Observations on *Fragilaria longisiformis* comb. nov. et nom. nov. (Bacillariophyceae), a widespread planktic diatom documented from North America and Europe

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**SUMMARY**

*Syneclina planktonica* was originally described by Hains and Sebring from a freshwater locality in the southeastern USA using light and transmission electron microscopy. The authors placed *S. planktonica* into the genus *Syneclina* Ehrenberg because of its solitary habit and lack of marginal linking spines. Since the original description of *S. planktonica*, the concepts of *Syneclina* and the related genus *Fragilaria* Lyngbye have undergone significant change and debate. Today, details of the areolae, apical pore fields, cingulum and rimoportulae, all lacking in the original description of *S. planktonica*, are now commonly used to distinguish between taxa in *Fragilaria*, *Syneclina* and related genera. We provide details of these ultrastructural characters for *S. planktonica* based on specimens collected from the type locality, along with observations of cells from other sites in North America and Europe. Based on these findings, an emended description is presented for *S. planktonica* and the taxon is transferred to *Fragilaria*, as *F. longisiformis* comb. nov. et nom. nov. According to the International Code of Botanical Nomenclature, the epithet *planktonica* could not be applied because it was previously used to describe a marine species of *Fragilaria*. We discuss the relationship of *S. planktonica* with morphologically similar taxa, including the genus *Reimerothrix* Prasad.

Key words: ecology, Europe, *Fragilaria*, fragilariid diatoms, North America, *Reimerothrix*, *Syneclina*, taxonomy.

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**INTRODUCTION**

*Syneclina planktonica* was originally described by Hains and Sebring (1981) from a locality in South Carolina, USA and confirmed from additional sites in the southeastern part of the country. The long slender frustules with highly protracted needle-like ends made this species unique and well adapted for survival in the plankton. Hains and Sebring (1981) compare *S. planktonica* to *Syneclina nana* Meiser, *Syneclina subhombica* Nygaard and *Syneclina aliansoni* Cholnoky, concluding that it is distinct based on valve shape. Furthermore, Hains and Sebring (1981) argue that the taxon be placed in *Syneclina*, instead of *Fragilaria*, because of the solitary nature of the cells and the fact that it lacks well-developed marginal spines. To our knowledge, *S. planktonica* has not been reported since the Hains and Sebring (1981) paper, although Prasad et al. (2001) discusses it in relation to *Reimerothrix* Prasad.

In a paleoecological investigation of lakes and ponds in Connecticut, USA, Siver (1999) noted a long, thin, spindle-shaped diatom living in the plankton. A distinguishing feature of this organism, referred to as *Syneclina delicatissima* W. Smith, was the fact that markings were difficult to resolve with light microscopy (LM), resulting in the valves possibly being mistaken for girdle bands or even valves of *Nitzschia acicularis* (Kützing) W. Smith (or related species of *Nitzschia*). More recently, the same organism was found in a suite of ponds and lakes on Cape Cod (Siver et al. 2005) and referred to as *Syneclina* sp. 1 (Siver et al. 2005), as well as in several rivers in Europe (the present paper). We critically examined populations of the organism from all of these regions, as well as a population of

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Communicating editor: K. Okuda.
Received 22 August 2005; accepted 23 December 2005.*
S. planktonica recently collected by the original author (J. Hains) from the type locality, with scanning electron microscopy (SEM). Although the original description of S. planktonica lacks details of the areolae structure, pore field, cingulum and rimoportulae, we conclude that the taxon found in Connecticut, Cape Cod and Europe is indeed equivalent to this species. We base this conclusion on observations made of the type slide, comparisons with both the original published figures and newly collected material from the type locality, and confirmation by J. Hains. The objectives of the present paper are to emend the original description of S. planktonica, transfer it to the genus Fragilaria and to provide additional ecologic information on this widespread diatom.

MATERIALS AND METHODS

Surface sediments from 106 waterbodies in Connecticut and Cape Cod (Siver 1999; Ahrens & Siver 2000) were retrieved from the deep basins using a Glew (1989) gravity corer and sectioned with a Glew (1988) extruder. Plankton tows were taken from each study lake using a 10 µm mesh net. Approximately 0.5 g of surface sediment (0–1 cm) from each lake was oxidized with a mixture of sulfuric acid and potassium dichromate and cleaned according to Marsicano and Siver (1993). Aliquots of the cleaned slurries were air dried onto pieces of heavy-duty aluminum foil and glass coverslips. The aluminum foil samples were trimmed, attached to aluminum stubs with Apiezon wax, coated with a mixture of gold and palladium for 2 min with a Polaron Model E sputter coater (Quorum Technologies, East Sussex, UK) and observed with a Leo 982 field emission SEM (Zeiss) or a Hitachi S-4500 SEM. The coverslips were mounted onto glass slides with Naphrax and observed with a Leica DMR. Live plankton collections were observed directly with an Olympus BH-2 or Leica DMR using phase contrast, differential interference contrast and reflected interference contrast optics (Siver & Hinsch 2000).

