A consideration of some North American soft-water *Brachysira* taxa and description of *B. arctoborealis* sp. nov.

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*Dedicated to Prof. Dr. Dr. h.c. Horst Lange-Bertalot on the occasion of his 65th birthday*

**Abstract**


The most common representatives of *Brachysira* from dilute North American freshwater lakes are considered from historical, morphological, and ecological perspectives. Within this group, *B. brebissonii* and *B. microcephala* are the most common species, both of which are highly polymorphic. A new species, *B. arctoborealis* sp. nov., is described from similar habitats. This diatom is distinguished from *B. brebissonii*, which appears closely related morphologically and ecologically, by marked differences in valve morphometry and copula structure. Several additional species of *Brachysira* are also considered.

**Introduction**

The naviculoid diatom genus *Brachysira* Kützing 1836 was resurrected by Round & Mann (1981) following their examination and designation of the type species, *Brachysira aponina* Kützing, from Santorini and Abano (Italy) and from Lake Eilat (Israel). Although *B. aponina* is halophilous, other representatives of the genus are predominantly found in chemically dilute freshwater habitats. Many representatives of *Brachysira*, including the majority of taxa considered in this paper, are benthic diatoms typical of poorly buffered and/or acidic lakes. Until the revision of Round & Mann (1981), most limnologists and paleoecologists attributed these diatoms to the genus *Anomoeoneis* Pfitzer 1871. The distinction between *Brachysira* and *Anomoeoneis* sensu stricto (i.e., *A. sphaerophora* (Kützing) Pfitzer and allies) is clear in terms of valve morphology (Round & Mann 1981, Round et al. 1990). Species of *Brachysira* possess two sets of longitudinal ribs: one that surrounds the valve marginally at the junction of valve face and mantle, and another composed of two straight ribs, discontinuous in the central area, that border the raphe. Also diagnostic of *Brachysira* are the presence of siliceous warts.
on the external surface of the valve face, one or more longitudinal hyaline areas that interrupt the pattern of valve striation and, on the valve mantle, a row of elongate areolae. *Anomoeoneis* lacks each of these features, and has a curved raphe that terminates centrally and terminally in hooked external fissures. The raphe of *Brachysira* is for the most part straight and filiform, ending centrally in straight fissures, and distally in the absence of fissures (Round & Mann 1981). Within the scheme of Round et al. (1990), *Brachysira* is therefore viewed as sufficiently distinct to constitute the single genus within the family Brachysiraceae of the suborder Neidiineae, order Naviculales.

Diatom assemblages from the sediments of oligotrophic lakes frequently contain valves of *Brachysira*, implying the need for accurate taxonomic and ecological information surrounding individual species. Sediments containing abundant *Brachysira* have proven important in elucidating rates and degrees of both natural (Whitehead et al. 1989, Wolfe & Hårtling 1996) and anthropogenic (Jones et al. 1993, Davis et al. 1994) acidification trends in European and North American lakes. In studies that aim to calibrate modern sedimentary diatoms to measured limnological variables, in order to derive quantitative inferences from core assemblages (e.g. Charles 1985), unambiguous and consistent taxonomy is especially important. Taxonomic designations made in paleolimnological and ecological studies, however supplemented by electron microscopy, must nonetheless be applicable to routine counting with light microscopy. In this sense, the present study complements other taxonomic studies instigated by paleolimnologists addressing the floras of acid-sensitive lakes (e.g. Charles 1986, Camburn & Kingston 1986, Carter & Flower 1988, Flower & Jones 1989). Our objective is not to provide an exhaustive survey of *Brachysira*, especially in light of the important monograph of the genus (Lange-Bertalot & Moser 1994). Rather, our goal is to illustrate and describe the most common *Brachysira* taxa we have encountered in the sediments from dilute North American lakes. One outcome of this examination is the proposal of a new species, *Brachysira arctoborealis* sp. nov., which we describe in terms of both morphology and ecology.

