

***NAVICULA WHITEFISHENSIS*, A NEW DIATOM (BACILLARIOPHYTA) FROM THE NORTHERN ROCKIES**

Loren L. Bahls, The Montana Diatom Collection, 1032 12th Avenue, Helena, MT 59601

ABSTRACT

Navicula whitefishensis is described from two headwater lakes in the Northern Rocky Mountains of Montana. The new species is compared to two morphologically similar species that are common in the region: *Navicula trivalis* Lange-Bertalot and *Navicula oligotraphenta* Lange-Bertalot & Hofmann. *Navicula whitefishensis* is the eleventh new species in the genus *Navicula* to be described from the Northwest United States within the last year. All of these new species are local or regional endemics.

Key words: *Navicula trivalis*, *Navicula oligotraphenta*, *Navicula*, Northwest United States, Northern Rocky Mountains, Montana, diatoms, endemic species, biodiversity

INTRODUCTION

Diatoms are photosynthetic eukaryotic microbes distinguished by cell walls composed of silica. Diatoms are ubiquitous in aquatic habitats, where they are important primary producers and consumers of carbon dioxide. Diatoms are useful in biomonitoring and, as fossils in lake sediments, in reconstructing past climates and lake environments. With an estimated 200,000 species worldwide, diatoms are an important component of global biodiversity (Smol & Stoermer 2010, Seckbach & Kociolek 2011).

With only about 24,000 species already described, the bulk of the world's diatom flora remains uncatalogued. The Northwest is perhaps the most remote and undeveloped quarter of the contiguous United States and among the last regions in the country to be explored for diatoms. About 1500 diatom species have been reported from the region, including 209 species of *Navicula*, the region's largest genus (Bahls 2009). Recent studies have described over 30 new species from the Northwest, including 10 new species assigned to *Navicula* (Bahls 2011, 2012). All of these new species are local or regional endemics.

METHODS AND MATERIALS

Samples were collected from two oligotrophic lakes in the Canadian Rockies Ecoregion (USEPA 2000) of northwestern Montana. The region features higher elevations and higher precipitation than adjacent areas of the Northern Rockies. The prevailing rock types are argillites and quartzites. Lakes in the region are typically fed by glacier meltwater and have circumneutral pH and low conductivity. Specific conductance and pH were measured in the field with a Hanna Instruments waterproof meter, model 98129.

Composite diatom samples were collected from available substrates (rocks, sediment, and/or vegetation) using a tablespoon or a large-bore pipette with suction bulb. Samples were preserved with Lugols (IKI) solution before transport to the laboratory, where they were treated with concentrated sulfuric acid (H_2SO_4), potassium dichromate ($K_2Cr_2O_7$), and hydrogen peroxide (H_2O_2) to remove organic matter (American Public Health Association *et al.* 1992). After several rinses in distilled water, cleaned diatom material was mounted permanently on microslides using Naphrax and examined under a Leica DM LB2

light microscope (LM) with differential interference contrast optics and equipped with a Spot Insight Model 14.0 monochrome digital camera. Measurements were made from digital images using Spot Software (version 4.5). Slides and cleaned material from these samples have been deposited in the Montana Diatom Collection (MDC) in Helena and duplicate slides (when available) have been deposited in the University of Montana Herbarium (MONTU) in Missoula: (<http://herbarium.dbs.umt.edu/diatoms.asp>).

