at the Navarre Unit on 7 October 1977.

Neidium Pfitz.

Neidium affine var. *capitata* Mölder Figs. 10-11.

Critical reference; Hustedt (1930). Page 242, Fig. 377.

A few specimens were observed epiphytic upon dowel rod at the Navarre Unit on 10 June 1977.

Navicula Bory

Navicula menisculoides Hust. var. *menisculoides* Fig. 15

Critical reference: Hustedt (1962). Page 255; Fig. 1382.

This taxon was rare in collections from the Navarre Unit and Winous Point throughout the study.

Navicula scutteloides W. Sm. ex Greg. var. *scutelloides*

Critical reference: Patrick and Reimer (1966). Page 450; Pl. 41, Fig. 3.

Specimens were rare in collections from dowel rod at the Navarre Unit on 2 July 1977.

Navicula splendicula Van Landingham var. *splendicula* Fig. 16

Critical reference: Stevenson and Stoermer (1978). Page 183; Pl. 1, Fig. 13-17.

Distinguished by its slightly protracted ends, separated central striae, and punctate striae, this taxon was rare in collections from all marshes throughout the study. Stevenson and Stoermer have reported this taxon from the upper Great Lakes.

Navicula vaucheriae Petersen var. *vaucheriae* Fig. 14

Critical reference: Hustedt (1961). Page 159; Fig. 1292.

Specimens were rare to uncommon in collections from the Navarre Unit and Winous Point throughout the study. Greatest relative abundance (4.13%) was noted in mid-summer at Winous Point. This taxon is distinguished from *N. biconica* Patr. by its slightly attenuated apices.

Caloneis Cl.

Caloneis clevei (Lagst.) Cleve var. *clevei* Fig. 13

Critical reference: Hustedt (1930). Page 236; Fig. 359.

Two valves were observed in collections from *P. coccineum* at Moxley's Marsh on 2 July 1977. The specimens observed, although much smaller than the size range indicated by Hustedt, were distinguished by the undulate valve margin at the apices.

Pinnularia Ehr.

Pinnularia acrosphaeria W. Sm. var. *acrosphaeria* Fig. 4.

Critical reference: Patrick and Reimer (1966). Page 623; Pl. 60, Figs. 2-3.

Specimens were rare in collections from the Navarre Unit from 2 July to October 1977. This taxon was reported as *Pinnularia* #3 in Millie (1979). Most specimens observed were fragmented.

Entomoneidaceae

Plagiotropis Pfitz.

Plagiotropis lepidoptera var *proboscidea* (Cl.) Reim. Fig. 25.

Critical reference: Patrick and Reimer (1975). Page 7; Pl. 2, Figs. 3-5.

This taxon was rare in collections from all marshes throughout the study.

Cymbellaceae

Cymbella Ag.

Cymbella hauckii V.H. var. *hauckii*

Critical reference: Patrick and Reimer (1975). Page 37; Pl. 5, Figs. 5-7.

Two valves of this taxon were observed epiphytic upon *N. tuberosa* at the Navarre Unit on 6 September 1977.

Cymbella minuta var. *pseudogracilis* (Choln.) Reim. Fig. 7.