**Material and methods**

**Baffin Island material**

In the course of investigating the ontogeny of highly dilute cirque lakes on Baffin Island in the Canadian Arctic Archipelago (66° 16′N, 65° 45′W), large populations of *Brachysira* were encountered, primarily in sediments of early Holocene age (Wolfe 1994, Wolfe & Hårtling 1996). However, *Brachysira* is presently uncommon within the surface sediment, plankton and moss periphyton of these lakes. A total of 167 sediment samples were examined from the three Baffin Island lakes (unofficial names: Amarok, Tulugak and Ukalik lakes), of which 143 contained species of *Brachysira*. The samples range from silty clays of Wisconsinan age to Holocene gyttja. During this work, an enigmatic rhombic form was commonly encountered, and tallied separately from the two other *Brachysira* species encountered in these samples, *B. brebissonii* R. Ross and *B. microcephala* (Grunow) Compère. The subsequent search to identify and characterize this problematic diatom, and to situate its taxonomic position in relation to most similar congeners, represent the impetus for the present study. This objective has required the investigation of many supplemental samples, as well as the consideration of several additional taxa.
Lake 302 material, Experimental Lakes Area

Organic sediment samples from Lake 302, in the Experimental Lakes Area of western Ontario (49°40′N, 93°45′W), complement our study because *Brachysira* is among the best represented benthic diatom genera in this lake. These samples were collected in 1992 and are of particular interest because Lake 302 was experimentally manipulated between 1982 and 1991, the north basin (302N) with HNO₃ and the south basin (302S), maintained separate by an in-lake curtain, with H₂SO₄ (Findlay & Kasian 1990, Findlay et al. 1999). The ice-free, time-weighted epilimnetic pH of Lake 302 was 6.7–6.6 prior to any acid amendment. In Lake 302S, pH was decreased progressively to 5.0 until 1986, then more severely (4.9–4.5) until 1991. In Lake 302N, pH decreased to 6.3–5.9 between 1982 and 1986, then to 5.8–5.1 between 1987 and 1992. We prepared four modern samples (profundal and littoral surface sediments from each basin) that contain diatom assemblages affected by the acidification experiments, whereas a single sample from 30–31 cm in a core from Lake 302N reflects whole-lake, pre-manipulation, deep water diatom communities.

Supplemental material

The objective of correctly identifying the enigmatic rhombic *Brachysira* taxon led one of us (APW) to the diatom herbarium of the Academy of Natural Sciences of Philadelphia (ANSP). Two particular slides are of relevance to the current study. The first, slide 11649 from the General Collection, is original de Brébisson material from a cliff-face seep in the Calvados region of France. This slide is isotype material for the taxon *Navicula brachysira* Brébisson ex Rabenhorst, the diatom now referred to as *Brachysira brebissonii* R. Ross. The second museum slide is from the C.S. Boyer collection (ANSP Boyer 818), which represents a collection from Tom’s River (New Jersey, USA). This slide is the holotype material for an apparently closely related rhombic *Brachysira* initially named *Anomoeoneis follis* var. *hannae* Reimer. This diatom has subsequently been renamed *Brachysira hannae* (Reimer) Lange-Bertalot et Gerd Moser, although this transfer was not accompanied by an illustration of the diatom in question (Lange-Bertalot & Moser 1994).

A subsequent objective was to attempt a preliminary assessment of the distribution of this undescribed rhombic *Brachysira* diatom. This led us to investigate a major voucher slide collection from acid lakes in the Adirondack Mountains of New York, USA (Hamilton et al. 1992), as well as selected surface sediments from the Sudbury region of Ontario, Canada (Dixit et al. 1991). Both of these areas are characterized by dilute lakes that have been adversely impacted by acid deposition. Finally, in order to view our specimens in relation to the type of the name of the genus, *B. aponina*, we examined surface sediments from saline Mahoney Lake in south-central British Columbia, Canada (Heinrichs et al. 1997), in which this taxon is abundant.