Of the 106 waterbodies examined, 11 from Connecticut (Siver 1999) and 24 from Cape Cod (Siver et al. 2005) were found to have populations of Synedra planktonica. Eight of the collections, including ones from Waramaug, Squantz, Quassipaug and Gardner in Connecticut and Crooked, Flax (Brewster), Hoxie and Lawrence on Cape Cod, were examined with SEM. Physical and chemical features of the lakes in Connecticut and Cape Cod are given elsewhere (Canavan & Siver 1994; Ahrens & Siver 2000; Siver et al. 2005) and can be viewed at http://silicaceousdisk.conn.coll.edu. In addition, populations from the Aa River in Belgium were examined with LM and SEM.

To evaluate whether the organism found in Connecticut, Cape Cod and Europe was indeed S. planktonica, we compared specimens with ones on the holotype slide deposited at the Academy of Natural Sciences of Philadelphia (ANSP, GC #53763) and with the original figures presented by Hains and Sebring (1981). We further examined specimens of S. planktonica from the type locality, Lake Hartwell, South Carolina, USA, with SEM. Material from Lake Hartwell originally collected by Hains and Sebring was not available. As a result, on 29 VI 2005, J. Hains collected a 500 mL water grab sample from Lake Hartwell that contained S. planktonica. This sample was concentrated with centrifugation, observed live with the Leica DMR and imaged with a Sony DKC-ST5 digital camera. An aliquot of the concentrated sample was treated with sulfulic acid and potassium dichromate and prepared for observation with SEM as outlined above.

Numerous cells from each geographic region were viewed with LM and SEM throughout the present study. For each geographic region internal views from a minimum of 30 valves were examined to determine the presence/absence and position of rimoportulae on each apex. Length and width (center) measurements are based on both LM and SEM observations (n = 20), but stria density, number of pores in the apical fields, and width along the valve (not at the center), were determined using only SEM. The morphometric ranges listed in the emended description represent measurements from all populations examined, including those listed in the original description.

Light microscopy and SEM digital images were directly captured and plates were assembled using Adobe Photoshop version 4.0 (Adobe Systems, San Jose, California, USA). Morphological terminology follows Anonymous (1975), von Stosch (1975), Ross et al. (1979) and Round et al. (1990).

RESULTS

Synedra planktonica Hains and Sebring (1981)

Emended description: Valves are solitary, spindle-shaped with an inflated linear-lanceolate to lanceolate central region that diminishes rapidly in breadth to very narrow projected ends (Figs 1–6, 15, 24–26, 33). The apex is rounded and slightly inflated (Figs 12, 13, 20–23, 29). The narrow portion of the valve is consistently less than 1 µm and most often only approximately 600 nm (Figs 12, 13, 17, 19, 29, 30). The ratio of the width of the central inflated region to the narrow part of the valve is 4:1–6:1. Striae are short, parallel, composed of two to three (five) circular areolae, and can be arranged opposite and alternate on the same valve. Oppositely arranged striae are most often observed near the valve center (Figs 18, 28), but they almost always alternate along the slender projections.
the striae (Figs 7–9, 16–18, 27, 28, 33). Two, less often three, longer and more prominent spines are positioned on each apex (Figs 9–12, 22, 23, 29, 31). A small pore field, consisting of only two to six poroids, is found on each apex just below the apical spines, often within a concave indentation (Figs 9, 11–13, 20, 21, 22, 29, 30). A rimoportula, oriented at a slight angle to the apical axis, is found on the valve face within 1 μm of the apex (Figs 13, 21, 30). Plaques are present along the abvalvar margin of the mantle (Figs 8, 9). The cingulum is composed of three to four ligulate open (split) copulae (Figs 8–11) each with a single row of poroids on the pars interior (Figs 9, 14). Siliceous nodules can often be found scattered across or along the margin of the copulae. One to two small disc-like chloroplasts are found in the inflated portion of the cell (Figs 7–12).