NEW SPECIES DESCRIPTION

Division **Bacillariophyta**

Class **Bacillariophyceae** Haeckel 1878

emend. D. G. Mann in Round *et al.* 1990

Subclass **Bacillariophycidae** D. G. Mann in Round *et al.* 1990

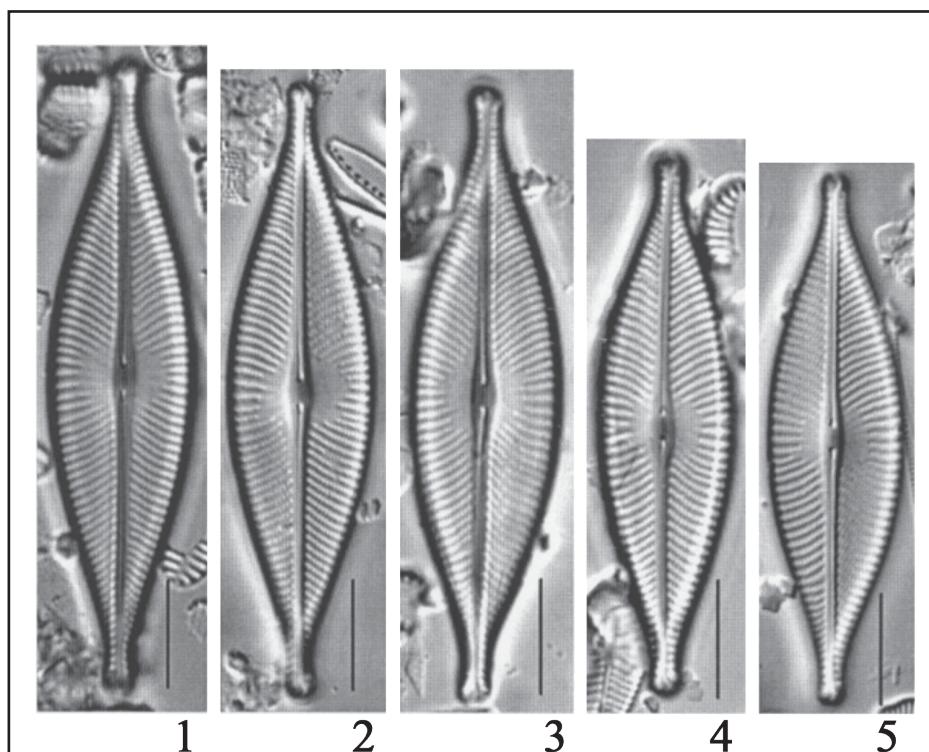
Order **Naviculales** Bessey 1907

Family **Naviculaceae** Kützing 1844

Genus **Navicula** Bory de Saint-Vincent 1822

***Navicula whitefishensis* Bahls, sp. nov.**

(Figures 1–5)



Figures 1–5. *Navicula whitefishensis* from Upper Whitefish Lake, Flathead County, MT. Figure 1 is the holotype specimen. Scale bars = 10 μm

Description

Valves broadly lanceolate with abruptly protracted and narrow subcapitate apices. Length 46–60 μm , width 11.3–14.2 μm . Axial area narrow, gradually widening toward a very large, rounded central area. Central area 5.9–8.2 μm in diameter. Raphe filiform to weakly lateral. Proximal raphe ends relatively distant, expanded and weakly deflected to one side. Terminal raphe fissures curved, opening toward the secondary side. Lineolate striae radiate almost throughout, becoming parallel then convergent only very near the poles, 12–14 in 10 μm . Areolae rather indistinct under LM, 28–30 in 10 μm .

Holotype

Here designated as circled specimen on slide MDC P3-24-8. Holotype specimen illustrated in Fig. 1.

Holotype locality

Upper Whitefish Lake, Flathead County, Montana, USA. 48.687° N, 114.578° W.

Sample collected from aquatic vegetation at a depth of 4 m by John Pierce on 18 August 1998.

Paratype

Here designated as circled specimen on slide MDC 117-72 prepared from sample MDC 398301.

Paratype locality

Redrock Lake, Glacier National Park, Montana, USA. 48.797° N, 113.706° W. Sample collected from rocks and sediment near shore by Loren Bahls on 28 June 2007.

Ecology and distribution

This taxon is known only from the holotype and paratype localities, where it is uncommon and rare, respectively. Upper Whitefish Lake lies at an elevation of 1348 m above mean sea level. Specific conductance on the sampling date was 130 µS/cm and pH was 7.4. Redrock Lake lies at an elevation of 1540 m above mean sea level. Specific conductance on the sampling date was 94 µS/cm and pH was 7.1.

Etymology:

This species is named for the holotype locality: Upper Whitefish Lake.

SIMILAR SPECIES

Navicula whitefishensis is morphologically similar to *Navicula trivalis* (Figs. 6-11) and *Navicula oligotraphenta* (Figs. 12-18). Below I describe these two species based on populations from the Northern Rockies.

Navicula trivalis Lange-Bertalot 1980, p. 31, plate 1, figs. 5-9

Valves are broadly lanceolate with apices acutely rounded and weakly protracted to somewhat rostrate. Valves are 25-65 µm long and 9.0-12.5 µm wide. The axial area is narrow, gradually widening toward a moderately large, rounded central area. The central area is 4.4-5.5 µm in diameter. The raphe is filiform to weakly lateral. Proximal raphe ends are relatively distant, expanded and weakly deflected to one side. Terminal raphe fissures are curved, opening toward the secondary side. Striae are radiate almost throughout, parallel then

convergent only very near the poles, 11-13 in 10 µm. Areolae are rather indistinct and number 28-32 in 10 µm.

With 425 records, *Navicula trivalis* is one of the most common *Navicula* species in the Montana Diatom Collection. It is found in lakes and streams throughout the Northwest and in streams and rivers across the entire western United States (Rushforth & Spaulding 2010). In Northwest waters where this species is found, the mean pH is 7.7 and the mean specific conductance is 708 µS/cm. Lange-Bertalot (2001) reports that this cosmopolitan species prefers eutrophic waters with moderate levels of electrolytes.