Sample preparation

All samples from Baffin Island were digested with H₂O₂, H₂SO₄ and K₂Cr₂O₇. Materials from Lake 302 were treated with 30% H₂O₂ only. Once cleaned of acids by successive rinsing and centrifugation, diluted drops of slurry were dried on coverslips and mounted permanently in either Naphrax or Hyrax media (refractive index ≥ 1.65). Although slightly different techniques were used with respect to the slides not prepared by ourselves, these are of similar optical quality, with the exception of the de Brébisson material, which is not acid-cleaned, and mounted in a resin that resembles Canada balsam. For light microscopy (LM), specimens were observed with a Leitz Orthoplan at 1000X under oil immersion using differential interference contrast optics (DIC, n.a. = -1.32). For scanning electron microscopy (SEM), drops of lightly diluted acid-cleaned slurry were evaporated onto stubs, sputter coated with gold, and examined with a Cambridge Instruments S100-90 SEM at 20 kV.
Fig. 1. Part of Plate XII of Van Heurck’s (1880) Synopsis des Diatomées de Belgique, illustrating several of the taxa reconsidered in the present study. Numbers and names are those of original author: (8) Navicula serians var. minor Grunow; (9) N. serians var. minima Grunow; (10) N. serians var. thermalis Grunow; (11-12) N. exilis Grunow; (13) N. gomphonemacea Grunow (=Gomphonema vitreum Grunow). Figures are enlarged and a modern scale bar added. Scale bar = 10 μm.
North American soft water Brachysira taxa

Results and Discussion

Historical survey of the investigated taxa

The diatoms under consideration in this paper are not new to science, but rather have been observed for well over a century. For example, Van Heurck’s Synopsis (1880) contains Grunow’s illustrations of both of the diatoms now referred to as Brachysira brebissonii and B. microcephala, then named Navicula serians var. minima Grun. and N. exilis Grunow, respectively (Fig. 1). Two additional historical notes are relevant from the specimens reproduced from Van Heurck’s Plate XII. First, a slightly larger and more rhombic form is taxonomically differentiated and named Navicula serians var. minor Grunow. We believe this to be the first documentation of the diatom that we have subsequently encountered throughout our collections, but which has never been formally separated from B. brebissonii. Secondly, Grunow also illustrated a finely striated and slightly

Figs 2-5. Brachysira brebissonii R. Ross. LM.
Various perspectives of de Brébisson isotype material for Navicula brachysira Kützing ex Rabenhorst, an almost purely monospecific assemblage of the diatom; slide from the Academy of Natural Sciences of Philadelphia General Collection (AGC-11649), “Falaise de Calvados”, France.
Scale bars = 10 μm (in Fig. 3 for Figs 3-5).
heteropolar form which was named *Navicula gomphonemacea* Grunow (= *Gomphonema? vitreum* Grunow). Here, the epithet *vitreum* is important as the basionym for *Brachysira vitrea*. It should be noted that this epithet was first used by Grunow (1878) and originally attached, as per his illustration (Fig. 1) to a diatom that clearly belongs within *Brachysira*, and not *Navicula* sensu stricto (see discussion by Ross in Patrick & Reimer 1966, p. 381).

Although Van Heurck’s (1880) publication of Grunow’s analysis was the earliest detailed account of these diatoms, it was certainly not the first. Several forms had previously been considered by Rabenhorst (1853), including specimens from materials collected by De Brébisson and published as *Navicula brachysira* Brébisson ex Rabenhorst. Some of this material has been re-examined (Figs 2-5), providing a useful reference for the type of *Brachysira brebissonii*. Although the slide is of poor quality since it is uncleaned material, it is nonetheless possible to observe lanceolate to rhombic-lanceolate valve shapes, and strong patterns of radiation of striae from the central area (Figs 2-4). Furthermore, copulae of these specimens are not characterized by poroids or other structures. Nowhere in this material are there any larger and more rhombic specimens resembling Grunow’s *N. serians* var. *minor* (Fig. 1). Our observations suggest a broad range of co-occurrent valve shapes within the diatom now referred to as *B. brebissonii*. This follows the broader morphological concept held by Hustedt (1930) for this diatom, who synthesized these nomenclatural issues by transferring the epithet *brachysira* from *Navicula* to *Anomoeoneis*, no longer as a species, but as a variety within *A. serians*.