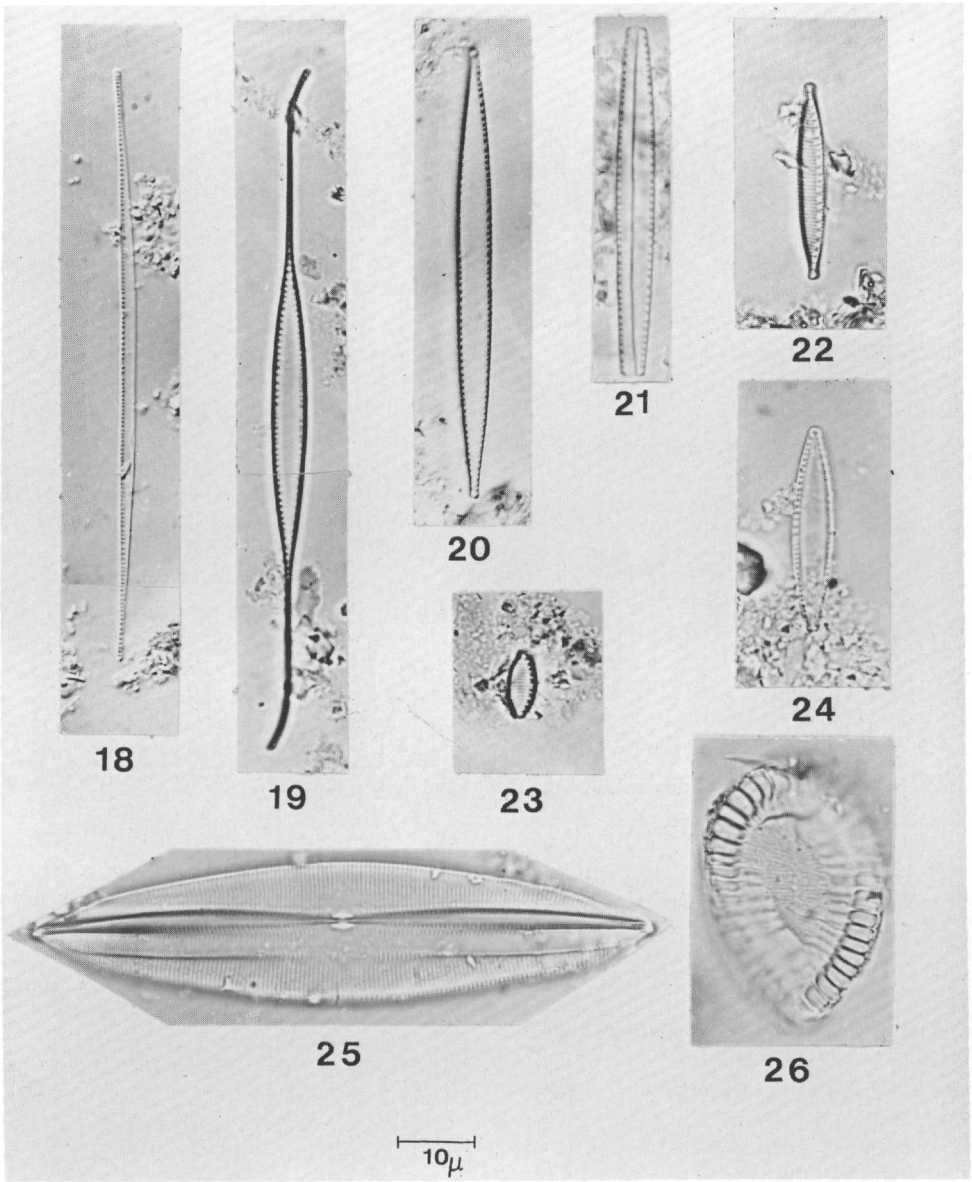
Critical reference: Patrick and Reimer (1975). Page 50; Pl. 9, Figs. 1a-2b.

This taxon was rare in collections from the Navarre Unit and Winous Point from 10 June to 13 August 1977. It is distinguished from *C. minuta* var. *silesiaca* (Bleisch ex Rabh.) Reim. by its larger size range and coarser striae and punctae.

Cymbella minuta var. *silesiaca* (Bleisch ex Rabh.) Reim. Fig. 8.

Critical reference: Patrick and Reimer (1975). Page 49; Pl. 8, Figs. 7a-10b.

Specimens were rare in collections from the Navarre Unit throughout the study. This taxon was also observed in a single collection from Moxley's Marsh on 6 September and 7 October 1977.



FIGURES 18-26. 18. *Nitzschia graciolodes* Hust. 19. *Nitzschia longissima* var. *reversa* Grun. 20. *Nitzschia tarda* Hust. 21. *Nitzschia philippinarum* Hust. 22. *Nitzschia amphioxoides* Hust. 23. *Nitzschia frustulum* var. *perminuta* Grun. 24. *Nitzschia pusilla* (Kütz.) Grun. emend. Lange-Bertalot. 25. *Plagiotropis lepidoptera* var. *proboscidea* (Cl.) Reim. 26. *Surirella iowensis* Lowe.

Cymbella prostrata var. *auerswaldii* (Rabh.) Reim. Fig. 9.

Critical reference: Patrick and Reimer (1975). Page 41; Pl. 6, Figs. 5-6.

Specimens were rare in collections from the Navarre Unit and Moxley's Marsh from 10 June to 23 August 1977.

Gomphonemaceae

Gomphonema Ehr.

Gomphonema var. *elongatum* (Mayer) Millie & Lowe comb. nov. Figs. 2-3.

Critical reference: Mayer (1928). Page 115; Pl. 3, Fig. 22 (as *G. insigne* var. *elongatum* Mayer).