Length: 50–175 μm, width (center): 2–4 μm, width (1/2 distance to apex): 450–800 nm, striae density: (18) 26–34 in 10 μm.

The following new combination is proposed:

Fragilariopsis longifusiformis (Hains et Sebring) comb. nov. et nom. nov.

Basionym: Synedra planktonica Hains and Sebring (1981), Trans. Am. Microsc. Soc. 100(2) p. 159–164, figures 2–9 (fig. 2 is a line drawing of the holotype specimen on slide: ANSP, GC. #53763).

The holotype slide originally deposited by Hains and Sebring at the Academy of Natural Sciences of Philadelphia was entered into the general collection in 1979, 2 years prior to the original publication (Hains & Sebring 1981), and recorded simply as Synedra sp.1. Apparently, the name Synedra planktonica was never updated on the corresponding reference card in the card catalog at the academy after publication (E. Morales, pers. obs., 2005). The card has been updated to reflect the original epithet and to include the combination here designated. Material collected by J. Hains in 2005 from Lake Hartwell, South Carolina will be deposited at the ANSP for public access.

This taxon has a very distinctive shape and with transmitted light optics often appears like a girdle band because of the thin nature of the valve and the inherent difficulty in discerning the striae. However, with reflected interference contrast optics (Siver & Hinsch 2001), the solid siliceous nature of the valve and the faint striae can be readily discerned (Siver et al. 2005). Variation in valve metrics between the different regions examined is given in Table 1. Specimens from Connecticut, Cape Cod, and southeastern USA, including Lake Hartwell, had similar length and width ranges and, except for a few valves from Cape Cod, striae densities. Specimens from Europe were smaller in length, but still overlapped with ranges from the other regions.

In addition to the localities in lakes and reservoirs from southeastern USA originally examined by Hains.
Figs 7–14. Scanning electron micrographs of *Fragilaria longifusiformis* from the type locality, Lake Hartwell, South Carolina. 7. External surface near the center of the valve depicting marginal areolae, short spines on the interstriae and ghost striae. Scale bar = 1 μm. 8. External view of a whole frustule showing girdle bands, position of marginal spines and mantle plaques. Scale bar = 1 μm. 9–10. External girdle views of apices of whole frustules. In Figure 9 Note the mantle plaques and position of the apical pore fields beneath the spines. Scale bar = 1 μm. In Figures 10–11 Note the nature of the open ligulate copulae. Scale bar = 250 nm. 11. Note the siliceous nodules on the bands and the recessed nature of the valve immediately beneath the apical spines. Scale bar = 250 nm. 12. External view of a valve near the apex showing the alternating marginal areolae, disc-like volae, two apical spines and the external opening of the rimoportula. Scale bar = 500 nm. 13. Internal view of a valve apex depicting a pore field consisting of two pores and a single rimoportula oriented more or less parallel with the apical axis. Scale bar = 500 nm. 14. Portion of an open copula with a single row of pores on the pars interior. Scale bar = 1 μm.
Fig. 15–23. Scanning electron micrographs of *Fragilaria longifusiformis* from Connecticut, USA (Figs 15, 16, 19, 20, 23) and Cape Cod, USA (Figs 17, 18, 21, 23).