With this historical perspective of the taxa under consideration in hand, it is now possible to extend our observations to the main representatives of *Brachysira* from dilute North American fresh waters, *B. brebissonii* and *B. microcephala*. This also provides the context for the presentation of a closely related new taxon.

**Brachysira brebissonii** R. Ross

Figs 6-13, 23-26, 41


Synonyms: *Navicula aponina* var. *brachysira* Kützing 1849, p. 69;
*N. brachysira* Brébisson ex Rabenhorst 1853, pl. 5: figs 11c-e;
*N. serians* var. *minima* Grunow in Van Heurck 1880, pl. XII: fig. 9;
*N. serians* var. *thermalis* Grunow in Van Heurck 1880, pl. XII: fig. 10;
*N. serians* var. *brachysira* (Brébisson ex Rabenhorst) Van Heurck 1885 (Synopsis p. 10 and Suppl. pl. B: fig. 31);
*Anomoeoneis brachysira* (Brébisson ex Rabenhorst) Grunow ex Cleve 1895, p. 7;
*A. serians* var. *brachysira* (Brébisson ex Rabenhost) Hustedt 1930, p. 263, fig. 427;
*A. serians* fo. *thermalis* (Grunow in Van Heurck) Hustedt 1930, p. 263, fig. 428;

Representative specimens from the populations of *Brachysira brebissonii* that we have examined are illustrated in LM (Figs 6-13) and SEM (Figs 23-26). Valve lengths range
Figs 6-20. *Brachysira brebissonii* R. Ross (Figs 6-13) and *B. microcephala* (Grunow) Compère (Figs 14-20). LM. Specimens are alternately from the Baffin Island (Figs 6, 8, 10-12, 14, 17, 19) and Lake 302 (Figs 7, 9, 13, 16, 18, 20) material, showing the ranges of valve shapes encountered in populations from both areas. Scale bar = 10 μm.
from 14–23 μm, whereas valves widths range between 5–7 μm. Average striae count is 22 in 10 μm, with a range of 19–25 in 10 μm. We consider *B. brebissonii* to be cosmopolitan and acidophilous. In material from both Baffin Island and Lake 302, where this diatom is abundant, we note the co-occurrence of lanceolate, elliptical, and more rostrate forms in valve outline. Lanceolate forms with striae that radiate strongly from the central area (Fig. 13) bear the closest resemblance to the de Brébisson material. However, from the range of materials examined, we are convinced that these different valve shapes merely represent intraspecific morphological variability. For this reason, we suggest that the slightly rostrate forms (e.g. Figs 6-8, 12), which other authors have applied the subspecific designations of var. or fo. *thermalis*, not be considered distinct from *B. brebissonii*.