Specimens were rare to uncommon at all marshes throughout the study. This taxon is distinguished by its large size, coarse striation, and a slightly broader head than foot pole. With Andrew's (1970) incorporation of *G. insigne* Greg. into the *G. affine* complex, it is felt that the proper systematic positioning of this taxon is a variety of *G. affine* Kütz.

Epithemiaceae

Epithemia Breb.

Epithemia adnata var. *proboscidea* (Kütz.) Patr. Fig. 5-6.

Critical reference: Patrick and Reimer (1975). Page 181; Pl. 24, Fig. 5.

This taxon was rare to uncommon in collections from all marshes throughout the study.

Nitzschiaceae

Nitzschia Hass.

Nitzschia amphioxoidea Hust. var. *amphioxoides* Fig. 22.

Critical reference: Hustedt (1949). Page 140; Pl. 13, Figs. 65-72.

Specimens were rare in collections from Moxley's Marsh and Winous Point throughout the study. This taxon is distinguished by its striation and capitate apices.

Nitzschia frustulum var. *perminuta* Grun. Fig. 23.

Critical reference: Van Heurck (1881). Pl. 68, Fig. 3.

This taxon was rare to uncommon in collections from all marshes throughout the study.

Nitzschia graciloides Hust. var. *graciloides* Fig. 18.

Critical reference: Hustedt (1959). Page 95; Pl. 2, Figs. 4-5.

Specimens were rare to uncommon in collections from the Navarre Unit and Winous Point from 10 June to 13 August 1977. This taxon was reported as Nitzschia #20 in Millie (1979).

Nitzschia longissima var. *reversa* Grun. Fig. 19.

Critical reference: Van Heurck (1881). Pl. 70, Fig. 4.

Specimens were rare to uncommon in all marshes throughout the study. This taxon is characterized by its sigmoid shape, protracted ends, and separated keel punctae in the middle of the valve.

Nitzschia philippinarum Hust. var. *philippinarum* Fig. 21.

Critical reference: Hustedt (1942). Page 137; Figs. 322-330.

A few valves of this taxon were observed at the Navarre Unit and Winous Point on 6 September 1977.

Nitzschia pusilla (Kütz.) Grun. emend Lange-Bertalot var. *pusilla* Fig. 24.

Critical reference: Lange-Bertalot (1976). Page 273; Pl. 7, Figs. 1-10.

A few specimens were observed from the Navarre Unit and Moxley's Marsh from 2 July to 13 August 1977.

Nitzschia tarda Hust. var. *tarda* Fig. 20.

Critical reference: Hustedt (1949). Page 138; Pl. 12, Figs. 24-26.

Specimens were rare at Winous Point on 2 July and at the Navarre Unit from 2 July to 7 October 1977. Lange-Bertalot (1976) synonymized this taxon with *N. intermedia* Hantz. However, due to the specimen's finer striation and protracted ends, the authors retain this taxon as a separate entity.

Surirellaceae

Surirella Turpin

Surirella iowensis Lowe var. *iowensis* Fig. 26.

Critical reference: Lowe (1972). Page 69; Pl. 5, Figs. 2-3.

Two valves of this taxon were observed in a random observation of a collection from Moxley's Marsh on 2 July 1977. This diatom is best distinguished by its torsioned transapical axis.

DISCUSSION

The large number of diatom taxa reported as new for Lake Erie is attributed to the paucity of previous periphytic studies, sampling technique, and habitat diversity within the littoral area. Hohn (1969), in a synopsis of previous literature, reported only 127 diatom taxa within the plankton of the western basin. The increased number of taxa identified in the present study is not unexpected, as the periphytic assemblages of the littoral region exhibit a more diverse flora than the plankton due to greater niche availability. The influx of river water also brings periphytic forms normally associated with lotic ecosystems into the littoral zone. These forms probably compete with littoral taxa and increase species diversity. (See table 3)

In collecting the epiphytic community, a cylinder was slid over the macrophytic surface to prevent the loss of loosely attached algae upon removal from the water. This procedure increased the potential species diversity and standing crop as many "planktonic" taxa were included in the collection. The major mode of attachment for epiphytic diatoms is either the attachment of the cell along its entire valve face,

TABLE 3

Phylogenetic list of diatom taxa new to Lake Erie.