15. Portion of a whole cell illustrating the slender needle-like shape of the valve. Scale bar = 20 μm.
16. Close-up of the frustule in Figure 15 showing short marginal striae each composed of 1–3 areolae. Scale bar = 1 μm.
17. External view of a valve close to the apex where the alternately arranged striae each consists of a single areola. Note the scattered short marginal spines. Scale bar = 500 nm.
18. Close-up of the external surface near the center of the valve depicting marginal areolae, short spines on the interstriae and ghost striae. In this part of the valve the striae are often oppositely arranged. Scale bar = 1 μm.
19. External view of a valve near the apex showing the alternating marginal areolae and the disc-like volae coverings. Scale bar = 200 nm.
20. Internal view of a valve apex depicting a pore field consisting of three pores situated in the depressed portion of the valve. A rimoportula is lacking on this end of the valve. Scale bar = 500 nm.
21. Internal view of a valve apex depicting a pore field consisting of five pores situated in a depressed portion of the valve and a single rimoportula. Scale bar = 200 nm.
22. External view of the valve apex. Note the two prominent spines and a smaller third spine (on the right side). The pore field is difficult to detect. Scale bar = 500 nm.
23. External view of a valve apex with a single prominent spine, two smaller spines and a reduced pore field. Scale bar = 500 nm.
Figs 24–33. Light (A–C) and scanning electron (D–J) micrographs of *Fragilaria longifusiformis* from the River Aa population (Belgium, Europe), 24–26. Light micrographs showing the range in dimensions within the European population. Scale bar = 10 μm. 27. External striae and marginal spine structure showing the disc-like volae. Scale bar = 600 nm. 28. External surface near the valve center depicting marginal areolae, spines and ghost striae. Scale bar = 2 μm. 29. External view of the valve end with a reduced apical pore field; marginal areolae that alternate position relative to one another, the opening of a single rimopore and reduced apical spines. Scale bar = 1 μm. 30. Internal view of a valve apex depicting the apical pore field and the internal opening of the rimopore. Scale bar = 800 nm. 31. External view of the valve end with a reduced apical pore field and the presence of one larger and several shorted apical spines. Scale bar = 900 nm. 32. Internal view near the valve center showing the openings of the marginal areolae. Scale bar = 2 μm. 33. External view of an entire valve depicting the marginal spines on the valve face/mantle edge and the presence of ghost striae. Scale bar = 20 μm.

Table 1. Measurements of valves of *Fragilaria longifusiformis* comb. nov. et nom. nov. from the type locality, Lake Hartwell, South Carolina, lakes and ponds in Connecticut and Cape Cod, and rivers in Europe. Measurements for Lake Hartwell include those in the original publication by Hains and Sebring (1981) and additional measures made as part of the present paper.

<table>
<thead>
<tr>
<th>Locality/region</th>
<th>Length (μm)</th>
<th>Width (center) (μm)</th>
<th>Width (projection) (μm)</th>
<th>Striae density (number of striae per 10 μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Hartwell</td>
<td>80–130</td>
<td>2–3.5</td>
<td>0.45–0.7</td>
<td>27–32</td>
</tr>
<tr>
<td>Connecticut</td>
<td>82–175</td>
<td>2–4</td>
<td>0.5–0.7</td>
<td>27–34</td>
</tr>
<tr>
<td>Cape Cod</td>
<td>70–170</td>
<td>2–4</td>
<td>0.5–0.7</td>
<td>(18) 26–31</td>
</tr>
<tr>
<td>Europe</td>
<td>50–90</td>
<td>3–4</td>
<td>0.6–0.8</td>
<td>28–33</td>
</tr>
<tr>
<td>Overall</td>
<td>50–175</td>
<td>2–4</td>
<td>0.45–0.8</td>
<td>(18) 26–34</td>
</tr>
</tbody>
</table>

and Sebring (1981), we found *F. longifusiformis* in 11 (22%) and 24 (40%) of the lakes and ponds sampled from Connecticut (Siver 1999) and Cape Cod (Siver et al. 2005), respectively. In Europe, very small populations of this taxon were observed from the Aa River, Belgium and the Ochtrum River, Germany. Both are rather eutrophic, slow-flowing, lowland rivers. Although the focus of our North American study is ponds and
lakes, *F. longifusiformis* was also observed in Gills Creek, Richland, South Carolina (ANSP GC #102885a and b). Even though *F. longifusiformis* was widespread among the waterbodies sampled in Connecticut and Cape Cod, it accounted for less than 1.5% of the valves observed in surface sediments.

*Fragilaria longifusiformis* was found in slightly acidic to circumneutral ponds on Cape Cod and circumneutral to slightly alkaline waterbodies in Connecticut. It was consistently lacking from the most acidic habitats in both regions. We have observed *F. longifusiformis* over a wide range of trophic conditions, including oligotrophic to mesotrophic ponds on Cape Cod, to primarily mesotrophic lakes in Connecticut, to eutrophic rivers in Europe. In North American localities, this taxon was most often observed in relatively dilute waters with a specific conductivity below 200 µS cm⁻¹.

**DISCUSSION**

Based on the overall shape and dimensions of valves, along with extensive analyses of areolae structure, striae structure and distribution, details of the apices, and position and number of rimoportulae, we are confident that the taxon found in Connecticut, Cape Cod, and Europe is the same species. The only discrepancy we encountered was a wider range in striae density among populations on Cape Cod. Although the majority of specimens from Cape Cod lakes had striae densities that overlapped with those from the other geographic regions, a few specimens had low measurements, possibly because of errors during collection of data. It is likely that the difference in length between the North American and European populations is a result of differences in habitats. The North American sites mainly represent ponds, lakes and reservoirs, whereas the European localities are exclusively rivers.