*Brachysira microcephala* (Grunow) Compère


The specimens of *Brachysira microcephala* that we have observed range in length from 12–36 μm and in width from 4–6 μm. Striae count is never below 30 in 10 μm, more typically 32–35 in 10μm. This is a cosmopolitan diatom of clean and dilute waters; it is circumneutral to slightly acidophilous with regards to pH. Before the resurrection of *Brachysira*, this diatom has traditionally been named *Anomoeoneis vitrea* in both North America (Patrick & Reimer 1966) and Europe (Germain 1981, Krammer & Lange-Bertalot 1986). However, the detailed investigation by Compère (1988) reveals that *Navicula microcephala* Grunow is in fact the earliest available basionym for the diatom equivalent to *Anomoeoneis vitrea*, leading to the conclusion that, within *Brachysira*, the correct name becomes *B. microcephala*. Unfortunately, Compère’s (1988) observations of the lectotype for *B. microcephala* (from the W. Smith collection) were not considered by Lange-Bertalot & Moser (1994), who published yet another name for the same diatom: *B. neoexilis*. 
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Figs 21-26. Brachysira microcephala (Figs 21-22,) and B. brebissonii (Figs 23-26). SEM. Figs 21-23, 25-26. Ukalik Lake, Baffin Island; Fig. 24. Lake 302S. Whereas the specimen in Fig. 23 (Ukalik Lake) has siliceous “warts” and longitudinal ribs surrounding the raphe, that illustrated in Fig. 24 from Lake 302S lacks both of these features. Viewed from the interior, valves of B. brebissonii from Ukalik Lake (Figs 25-26) reveal the absence of raphe fissures.

Scale bars = 5 μm.
It is further noted that *B. vitrea* (Grunow) R. Ross, based on *Gomphonema vitrea* Grunow, is an entirely different diatom, both morphologically and ecologically (Lange-Bertalot & Moser 1994). In relation to *B. microcephala*, *B. vitrea* is a broader (5.5–9 μm) and more strongly capitate diatom, occasionally heteropolar, and restricted to alkaline oligotrophic lakes. This diatom was never encountered in our collections from more dilute and acidic North American lakes. There is considerable intra-specific morphological variability in *B. microcephala*, which has led some authors to taxonomically differentiate forms that are lanceolate from those that are capitate. Our observations indicate that, in most populations, a continuum of valve morphologies between these two end-members is present (Figs 14-20), and therefore we find no compelling reasons to separate lanceolate and capitate forms. This conclusion is in agreement with earlier treatments of *A. vitrea* that endorse the concept of a highly variable valve shape in this diatom (Patrick & Reimer 1966, Krammer & Lange-Bertalot 1986).

*Brachysira arctoborealis* Wolfe et H.J. Kling, sp. nov. Figs 27-40, 42-47

**Synonyms:** *Brachysira brebissonii* R. Ross “Morphotyp latior” in Lange-Bertalot & Moser 1994: 21, pl. 42: figs 1-4;  
*B. brebissonii* R. Ross “Morphotyp major” in Lange-Bertalot & Moser 1994: 21, pl. 43: figs 2-3;  
*Anomoeoneis* “species 3 PIRLA” in Camburn et al. 1986, pl. 33: fig. 32.  
*Navicula serians* var. *minor* Grunow in Van Heurck 1880, pl. XII: fig. 8.


**Holotype:** CANA 52312 (Canadian Museum of Nature, Ottawa).

**Type locality:** Ukalik Lake, Baffin Island, Nunavut Territory, Canada (66°16’N 65°45’W), core 91J, 40–41 cm.

**Etymology:** the name alludes to the taxon’s presence in both Arctic and boreal lakes.
Fig. 27. Line diagram of *Brachysira arctoborealis* Wolfe et H.J. Kling, sp. nov. from the holotype material (Ukalik Lake, Baffin Island), illustrating a valve with an enlarged isolated areola on the left-hand side of the slightly asymmetrical central area, and an example of the indented margin of the copula. Scale bar = 10 μm.
Description: Cells solitary. Valves rhombic. Valve ends broadly rounded to slightly rostrate. Valve length 17–31 μm, valve breadth 7–10 μm. Striae lineate, uniseriate, composed of simple areolae, and 19–25 in 10 μm. Interposed striae occasionally present near the broadest part of the valve. Areolae irregularly spaced, producing longitudinal hyaline undulations on the valve surface. Transition of the shape of areolae from elliptic near the axial area to bacilliform near the margin. A single row of bacilliform areolae is present on the valve mantle. Central area small, symmetrical to slightly asymmetric, and occasionally bearing a large occluded areola. Raphe simple. Raphe ends sometimes terminating proximally as slightly curved fissures. Axial area straight, bordered closely by an elevated ridge. A similar ridge surrounds the entire valve periphery, often covering distal raphe endings. Copulae with a longitudinal fissure bordered with linking protuberances by which adjacent copulae are attached.

