Description of a new species of the diatom genus *Brachysira* (Bacillariophyta),
*Brachysira gravida* sp. nov. from the Ocala National Forest, Florida, U.S.A.

by

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With 33 figures and 1 table


Abstract: The diatom *Brachysira gravida* Shayler & Siver sp. nov. is described from an oligotrophic, acidic, freshwater lake in the Ocala National Forest in north-central Florida, U.S.A. The richness of *Brachysira* was previously investigated to reveal that the genus is both abundant and morphologically diverse in this region of Florida and is therefore of particular taxonomic interest. Valves of *Brachysira gravida* are elliptical-rhombic with a swollen and rounded mid-region, concave margins that are not straight, and protracted rostrate apices. The combination of valve shape and size easily distinguish *B. gravida* as a distinct species, and provides a designation for several specimens previously published by other authors that could not be conclusively identified. Even though the new species has only been observed in one pond and from a nearby fossil deposit, it supports the concept that a relatively large number of unique and potentially endemic species of siliceous algae exist in the Ocala National Forest.

Key words: Diatom morphology, species richness, *Brachysira*, *Anomoeoneis* sensu lato, Ocala National Forest, Florida, U.S.A.

Introduction

The genus *Brachysira* originally included only the halophilous type species *Brachysira aponina* described by Kützing in 1836, but has expanded to include more than 80 primarily freshwater taxa (Lange-Bertalot & Moser 1994, Metzeltin & Lange-Bertalot
1998, Wolfe & Kling 2001, Shayler & Siver in press). Many of the current species of *Brachysira* were formerly classified within the genus *Anomoeoneis* Pfitzer, but were transferred to *Brachysira* (Round & Mann 1981). This reorganization, along with the addition of many new *Brachysira* taxa by Lange-Bertalot & Moser (1994) and in subsequent works (Metzeltin & Lange-Bertalot 1998, Wolfe & Kling 2001, Shayler & Siver in press), has emphasized the morphological diversity and taxonomic richness of *Brachysira* as new taxa continue to be discovered in freshwaters throughout the world.

Species of *Brachysira* are most commonly part of the attached diatom assemblage in acidic freshwater ponds and lakes (Patrick & Reimer 1966, Lange-Bertalot & Moser 1994, Camburn & Charles 2000, Gaiser & Johansen 2000). Although species are widely distributed, it is not common for this genus to dominate the diatom flora of a single water body (Camburn & Charles 2000, Gaiser & Johansen 2000). However, in a group of largely acidic, oligotrophic seepage ponds in the Ocala National Forest in north central Florida, U.S.A., *Brachysira* exhibited a remarkable morphological diversity and was abundant within the attached diatom assemblage. *Brachysira, Frustulia,* and *Eunotia* together accounted for 60-70% of all diatom valves in this region (Shayler & Siver in press). Some *Brachysira* taxa are quite common and cosmopolitan (i.e. *B. brebissonii* Ross and *B. microcephala* (Grunow) Compère, which were the most abundant species in the Ocala National Forest), while others are rare and may be endemic to particular regions (Lange-Bertalot & Moser 1994, Metzeltin & Lange-Bertalot 1998, Wolfe & Kling 2001, Shayler & Siver in press). Based on recent works, the flora from Ocala appears to contain taxa that are unique to this region, including species of *Brachysira* (Shayler & Siver in press), *Frustulia* (Lange-Bertalot 2001), *Neidium* (Stachura-Suchoples et al. in press) and the scaled chrysophyte *Mallomonas* (Siver 1994; 1999; 2002a; 2002b).

The *Brachysira* assemblage in the Ocala National Forest now includes at least eight species (Shayler & Siver in press). The taxa documented in our previous investigation included the newly described *B. ocalanensis* Shayler & Siver, *B. brebissonii* Ross in Hartley, *B. arctoborealis* Wolfe & Kling, *B. microcephala* (Grunow) Compère, *B. neoacuta* Lange-Bertalot, *B. vitrea* (Grunow) Ross in Hartley, and *B. serians* (Brébisson) Round & Mann (Shayler & Siver in press). This paper describes another new species, *B. gravida,* from Grasshopper Lake and further discusses this genus in the Ocala region.