At first glance, the overall valve morphology, arrangement and characteristics of the striae, and shape and position of spines on the apices of our specimens all appeared to match nicely those of *S. planktonica* (Hains & Sebring 1981). However, in their original description, Hains and Sebring (1981) made no mention of rimoportula, apical pore fields, areolae coverings or cingulum bands, and these features could not be resolved on the published transmission electron microscopy images. Our examination of the population from Lake Hartwell with SEM, confirmed by J. Hains as *S. planktonica*, verified the presence of a single rimoportula per valve, reduced apical pore fields, plate-like valvae coverings and ligulate open banded copulae. The ultrastructural character of the valves from Lake Hartwell clearly matched that of the specimens we observed in all other regions investigated.

At the time when Hains and Sebring (1981) described *S. planktonica*, the distinction between the genera *Synedra* and *Fragilaria* was based primarily on growth habitat and the presence or absence of marginal spines (Hustedt 1930; Patrick & Reimer 1966). Taxa assigned to *Synedra* grew as solitary or loose associations of cells and lacked well-developed marginal spines. Cells of *Fragilaria* species were linked valve to valve by marginal spines, forming linear colonies. As a result, Hains and Sebring (1981) conclude that *S. planktonica* is best placed into the genus *Synedra*, and not *Fragilaria*.

The concept of these 2 genera has changed significantly since the Hains and Sebring (1981) publication and the use of the generic name *Synedra* has been challenged (Krammer & Lange-Bertalot 1991 (pp. 111–12); Compère 2001). Although detailed historical accounts of the genus *Synedra* have been given by Williams (1986), Williams and Round (1986) and Compère (2001), a brief discussion is given below.

*Synedra* was established by Ehrenberg in (1830); although apparently he did not ascribe any species to the genus until a subsequent publication in 1832 in which he described four new species and transferred a fifth, *Synedra ulna* (Nitzsch) Ehrenberg, into *Synedra*. Boyer (1927) designated *S. ulna* as the lectotype for *Synedra*, but Compère (2001) argues that this taxon is ineligible as a lectotype because at the same time that Ehrenberg had described *Synedra* in 1830, he also transferred *Bacillaria ulna* Nitzsch to the genus *Navicula* Bory, Compère (2001) further discusses each of the four *Synedra* species described by Ehrenberg in (1832) as a possible type species for the genus *Synedra* and concludes that only *S. baltica* was eligible for lectotypification of the genus because it is the only taxon linked to *Synedra* after the other three species were moved to other genera. Compère (2001) further notes that under this latter scenario the taxa known as *S. ulna* and related species would not belong to *Synedra*. As a result, the same author formally proposed the genus *Ulnaria* (Kützing) Compère, typified by *S. ulna*, to accommodate taxa formerly in *Fragilaria* subgenus *Alterasynedra* Lange-Bertalot.

Past difficulties in separating *Fragilaria* from *Synedra* have been noted by many authors (e.g. Patrick & Reimer 1966; Poulin et al. 1986). To solve this problem, Lange-Bertalot (1980) and Krammer and Lange-Bertalot (1991) propose combining the majority of the taxa under *Fragilaria*. However, more recently and based largely on characters described with SEM, it became clear that many of the species within these 2 genera were quite different and belonged in separate (many new) genera. As a result, both *Synedra* (e.g. Williams & Round 1986; Round et al. 1990) and *Fragilaria* (e.g. Williams & Round 1987; Flower et al. 1996) have been split into at least 24 genera. Although some of the new genera appear to be well circumscribed,
others are not recognized among all taxonomists
(Lange-Bertalot 1989, 1993a; Compère 2001; Morales
2003a). In addition to the controversies over the valid-
ity of some of the new genera, the characteristics used
to distinguish between the species remaining in Syned-
ra (= Ulnaria sensu Compère) and Fragilaria are also
currently debated.