Because we failed, despite an exhaustive search, to find a suitable name for a diatom commonly encountered in samples from North American soft-water lakes, we propose the new species *Brachysira arctoborealis*. In all likelihood, this is the diatom Grunow illustrated and referred to as *Navicula brachysira* var. *minor* Grunow in Van Heurck’s (1880) Synopsis (Fig. 1). The same diatom was identified as *Anomoeoneis* species 3 PIRLA during investigations of natural and anthropogenic lake acidification across eastern North America (i.e. paleoecological investigation of recent lake acidification; Camburn et al. 1986). Other diatomists simply considered this to a slightly larger variant of *B. brebissonii*, including Lange-Bertalot & Moser (1994), who provide illustrations on their plate 42: figs 2-6 (*B. brebissonii* “Morphotyp latior”), as well as on pl. 43: figs 2-3 (*B. brebissonii* “Morphotyp major”). However, comparative valve measurements (Fig. 48) from several distinct populations indicate no overlap between the valve widths of *B. brebissonii* and *B. arctoborealis*. Furthermore, the structure of the copulae in *B. arctoborealis* is fundamentally different from that of *B. brebissonii*: each copula bears a row of indentations that serve to bind adjacent copula more securely, presumably providing an overall strengthening of the frustule (Figs 27, 47). Though minute, these structures are nonetheless visible in LM (Fig. 40) and should be considered diagnostic of *B. arctoborealis*, since we have never observed them in *B. brebissonii*, for which the copulae borders are always smooth (Fig. 41). Another distinctive feature in *B. arctoborealis* are the stigmoid areolae observed in the central areas of some, but not all, specimens (Figs 27, 29, 34, 36, 37). Although Round & Mann (1981) indicate that species of *Brachysira* do not to have raphe fissures, we have noted unilaterally curved proximal fissures in specimens of *B. arctoborealis* (Fig. 46). The evolutionary significance of these features remains unclear, although it supports a close phylogenetic relationship with *Neidium* (Round et al. 1990).
Figs 28-41. Brachysira arctoborealis Wolfe et H.J. Kling, sp. nov., LM. Specimens are alternately from the holotype location (Ukalik Lake, Baffin Island; Figs 29, 31, 35-39) and Lake 302S (Figs 28, 30, 32-34). The characteristic indentations of copulae in this taxon are visible in LM (Fig. 40), and contrast those of *B. brebissonii*, which lack such features (Fig. 41).

Scale bar = 10 μm.
Figs 42-47. *Brachysira arctoborealis* Wolfe et H.J. Kling, sp. nov., SEM. Whole valve (Figs 42-43) and interior valve views (Fig. 44) from the Ukalik Lake material. Figures 45 and 46 are from Lake 302S, the latter showing slightly curved proximal raphe fissures on the valve interior. The ornamented copula structure, serving a mechanical role in the attachment of valves, is shown in Fig. 47 from holotype material.

Scale bars = 10 μm (Figs 43-44), scale bars = 5 μm (Figs 42, 45, 47), scale bar = 2 μm (Fig. 46).
North American soft water *Brachysira* taxa

B. *brebissonii* (n=62)

B. *arctoborealis* (n=74)

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Fig. 48. Comparative valve measurements for specimens of *Brachysira brebissonii* (n=62) and *B. arctoborealis* (n=74). Boxes circumscribe ranges of measurements, circles are the means, and bars are 2 SD. In the measured populations that include specimens from both Baffin Island and Lake 302, valve widths never overlapped, and valve lengths do not overlap at ± 1 SD.