The Ocala National Forest is located on 1740 km² within the subtropical zone of north-central Florida (Greis 1985). Most of the freshwater lakes and ponds of the region formed as solution basins that subsequently became lined with clay and are surrounded by acidic soils with low buffer capacities (Greis 1985). The majority of these waterbodies are seepage lakes that are highly acidic, oligotrophic, and low in dissolved salts, and because of the clay linings, few are influenced by the highly alkaline groundwater of the region (Greis 1985). Grasshopper Lake is acidic with a mean pH of 4.0, low concentrations of phosphorus and nitrogen at 7.0 µg L⁻¹ and 0.026 mg L⁻¹, respectively, and a specific conductivity of 65 µS cm⁻¹. Sodium was the dominant cation with a mean concentration of 8.0 mg L⁻¹, and concentrations of K⁺, Ca²⁺ and Mg²⁺ were very low (Shayler & Siver in press). Grasshopper Lake is
located in Lake County, where selected diatoms have been documented by Camburn et al. (1984-1986) in South Grasshopper Pond (i.e. Grasshopper Lake), by Patrick & Reimer (1966) in Mascotte, Florida, and by Lange-Bertalot & Moser (1994) and Lange-Bertalot (2001) in Clermont, Florida.

Material and methods

Periphyton samples were collected from thirty-one primarily oligotrophic, acidic lakes in the Ocala National Forest, Florida, U.S.A., during March of 2000. Aliquots of each cleaned sample were air-dried onto heavy-duty aluminum foil and glass cover slips. Trimmed foil samples were mounted onto aluminum stubs with Apiezon® wax and coated with gold/palladium using a Polaron Model E sputter coater. Specimens were viewed and measured with either a LEO 435VP or a LEO 982 field emission scanning electron microscope. The glass cover slips were mounted on slides using Naphrax® mounting medium and observed with a Leica DMRD light microscope. Out of the thirty-one lakes sampled in the Ocala National Forest, specimens of *Brachysira gravida* were found only in Grasshopper Lake.

Results and discussion

**Brachysira gravida** Shayler & Siver sp. nov. Figs 1-22


Frustules solitary. Valves elliptical-rhombic with wide and swollen midregions and concave margins that terminate in narrow, protracted, rostrate apices. Length 15-30 μm, width 6-9 μm. Axial area narrow, linear with central area round to narrow and elongated. Valve face flat, with uniseriate, lineate striae, 27-31 in 10 μm. Internal hymens not observed. Proximal raphe apices straight on external valve surface, curved unilaterally on internal surface. Raised siliceous ridges may border raphe and edge of valve face. Numerous papillae often scattered irregularly on valve face. Evenly distributed protrusions line internal copulae surface.

Holotype: Marked specimen on microscope slide (California Academy of Sciences, Slide # 221063, Accession # 624784), Fig. 4, this paper.

Type material: Cleaned periphyton composite (California Academy of Sciences, Accession # 624784), collector: P.A. Siver, 13 March 2000.

Isotype material: Canadian Museum of Nature (CANA 76137), Fig. 6, this paper.

Type locality: Grasshopper Lake, Ocala National Forest, Florida, U.S.A. (29°08’02.66"N, 81°37’09.80"W).