Division Bacillariophyta
Class Bacillariophyceae
Order Eupodiscales
Family Coscinodiscaceae
Sub-Family Melosiroideae
Melosira italica (Ehr.) Kütz. var. *italica*
Sub-Family Sceletonemoideae
Microsiphona potomos Weber var. *potomos*
Thalassiosira lacustris Grun. var. *lacustris*
Thalassiosira weisflogii (Grun.) Fryxell & Hasle var. *weisflogii*
Sub-Family Coscinodiscoideae
Cyclotella atomus Hust. var. *atomus*
Cyclotella comensis Grun. var. *comensis*
Stephanodiscus minutus Grun. ex Cleve & Moll. var. *minutus*
Stephanodiscus subtilis (Van Goor A. Cleve var. *subtilis*
Order Fragilariales
Family Fragilariaceae
Sub-Family Fragilarioideae
Opephora martyi Héribaud var. *martyi*
Fragilaria brevistriata Grun. var. *brevistriata*
Fragilaria brevistriata var. *inflata* (Pant.) Hust.
Fragilaria capucina var. *mesolepta* Rabh.
Fragilaria construens var. *binoides* (Ehr.) Grun
Fragilaria construens var. *pumilla* Grun.
Fragilaria construens var. *venter* (Ehr.) Grun.
Hannea arcus (Ehr.) Patr. var. *arcus*
Synedra delicatissima var. *angustissima* Grun.
Synedra fasiculata (Ag.) Kütz. var. *fasiculata*
Synedra netronoides Hohn & Hellerm. var. *netronoides*
Synedra pulchella var. lacerata Hust.
Synedra rumpens Kütz. var. *rumpens*
Synedra rumpens var. *familiaris* (Kütz.) Hust.
Synedra tenera W. Sm. var. *tenera*
Order Eunotiales
Family Eunotiaceae
Sub-Family Eunotioideae
Eunotia arcus var. *bidens* Grun.
Eunotia pectinalis var. *minor* (Kütz) Rabh.
Order Achnanthales
Family Achnanthaceae
Sub-Family Cocconeiodeae
Cocconeis placentula var. *lineata* (Ehr.) V.H.
Sub-Family Achnanthoideae
Achnanthes exigua var. *constricta* (Grun.) Hust.

TABLE 3. *Continued.*

Achnanthes exigua var. *heterovalva* Krasske
Achnanthes lanceolata var. *apiculata* Patr.
Achnanthes lanceolata var. *dubia* Grun.
Achnanthes lanceolata var. *omissa* Reim.
Achnanthes linearis W. Sm. var. *linearis*

Order Navicuales
Family Naviculaceae
Mastogloia smithii var. *lacustris* Grun.
Amphipleura pellucida (Kütz. var. *pellucida*
Frustulia vulgaris (Thwaites DeT. var. *vulgaris*
Gyrosigma macrum (W. Sm.) Griff & Henfr. var. *macrum*
Gyrosigma obscurem (W. Sm.) Griff & Henfr. var. *obscureum*
Neidium affine var. *capitata* Mölder
Neidium dubium (Ehr.) Cl. var. *dubium*
Neidium hankensis Skvortzow var. *hankensis*
Diploneis ovalis (Hilse) Cl. var. *ovalis*
Diploneis puella (Schum.) Cl. var. *puella*
Stauroneis anceps Ehr. var. *anceps*
Stauroneis kriegeri Patr. var. *kriegeri*
Anomoeoneis sphaerophora (Kütz.) Pfitzer var. *sphaerophora*
Navicula abiskoensis Hust. var. *abiskoensis*
Navicula accomoda Hust var. *accomoda*
Navicula capitata var. *hungarica (Grun.) Ross*
Navicula cincta var. *rostrata* Reim.
Navicula confervacera (Kütz.) Grun. var. *confervacea*
Navicula contenta var. *biceps* (Arn.) Grun.
Navicula cryptocephala var. *exilis* (Kütz.) Grun.
Navicula cryptocephala var. *veneta* (Kütz.) Rabh.
Navicula cuspidata var. *ambigua* (Ehr.) Cl.
Navicula elginensis var. *rostrata* (A. Mayer) Patr.
Navicula gregaria Donk. var. *gregaria*
Navicula halophila f. *tenurostris* Hust.
Navicula heufleri Grun. var. *heufleri*
Navicula heufleri var. *leptocephala* (Bréb.) Patr.
Navicula hustedtii Krasske var. *hustedtii*
Navicula insociablis var. *dissipatoides* Hust.
Navicula integra (W. Sm.) Ralfs var. *integra*
Navicula lanceolata (Ag.) Kütz. var. *lanceolata*
Navicula menisculus var. *upsaliensis* (Grun.) Grun.