Based largely on revisions of Fragilaria and Synedra
by Williams (1986), Williams and Round (1986, 1987)
and subsequent work by Round et al. (1990), the gen-
era are separated on the basis of areolae structure,
presence and structure of spines, presence of mantle
plaques, details of apical pore fields, alignment of the
striae, position and number of rimoportulae, and the
structure of the cirri. Organisms belonging to
Synedra are circumscribed by these authors as having
simple areolae that lack external volae covers; a well
defined, large apical pore field, called an ocellulum,
composed of rows of small pores arranged in an ordered
manner and often depressed from the valve surface;
oppositely arranged striae; a rimoportula at each valve
apex; and closed valvoculata bands often with a row
of pores close to the pores interior. Synedra taxa lack
well developed marginal spines and mantle plaques.
Although the lack of spines appears to be typical for
most species of Synedra, this is not the case for Syned-
ra ungeriana (Grunow) Williams (Williams 1986;
Morales 2003b), and Round et al. (1990) point out that
a number of species often have a pair of spines on
each apex above the pole field. In contrast, species of
Fragilaria have areolae that are covered externally with
a disc-shaped velum; a less developed (compared with
Synedra) pole field; striae arranged in a less organized
manner, often with an alternating pattern; a single
rimoportula on only one apex; ligulate open copulae
bands; mantle plaques; and spines along the valve
margin that can encircle the apices and usually link
cells into linear colonies. Despite the differences be-
tween Synedra and Fragilaria, some species, such as
Fragilaria synegrotesca Lange-Bertalot, remain prob-
lematic (Lange-Bertalot 1993b).

Based on the concepts of Synedra and Fragilaria,
as proposed by Williams and Round (1986, 1987)
S. planktonica should be transferred to Fragilaria. This
would be in agreement with the concept of Fragilaria
also proposed by Krammer and Lange-Bertalot (1991).
The fact that S. planktonica has a single rimoportula
per valve, disc-like volae, open ligulate copulae bands,
mantle plaques, reduced apical pore fields and alter-
nately arranged striae strongly support this transfer.
Furthermore, the observation that the apical pore field
is reduced to a small cluster of pores is not surprising
given the overall small width of the valve. In addition,
although spines are found only on the apices of a few
specimens, the majority of valves have small, reduced
spines scattered along the entire margin. We are unable
to retain the specific epithet ‘planktonica’ because it
was previously used by Heiden (Heiden & Kolbe 1928)
to describe a different species of Fragilaria from a
marine environment.

Fragilaria longifusiformis is similar in valve mor-
phology to Reimerothrix floridensis Prasad and, in fact, both
taxa are difficult to separate based solely on LM obser-
vations (Prasad et al. 2001). The genus Reimerothrix
was recently described by Prasad et al. (2001) and
separated from Synedra based on differences in plas-
tids, pore fields and copulae bands. The same authors
further noted that the slightly arcuate and drawn out
nature of the valves of R. floridensis and the fact that
it is a marine organism also served to distinguish it from
Synedra.

In their discussion on the difficulty of separating
F. longifusiformis (treated as S. planktonica) from
R. floridensis, Prasad et al. (2001) did not seem con-
vinced that the former species belonged in Synedra,
although they did not attempt to transfer it. These
authors used the presence of well-developed pore fields
and rimoportulae in R. floridensis, and their absence in
F. longifusiformis, as part of the basis for separating the
two taxa. Now that we know that F. longifusiformis has
a reduced pole field and a single rimoportula per valve,
the difference between it and R. floridensis becomes
less obvious. However, as pointed out by Prasad et al.
(2001), R. floridensis also differs from F. longifusifor-
mis in being larger, marine, possessing arcuate valves
and in having apices that are asymmetrically elongated.
In addition, Reimerothrix lacks volae and its valves have
a rimoportula on each apex, both characters that differ
from F. longifusiformis.

In summary, F. longifusiformis is a planktic diatom
that belongs in Fragilaria based on all current concepts
of this genus. This distinctive taxon is distributed in
freshwater localities in at least two continents from the
northern hemisphere, including ponds, lakes, reservoirs
and rivers. The relatively high percentage of lakes and
ponds that contain populations of this species along the
east coast of North America suggests that
F. longifusiformis might have a much wider distribution
and has probably been overlooked in previous works.

ACKNOWLEDGMENTS

We would like to thank Anne Marie Lizarralde and
Hannah Shayler for help with the preparation of sam-
ples. We also thank Jim Romanow and Marie Cantino
(University of Connecticut) and M. Ruppel (Botan.
Institute University of Frankfurt) for their help and
support with SEM. This work was funded, in part, with
grants #DEB-961506, #DEB-9972120 and DEB-
0343355 from the National Science Foundation. PAS
thanks the Nancy Rash Research Fund at Connecticut
College for support in purchasing taxonomic references.
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