A further case for the distinction of *B. arctoborealis* from *B. brebissonii* can be gained from investigations of lake sediments in which both taxa co-occur. In cores from three lakes on Baffin Island (Wolfe 1996, Wolfe & Härtling 1996), maximum relative frequencies of *B. arctoborealis* are generally asynchronous to peaks of *B. brebissonii*, indicating subtle ecological differences (Fig. 49). Furthermore, the stratigraphic data from these lakes, which occupy unglaciated refugial uplands, indicate the presence of *B. arctoborealis* throughout the late Wisconsinan. The oldest record of this diatom to date is from another lake on Baffin Island, in sediments estimated to be at least 90,000 years old (Miller et al. 1999). *B. arctoborealis* is therefore clearly not the results of recent (Holocene) speciation from *B. brebissonii* or another ancestral *Brachysira*, an observation that is consistent with the elements of morphological distinctness we have reported.

In Lake 302, *B. arctoborealis* is also common, especially in littoral sediments from the more strongly acidified of the sub-basins, 302S (Fig. 50). A similar distribution is evident for *B. brebissonii*, whereas *B. microcephala* is more frequent in the littoral sediments of the less intensely acidified portion of the lake. We also note that *B. arctoborealis* is present in the sediments of Big Moose Lake in the Adirondack Mountains (Charles et al. 1991) as well as those from Whirligig Lake near Sudbury (Dixit et al. 1991).
Amarok Lake (core 91A, 12.8 m)

Ukalik Lake (core 91J, 5.7 m)

large ticks on all horizontal axes represent
10% relative frequency intervals based on
the sum of all subfossil diatoms
North American soft water *Brachysira* taxa

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**A**

- *Brachysira brebissonii*
- *B. microcephala*
- *B. arctoborealis*

**B**

Relative frequencies (C) are based on counts of at least 500 valves; dominant co-occurent genera are listed in order of abundance (1 highest – 6 lowest).

**C**

1. Cyclotella
2. Aulacoseira
3. Tabellaria
4. Asterionella
5. Synedra
6. Achnanthes

**Fig. 50.** Selected elements of diatom assemblages contained in five samples from Lake 302, Experimental Lakes Area, Ontario. The comparative frequencies of the major representatives of *Brachysira* (A) are shown in the context of the genus’ representation within entire diatom assemblages (B). Relative frequencies (C) are based on counts of at least 500 valves; dominant co-occurent genera are listed in order of abundance (1 highest – 6 lowest).

**Fig. 49.** Stratigraphic profiles of *Brachysira* from cores of three Baffin Island lakes, illustrating asynchronous maxima of the three taxa present. The Amarok Lake core is shown at two distinct stratigraphic resolutions, 5 cm intervals (A) and continuous 0.25 cm sampling over the interval of peak representation by *B. brebissonii* (B). Additional cores are from Tulugak Lake (C) and Ulkalik Lake (D), the holotype location for *B. arctoborealis*. Relative frequencies are based on total diatom sums of at least 500 valves, except in (B), where the sum was reduced to 200 to attain higher stratigraphic resolution. Available radiocarbon dates (uncalibrated) are included for reference. Full details are presented elsewhere (Wolfe 1996, Wolfe & Hårtling 1996).
When coupled to our observations from the Canadian Arctic archipelago, those of Lange-Bertalot & Moser (1994) from the Rocky Mountains and Borneo, and Grunow’s original documentation of *N. serians* var. *minor* from Europe, it appears that *B. arctoborealis* is cosmopolitain, in the same way as *B. brebissonii* and *B. microcephala*. This contrasts the apparent high degree of endemism present within the genus, a trait that is especially evident with respect to the more alkaliophilic taxa (Lange-Bertalot & Moser 1994).