TABLE 3. *Continued.*

Navicula menisculoides Hust. var. *menisculoides*
Navicula mutica var. *cohnii* (Hilse) Grun.
Navicula mutica var. *undulate* (Hilse) Grun.
Navicula paucivisitata Patr. var. *paucivisitata*
Navicula pupula var. *rectangularis (Greg.) Grun.*
Navicula radiosa Kütz. var. *radiosa*
Navicula radiosa var. *tenella* (Bréb. ex Kütz.) Grun.
Navicula rhynchocephala var. *germanii* (Wallace) Patr.
Navicula salinarum Grun. var. *salinarum*
Navicula schroeteria var. *escambia* Patr.
Navicula seminulum Grun. var. *seminulum*
Navicula seminulum var. *hustedtii* Patr.
Navicula simplex Krasske var. *simplex*
Navicula splendicula VanLandingham var. *splendicula*
Navicula symmetrica Patr. var. *symmetrica*
Navicula tantula Hust. var. *tantula*
Navicula tenera Hust. var. *tenera*
Navicula vaucheriae Petersen var. *vaucheriae*
Navicula viridula var. *linearis* Hust.
Navicula viridula var. *rostellata* (Kütz.) Cl.
Caloneis bacillum var. *fontinalis* (Grun.) Cl.
Caloneis bacillaris var. *thermalis* (Grun.) A. Cl.
Caloneis clevei (Lagst.) Cl. var. *clevei*
Pinnularia abaujensis var. *rostrata* (Patr.) Patr.
Pinnularia acrosphaeria W. Sm. var. *acrosphaeria*
Pinnularia biceps Greg. var. *biceps*
Pinnularia brebissonii (Kütz.) Rabh. var. *brebissonii*
Pinnularia brebissonii var. *diminuata* (Grun.) Cl.
Pinnularia intermedia (Lagerst) Cl. var. *intermedia*
Pinnularia stomatophora (Grun.) Cl. var. *stomatophora*
Pinnularia subcapitata Greg. var. *subcapitata*

Family Entomoneidaceae
Plagiotropis lepidoptera var. *proboscidea* (Cl.) Reim.

Family Cymbellaceae
Cymbella hauckii V.H. var. *hauckii*
Cymbella inaequalis (Ehr.) Rabh. var. *inaequalis*
Cymbella minuta var. *pseudogracilis* (Choln.) Reim.
Cymbella minuta var. *silesiaca (Blesich ex Rabh.) Reim.*

TABLE 3. *Continued.*

Cymbella prostrata var. *auerswaldii* (Rabh.) Reim.
Cymbella tumida (Bréb. ex Kütz.) V.H. var. *tumida*
Amphora coffeiformis (Ag.) Kütz. var. *coffeiformis*
Amphora veneta Kütz. var. *veneta*

Family Gomphonemaceae
Gomphonema affine var. *elongatum* (Mayer) Millie & Lowe
Gomphonema brebissonii Kütz. var. *brebissonii*
Gomphonema dichotomum Kütz. var. *dichotomum*
Gomphonema intracatum var. *vibrio* (Ehr.) Cl.
Gomphonema subclavatum (Grun.) Grun. var. *subclavatum*
Gomphonema truncatum Ehr. var. *truncatum*
Gomphonema truncatum var. *capitatum* Patr.
Gomphonema turris Ehr. var. *turris*

Order Epithemiales
Family Epithemiaceae
Epithemia adnata var. *proboscidea* (Kütz.) Patr.

Order Nitzschiales
Family Nitzschiaceae
Nitzschia actinostroides (Lemerman) V. Goor var. *actinostroides*
Nitzschia adapta Hust. var. adapta
Nitzschia agnita Hust. var. *agnita*
Nitzschia amphibia Grun. var. *amphibia*
Nitzschia amphioxoides Hust. var. *amphioxoides*
Nitzschia apiculata (Greg.) Grun. var. *apiculata*
Nitzschia bacata Hust. var. *bacata*
Nitzschia bremensis Hust. var. *bremensis*
Nitzschia capitellata Hust. var. *capitellata*
Nitzschia debilis (Arn.) Grun. var. *debilis*
Nitzschia dissipata var. *media* (Hantz.) Grun.
Nitzschia filiformis (W. Sm.) Hust. var. *filiformis*
Nitzschia fonticola Grun. var. *fonticola*
Nitzschia frustulum var. *perminuta* Grun.
Nitzschia frustulum var. *perpusilla* (Rabh.) Grun.
Nitzschia hungarica Grun. var. *hungarica*
Nitzschia intermedia Hantz. var. *intermedia*
Nitzschia kutzingiana Hilse var. *kutzingiana*
Nitzschia longissima var. *reversa* Grun.
Nitzschia microcephala Grun. var. *microcephala*
Nitzschia parvula var. *terricola* Lund.