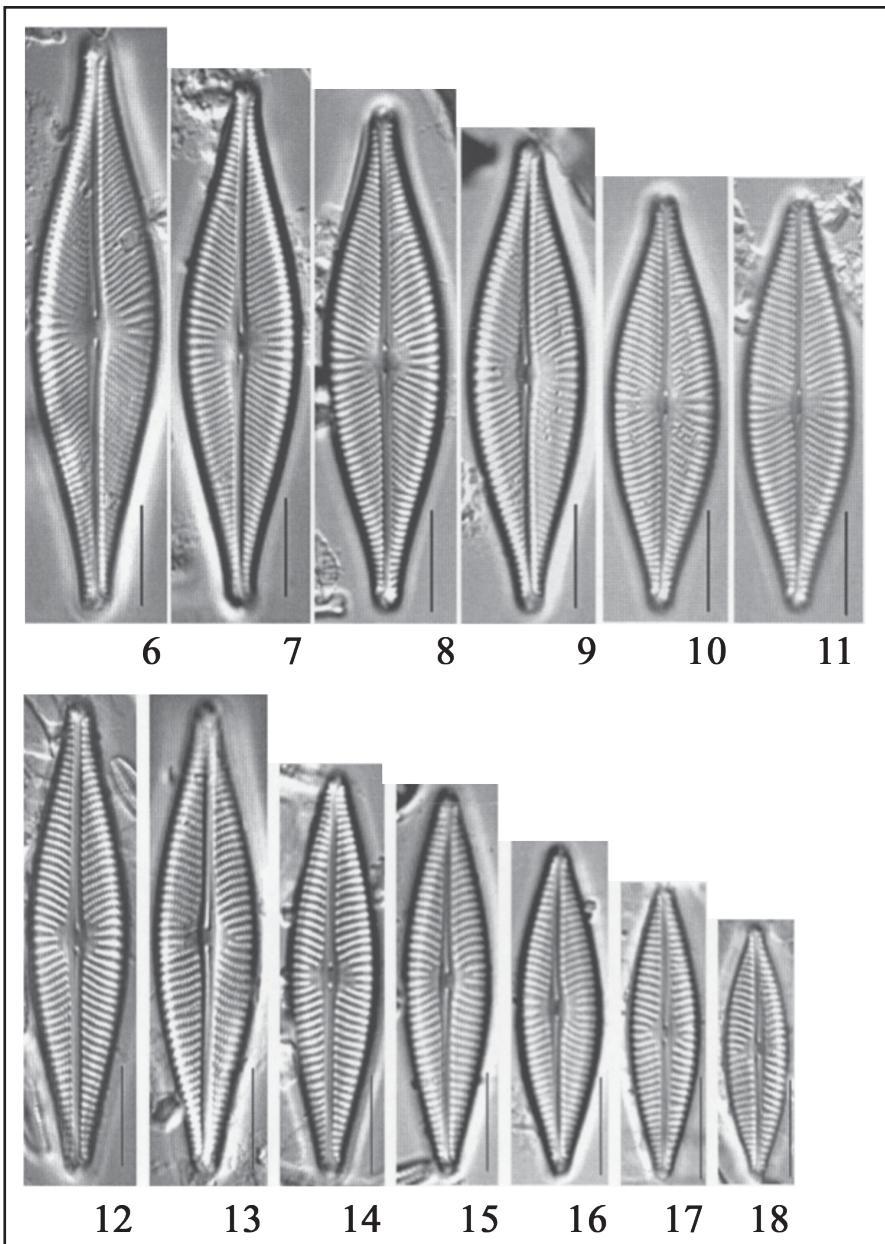
Navicula oligotraphenta Lange-Bertalot & Hofmann in Lange-Bertalot 1993, p. 128, plate 48, figs. 6-11; plate 49, figs. 3, 4

Valves are lanceolate with weakly protracted and acutely rounded apices. Valves are 28-38 µm long and 8.0-9.5 µm wide. The axial area is narrow, gradually widening toward a small rounded central area. The central area is 2.5-4.2 µm in diameter. The raphe is filiform to weakly lateral. Proximal raphe ends are relatively close, expanded and weakly deflected to one side. Terminal raphe fissures are curved, opening toward the secondary side. Striae are radiate almost throughout, parallel then convergent only very near the poles, 10-12 in 10 µm. Areolae are rather indistinct and number 26-28 in 10 µm.