**Additional taxa**

Several additional species of *Brachysira* were encountered during the survey portion of our investigation. These are illustrated (Figs 51-58) and discussed briefly for purposes of comparison to the more abundant taxa we have concentrated on thus far. Excellent specimens of *B. aponina* Kützing, the type of the name of the genus, are present in the sediments of saline Mahoney Lake, situated in the British Columbia (Canada) interior (Figs 51-52). It remains enigmatic how the ecology of this cosmopolitan halophil has arisen, given that almost all congeners live in oligotrophic fresh waters. The gomphonemoid form illustrated from Lake 302N (Fig. 53) can not be identified with certainty without the examination of whole populations. Certainly, it bears a very close resemblance to *B. gomphonemoides* (R. Maillard) Lange Bertalot et Gerd Moser, a species described from New Caledonia as an acidophil. A more common species, easily recognized by the elongated central area along the apical axis, coupled to a proximally shortened raphe, is *B. styriaca* (Grunow) R. Ross (Fig. 54).

The remaining illustrations (Fig. 55-58) are from Tom’s River (Boyer Collection slide 818 from ANSP), the holotype for *Anomoeoneis follis* var. *hannae* Reimer, a taxon since transferred and given species status as *Brachysira hannae* (Reimer) Lange-Bertalot et Gerd Moser. We originally sought this material to enable direct comparisons with *B. arctoborealis*, because both have pronounced rhombic valve shapes. The examination and illustration (Figs 55-57) of the Tom’s River material reveal a larger and more coarsely striated diatom, clearly distinct from *B. arctoborealis*, which we have never seen in other locations. Furthermore, because Lange-Bertalot & Moser (1994) were unable to illustrate specimens of this diatom at the time their transfer was effectuated, despite having exhaustively studied a broad array of *Brachysira* material, it can safely be concluded that *B. hannae* is rare. On the other hand, the gibbous form *B. follis* (Ehrenberg) R. Ross (Fig. 58) is relatively common in regions of low pH lakes, including the Adirondacks and Sudbury. It is worth noting that Hustedt (1959) included a rhombic form (i.e. *B. hannae*) within his treatment of *Anomoeoneis follis* (Ehrenberg) Cleve. However, as Reimer (1961) indicates, there are no intermediate valve shapes between the gibbous and rhombic forms in the Tom’s River material, implying the legitimacy of *B. hannae* as a truly distinct species.
North American soft water Brachysira taxa

Figs 51-58. Additional Brachysira taxa encountered in the course of this study. LM.

Fig. 51-52. *B. aponina* Kützing from Mahoney Lake, British Columbia, Canada. Fig. 53. *B. cf. gonphonemoides* (R. Maillard) Lange-Bertalot et Gerd Moser from Lake 302N. Fig. 54. *B. styriaca* (Grunow) R. Ross from Lake 302N. Figs 55-57. *B. hannae* (Reimer) Lange-Bertalot et Gerd Moser from the holotype slide (Boyer 818 ANSP, Tom’s River) for *Anomoeoneis follis* var. *hannae* Reimer. Fig. 58. *B. follis* (Ehrenberg) R. Ross from the Tom’s River material.

Scale bar = 10 μm.
Conclusion

Our survey of *Brachysira* from North American lakes reveals that *B. brebissonii* and *B. microcephala* are the most abundant taxa in dilute boreal and arctic lakes. Both species are highly polymorphic with respect to valve shape. We concur with Compère's (1988) analysis that *B. microcephala* is the correct name to be applied to the traditional concept of *Anomoeoneis vitrea* (e.g. Patrick & Reimer 1966, Krammer & Lange-Bertalot 1986), and that this name should have precedence over *B. neoexilis* sensu Lange-Bertalot et Moser (1994). A new taxon, *B. arctoborealis*, is proposed for the rhombic forms that commonly co-occur with *B. brebissonii* and *B. microcephala* throughout the regions we have investigated. *B. arctoborealis* is distinct from *B. brebissonii* with respect to both valve morphometry and copula structure, and, as an indicator of low pH environments, should be identified as distinct from *B. brebissonii* in ecological and paleolimnological studies.

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References


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