TABLE 3. *Continued.*

Nitzschia phillippinarum Hust. var. *philippinarum*
Nitzschia pusilla (Kütz.) Grun. emend. Lange-Bertalot var. *pusilla*
Nitzschia recta Hantz. var. *recta*
Nitzschia romana Grun. var. *romana*
Nitzschia spiculum Hust. var. *spiculum*
Nitzschia stricta Hust. var. *stricta*
Nitzschia subacicularis Hust. var. *subacicularis*
Nitzschia subcapitellata Hust. var. *subcapitellata*
Nitzschia subrostratoides Choln. var. *subrostratoides*
Nitzschia tarda Hust. var. *tarda*
Nitzschia thermalis var. *minor* Hilse
Nitzschia tropica Hust. var. *tropica*
Nitzschia vermicularis (Kütz.) Grun. var. *vermicularis*
Order Surirellales
Family Surirellaceae
Surirella iowensis Lowe var. *iownesis*
Surirella suecica Grun. var. *suecica*

mucilaginous stalks and sheaths, or gelatinous pads. Several researchers (Behre 1956, Knudson 1957, Allen 1971, Allanson 1973), however, have noted the importance of the three dimensional algal growth as a substratum for many non-motile taxa. The high abundance of the planktonic genera *Stephanodiscus* Ehr. and *Cyclotella* Kütz. within the epiphyton at Winous Point (Millie 1979) illustrated the importance of this assemblage. Due to fluctuations of Sandusky Bay, water levels at the sampling sites within this marsh were subject to variation. Substrates, therefore, were constantly exposed to planktonic taxa, which easily became established within the algal matrix.

The diversity of habitats sampled was the greatest factor contributing to the large number of taxa reported. Fluctuations in physical and chemical parameters within the littoral zone (Mollie 1979), which were attributed to continual mixing of newly introduced water through drawdown and flooding procedures and the inflow of river water, caused the creation of many distinct habitats. The variability of taxa between marshes illustrated this heterogeneity of habitats along the shoreline of the lake. Each marsh possessed a unique physical and chemical nature, which affected diatom communities able to colonize the macrophytes. Turbidity differences, for example, caused an extremely large variability between sampling sites. Substrates at Winous Point were subject to the greatest turbidity due to the extreme shallowness of Sandusky Bay and sediment loading by the Sandusky River. Since certain taxa are more dependent upon strong sunlight than others (Verduin 1954, Edsbagge 1968), a different diatom flora would be expected in this marsh than in the Navarre Unit and Moxley's Marsh.

The diatom taxa observed in the epiphytic collections further illustrated the increasing eutrophy of the western basin. Almost all the dominant taxa observed in the original study are reported to be taxa able to withstand a wide range of ecological conditions (Lowe 1974). This is, of course, a physiological necessity for perennial species in an ecosystem undergoing as much pertubation as Lake Erie. For example, *Actinocyclus normanii* f. *subsalsa* (Juhl-Danf) Hust. and *Stephanodiscus subtilis* (Van Goor) A. Cleve, two taxa observed in all marshes, have been noted in large populations in Lake Erie plankton (Hohn 1969, Hasle 1977). Stoermer and Yang (1969) noted the preference for brackish water or water with high levels of dissolved solids by these taxa. Their study reported these taxa to be well established in near shore waters of high nutrient enrichment in the Great Lakes.

The list of diatom taxa presented here is by no means complete. There remain many unnamed taxa in the authors' collections, which we plan to present in future papers. Also, while it would be pleasing to think that the sites selected for sampling represented a large portion of the habitat spectrum within the littoral zone, only a small portion of the near shore diatom flora has actually been observed. Since Lake Erie is an extremely important resource, increased systematic and ecological information concerning the littoral zone is sorely needed. This information will lead to increased knowledge of the system, knowledge which is important for future prediction and control of the lake's productivity.

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