Etymology: The specific epithet is named for the characteristic wide valves with swollen mid-regions, from the Latin *gravidus* meaning heavy, laden, filled, or full.
Valves of *Brachysira gravida* are elliptical-rhombic with swollen mid-regions, concave margins, and protracted, rostrate apices (Figs 1-22). Valves range in size from 15-30 \( \mu \text{m} \) long and 6-9 \( \mu \text{m} \) wide, with 27-31 striae in 10 \( \mu \text{m} \) (Table 1, Figs 1-22). The length to width ratio ranges from 2.2 to 2.9, with a mean value of 2.5. The axial area is narrow and straight. The central region is small, more or less round, and approximately 1 \( \mu \text{m} \) in diameter (Figs 17, 18). The striae are radiate over most of the valve, becoming more or less parallel at the apices. At the wide central region of the valve striae consist of 3-5 elongated areolae that are often completely or partially fused (Figs 12-17). At the narrow apices each striae is composed of only a single elongated areola (Figs 19, 20). Interposed striae are present in the center of the valve. The raphe is straight and filiform.

On the external valve surface, the distal raphe apices are T-shaped (Fig. 20), while the proximal raphe apices are simple and unmodified (Fig. 18). Thickened ridges align each side of the raphe (Figs 18, 20) and the junction of the valve face and the mantle (Figs 12, 16), and the valve is often covered with numerous small papillae (Figs 12, 16, 18, 20). Internally, the distal raphe apices terminate in small helictoglossae (Fig. 19), while the proximal apices are unilaterally curved (Fig. 17). A single row of bacilliform areolae lines the entire mantle, including the valve apices. The mantle slopes away slightly from the valve face so that this lateral row of bacilliform areolae is partially visible in valve view (Figs 12, 20). The copulae are lined by evenly spaced vertical ridges along the inner surface where the band attaches to the valve (Figs 21, 22).

A specimen of *Brachysira gravida* from South Grasshopper Pond (i.e. Grasshopper Lake) was published previously by R. Sweets in Camburn et al. (1984-1986) as *Anomoeoneis serians* var. *apiculata* Boyer and is reprinted with permission here as Fig. 33. In addition, the specimen illustrated in Fig. 32 was taken by us from surface sediment collected and prepared by Sweets from Grasshopper Lake and given to us by Alex Wolfe (Univ. of Alberta). Camburn et al. (1984-1986) acknowledged that the specimen was significantly smaller (16 x 7 \( \mu \text{m} \)) than the size range outlined by Patrick & Reimer (1966) for *Anomoeoneis serians* var. *apiculata*, but noted similarities in valve form and striae patterns to that taxon as well as to *Anomoeoneis follis* var. *hannae* (Camburn et al. 1984-1986). Indeed, specimens of *A. serians* var. *apiculata*, now *B. apiculata* (Boyer) Lange-Bertalot & Moser, are significantly larger than those of *B. gravida* (Table 1), and differ in having valves with triundulate margins, capitate apices, and a lower striae density (Patrick & Reimer 1966). The shape of
Table 1. Length, width, and striae density ranges (mean value indicated in parentheses) for comparison with *Brachysira gravida* sp. nov. for a) *Brachysira* specimens from the Ocala National Forest, FL, U.S.A., and b) relevant taxa described in *Brachysira*: Monographie der Gattung (Lange-Bertalot & Moser 1994). The values indicated in parentheses for *B. apiculata* and *B. hannae* are as reported in Patrick & Reimer (1966).