There are 92 records of *Navicula oligotraphenta* in the MDC, from lakes and streams in the Northwest. The mean pH of these waters is 8.2 and the mean specific conductance is 833 µS/cm. Lange-Bertalot (2001) reports this species as common in calciferous and oligotrophic to mesotrophic lakes in the Alps and their foothills.

COMPARISON OF SPECIES

The sample that produced the holotype slide of *Navicula whitefishensis* was not saved, hence it is not possible to examine specimens from type material under a scanning electron microscope (SEM). In the more recent



Figures 6-18. *Navicula trivialis* and *Navicula oligotraphenta* from the Northern Rockies. Figures 6-11. *Navicula trivialis* from Swiftcurrent Ridge Lake, Glacier National Park, MT (MDC sample 430301, MDC slide 118-76). Figures 12-18. *Navicula oligotraphenta* from Mission Creek, Benewah County, ID (MDC sample 340301, MDC slide 102-41). Scale bars = 10 μm .

paratype sample, for which cleaned material is available, *Navicula whitefishensis* is so rare (only one specimen was found) that SEM work was not practical. Nevertheless, the features that distinguish this taxon from

similar taxa are quite apparent in LM.

Three features, easily observed in LM, distinguish *Navicula whitefishensis* from *Navicula trivialis* and *Navicula oligotraphenta*: (1) More abruptly protracted

and narrower, subcapitate apices, even in the smallest specimens; (2) Wider valves (up to 14.2 µm); and (3) A larger central area. *Navicula whitefishensis* is further distinguished from *Navicula oligotraphenta* (but not from *Navicula trivialis*) by having more distantly spaced proximal raphe ends. In other respects—structure of the raphe, size and deflection of proximal raphe ends, orientation and spacing of the striae, and spacing of the areolae in the striae—the three taxa are quite similar.

Comparison of these taxa would benefit from SEM analysis of *N. whitefishensis*, if and when material containing sufficient numbers of this taxon becomes available.

ACKNOWLEDGEMENTS

I thank John Pierce of Missoula, Montana for collecting the sample from which the holotype slide was made. Marina Potapova and an anonymous reviewer provided several helpful suggestions that improved the paper.

LITERATURE CITED

- American Public Health Association, American Water Works Association, and Water Environment Federation. 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association, Washington, D.C. 1100 pp.
- Bahls, L. L. 2009. A checklist of diatoms from inland waters of the northwestern United States. Proceedings of the Academy of Natural Sciences of Philadelphia 158:1-35.
- Bahls, L. L. 2011. Three new species of *Navicula* (Bacillariophyta) from Oregon and Montana and a review of diatom endemism in the Northwest. Northwest Science 85(4):517-526.
- Bahls, L. L. 2012. Seven new species in *Navicula* sensu stricto from the Northern Great Plains and Northern Rocky Mountains. In A. Witkowski, P. Kociolek, and P. Compere, editors, Festschrift in honor of Prof. Dr. Horst Lange-Bertalot's 75th Birthday. Nova Hedwigia Beiheft 141, J. Cramer, Stuttgart, pp. 19-38.
- Lange-Bertalot, H. 1980. Zur taxonomischen Revision einiger ökologisch wichtiger "Naviculae lineolatae" Cleve. Die Formenkreise um *Navicula lanceolata*, *N. viridula*, *N. cari*. Cryptogamie: Algologie 1:29-50.
- Lange-Bertalot, H. 1993. 85 Neue Taxa und über 100 weitere neu definierte Taxa ergänzend zur Süßwasserflora von Mitteleuropa. Vol. 2/1-4. Bibliotheca Diatomologica, Band 27, J. Cramer, Berlin, Germany. 454 pp.
- Lange-Bertalot, H. 2001. *Navicula* sensu stricto, 10 Genera Separated from *Navicula* sensu lato, *Frustulia*. In H. Lange-Bertalot, editor, Diatoms of Europe: Diatoms of the European Inland Waters and Comparable Habitats, Volume 2. A.R.G. Gantner Verlag K.G., Ruggell, Liechtenstein. 526 pp.
- Rushforth, S., and S. Spaulding. 2010. *Navicula trivialis*. In Diatoms of the United States. Retrieved February 13, 2012, from http://westerndiatoms.colorado.edu/taxa/species/navicula_trivialis.
- Seckbach, J., and J. P. Kociolek (editors). 2011. The Diatom World. Springer, New York., 534 pp.
- Smol, J. P., and E. F. Stoermer (editors). 2010. The Diatoms: Applications for the Environmental and Earth Sciences, Second Edition. Cambridge University Press, Cambridge, UK. 667 pp.
- USEPA. 2000. Level III Ecoregions of the Continental United States (map). U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Corvallis, Oregon.

Received February 29, 2012

Accepted August 2, 2012