<table>
<thead>
<tr>
<th></th>
<th>Length (μm)</th>
<th>Width (μm)</th>
<th>Striae Density (#/10 μm)</th>
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<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. gravida sp. nov.</td>
<td>15-30 (20)</td>
<td>6-9 (7.5)</td>
<td>27-31 (29)</td>
</tr>
<tr>
<td>B. brebissonii (Group 1a)</td>
<td>8-19 (15)</td>
<td>3-6 (5)</td>
<td>30-48 (33)</td>
</tr>
<tr>
<td>B. arctoborealis (Group 1b)</td>
<td>14.5-24 (20)</td>
<td>6-8 (7)</td>
<td>27-32 (29)</td>
</tr>
<tr>
<td>B. brebissonii (Group 1c)</td>
<td>13.5-17.5 (16)</td>
<td>5-7 (6)</td>
<td>32-36 (34)</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. brebissonii ssp. brebissonii</td>
<td>12-45</td>
<td>4.5-8.0</td>
<td>24-27</td>
</tr>
<tr>
<td>B. apiculata</td>
<td>35-60 (50-80)</td>
<td>14-20 (12.5-20.0)</td>
<td>20-22 (21-24)</td>
</tr>
<tr>
<td>B. follis</td>
<td>20-54</td>
<td>12-20</td>
<td>23-26</td>
</tr>
<tr>
<td>B. hannae</td>
<td>(25-73)</td>
<td>(13-21)</td>
<td>(19-22)</td>
</tr>
<tr>
<td>B. speluncola</td>
<td>12-40</td>
<td>8-15</td>
<td>21-23</td>
</tr>
<tr>
<td>B. sp. cf. brebissonii</td>
<td>20-33</td>
<td>7-9</td>
<td>26-27</td>
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some smaller specimens of *B. apiculata* approaches that of *B. gravida* (i.e. Plate 23: Fig. 3, Lange-Bertalot & Moser 1994), but even these small valves are significantly larger than those of *B. gravida*. *Anomoeoneis follis* var. *hannae* Reimer, now *Brachysira hannae* (Reimer) Lange-Bertalot & Moser, is also a much larger taxon with a smaller striae density than *B. gravida* (Reimer 1961, Lange-Bertalot & Moser 1994). Based on the illustrations in Patrick & Reimer (1966), including one of the holotype, the valve margin of *B. hannae* specimens is straighter and less concave than those of *B. gravida*, and the ends are not as protracted and rostrate. Thus, the size and morphological characteristics of the specimen illustrated by Camburn et al. (1984-1986) clearly fits within the concept of *B. gravida*, rather than that of *B. apiculata* or *B. hannae*.

Lange-Bertalot & Moser (1994) identified several specimens as *Brachysira* sp. cf. *brebissonii* (Plate 45: Figs 6-7, 14, and Figs 29-31 of our paper) that we believe are identical to *B. gravida*. The length to width ratios of the valves are similar to those of *B. gravida*, and both exhibit the same general valve shape. Most importantly, these specimens are from an unspecified Florida location. Other *Brachysira* specimens published in the Lange-Bertalot & Moser (1994) monograph originated from fossil material collected in Clermont, Florida, in the immediate vicinity of Grasshopper Lake where *B. gravida* was found. Similarities in the size, striae density, and form of the three specimens pictured in Lange-Bertalot & Moser (1994) and *B. gravida* (Table 1) and the likely geographic proximity of the two habitats strongly support the conclusion that these specimens are in fact representative of *B. gravida*.

The shape and overall dimensions of the valve also distinguish *Brachysira gravida* from *Brachysira brebissonii* Ross in Hartley and *Brachysira arctoborealis* Wolfe & Kling, both also found in the Ocala National Forest (Shayler & Siver in press), and *Brachysira speluncola* Lange-Bertalot. Specimens of *B. gravida* are wider and have

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Fig. 17. SEM. Internal valve view. Note unilaterally curved proximal raphe apices, small and narrow central area, and slightly radiate pattern of areolae. Scale bar = 2 μm.

Fig. 18. SEM. External valve view. Note straight and unmodified proximal raphe apices, papillae, and raised ridges along both sides of the raphe. Scale bar = 1 μm.

Fig. 19. SEM. Internal valve view. Note straight distal raphe apex with rudimentary helictoglossa. Scale bar = 2 μm.

Fig. 20. SEM. External valve view. Note T-shaped distal raphe apex, papillae, marginal ridge, ridges along both sides of raphe, and row of elongated areolae on mantle edge. Scale bar = 1 μm.

Fig. 21. SEM. Copulae structure. Scale bar = 2 μm.

Fig. 22. SEM. Enlargement of copulae structure showing pattern of raised ridges. Scale bar = 500 nm.
Figs 23-28. SEM. *Brachysira* taxa from the Ocala National Forest, FL, U.S.A. Scale bars = 10 μm. All images are to scale relative to each other and to Figs 12-16.


Fig. 32. LM. *Brachysira gravida* from S. Grasshopper Pond. Micrograph taken by the authors from sediment material collected and prepared by R. Sweets and provided by A. Wolfe.

Fig. 33. LM. *Brachysira gravida* from S. Grasshopper Pond, FL, from Plate 27, Fig. 44, Camburn et al. 1984-1986. Light micrograph taken by R. Sweets and reprinted here with permission. In the original publication the specimen was designated as *Anomoeoneis serians* var. *apiculata* Boyer.

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a lower striae density than specimens of *B. brebissonii* Ross in Hartley found in the Ocala National Forest (Figs 23, 24, Table 1). The length to width ratios of valves of *B. gravida* (mean value 2.5) are lower than those of *B. brebissonii* (mean value 3.1). The shape of *B. brebissonii* valves is variable, but can be more oval-shaped with relatively straight or slightly convex margins, and lacks the protracted rostrate apices characteristic of *B. gravida* (Figs 1-16). Valves of a hitherto undescribed form of *B. brebissonii* with wide valves from Ocala ponds (Group 1c in Shayler & Siver in press) are considerably more oval, are wider throughout the valve, and lack protracted apices (Figs 25, 26). Additionally, the striae density of this form is significantly higher than that of *B. gravida*, with 32-36 striae in 10 μm (Table 1), and the number of areolae per striae is greater. Although ridges and papillae were consistently observed on *B. gravida* specimens from Grasshopper Lake, these morphological structures are highly variable in *B. brebissonii* and other *Brachysira* taxa from the Ocala National Forest (Shayler & Siver in press) and therefore may also be less developed or absent on *B. gravida*.

The swollen central portion of the valve and rostrate apices also distinguish *B. gravida* from *B. arctoborealis*. Valves of *B. arctoborealis* (Figs 27, 28) are rhomboidal with relatively straight margins that differ from the more concave margins of *B. gravida*. In addition, valves of *B. arctoborealis* commonly have a large isolated pore on one side of the central area (Wolfe & Kling 2001). Valves of *B. speluncola* are 12-40 μm long and 8-15 μm wide with 21-23 striae in 10 μm (Lange-Bertalot & Moser 1994, Table 1). Specimens of this taxon are much wider than those of *B. gravida*, and the valve apices are considerably more extended and drawn out. The central area of *B. speluncola* is very large and pronounced, while by comparison the central area of *B. gravida* is much smaller and less distinct.

Based primarily on the distinctive shape of the valve, coupled with subtle differences in size, striae density, and the arrangement of areolae, *B. gravida* warrants distinction at the species level. Although some *B. brebissonii* and *B. apiculata* specimens may initially appear similar to *B. gravida*, the combination of morphological features of the latter taxon validates its placement as a new species. Most importantly, this new species provides a taxonomic designation for several specimens previously published by Sweets (in Camburn et al. 1984-1986) from the Ocala National Forest and by Lange-Bertalot & Moser (1994) from a nearby locality that could not be conclusively identified. It is clear that this region of Florida harbors a unique and diverse diatom flora that has already yielded new species of *Brachysira* (Shayler & Siver in press), *Neidium* (Stachura-Suchoples et al. in press) and *Frustulia* (Lange-Bertalot 2001). In addition, six new taxa of *Mallomonas* have also been described from the acidic Ocala ponds (Siver 1994; 1999; 2002a; 2002b), further emphasizing the unique algal flora of this region. The reason for such a high number of new algal species in Ocala is not clear, but it may be related to the history of how the ponds were formed. Presumably, the ponds were highly alkaline when they originally formed as sink holes in limestone deposits. Over time, clay lenses developed and effectively sealed each pond from the alkaline groundwater. Eventually, the primary sources of water for the ponds came directly from precipitation and from water draining the sandy acidic soils characteristic of the region (Greis 1985). It is possible that the transition
from very alkaline to very acidic conditions provided a unique set of ecological constraints that were overcome by a few select organisms that eventually evolved into new species.

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