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Three new species of the diatom genus *Halamphora* (Bacillariophyta) from the prairie pothole lakes region of North Dakota, USA

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Abstract

The prairie pothole region of North America is characterized by a large number of lakes and wetlands created during the last glacial retreat. These waterbodies are characterized by their generally small sizes (70% of waterbodies are less than 0.4 ha), high densities (as many as 40 waterbodies km $^{-2}$) and elevated but variable conductivities, ranging between 230–70,000 µS cm^{-1}. Although this region boasts a great number and diversity of habitats, few studies have investigated the diatom diversity present. Presented here are descriptions and illustrations of three new species from the genus *Halamphora* based on light microscope and scanning electron microscope observations. *Halamphora pratensis* was collected from Long Lake, Burleigh County, with a conductivity of 2187 µS cm^{-1}, and appears to be most closely allied with the common freshwater *H. veneta* group within the genus. *Halamphora pertusa* and *H. attenuata* were collected from Salt Alkaline Lake, Kidder County, with an elevated conductivity of 9811 µS cm^{-1}. Both of these taxa, although unique, exhibit some morphological similarity to several marine and estuarine species.

Key words: Diatom, North Dakota, Halamphora, pothole lakes, new species

Introduction

The prairie pothole region (PPR) of North America covers an area of over 700,000 km^2, extending from south central Canada into the north central United States (Sloan 1972, Sethre *et al*. 2005). This area marks the furthest extent and end moraine of the Wisconsin glaciation and is characterized by closed basin pothole lakes, which range from freshwater to hypersaline, formed from melting blocks of ice into glacial till and outwash during the glacial retreat (Shjeflo 1968, Sloan 1972). These lakes tend to be small, with approximately 70% of the waterbodies 0.4 ha or smaller (Johnson & Higgins 1997) and can reach densities of 40 waterbodies km $^{-2}$ (Sethre *et al*. 2005).

Pothole basins are largely composed of poorly permeable glacial till comprised of equal parts clay silt and sand (Shjeflo 1968). Although these waterbodies typically have no stream inputs or outputs, they are in continuous contact with groundwater and the relative conductivity of individual waterbodies is largely determined by seepage inflow and outflow. Because of this groundwater influence and differences in substrate and elevation, there can be a great deal of heterogeneity in waterbody conductivity over small spatial scales, with surface waters ranging between 230–70,000 µS cm^{-1} (Sloan 1972). This heterogeneity in water chemistry creates a unique diversity of aquatic habitats over relatively small areas.

Although the PPR is expansive in both area and number of lakes, investigations into the diatom diversity present in these habitats is lacking. Currently only three diatom species have been described from the waters of North Dakota, two (Boyer 1914, Elmore 1921) from the often studied Devils Lake (Stoermer *et al*. 1971, Fritz 1990, Fritz *et al*. 2000), and one fossil taxon from Moon Lake (Hamilton & Laird 2001). It has previously been suggested that elevated conductivity inland waters of the United States may hold significant undescribed *Amphora* Ehrenberg ex Kützing (1844: 107) and *Halamphora* (Cleve) Levkov (2009: 165; basionym: *Amphora* subgenus *Halamphora* Cleve 1895: 117) diversity (Stepanek & Kociolek 2013), and this has been evidenced by the recent publication of 11 new species from the western United States (Stepanek & Kociolek 2013, Kociolek *et al*. 2014).

The number and variety of elevated conductivity habitats available throughout the PPR make it ideal for an investigation into the undescribed diversity of *Halamphora* present in inland waters of the western United States.

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are common and widespread in coastal marine and estuarine environments. This is especially apparent in the case of *H. pertusa*. The valve outline, distinctly punctate dorsal striae and the presence of an internal silica band near the dorsal axial area indicate a close affinity between *H. pertusa* and the brackish to marine taxa *Halamphora holsatica* (Hustedt) Levkov (2009: 196; basionym: *Amphora holsatica* Hustedt 1925: 115) and *H. subholsatica*.

Given the small number of waterbodies examined in this current study (38 lakes and wetlands), it seems likely that the PPR of North America, which covers an area of over 700,000 km^2 (Sloan 1972), may hold a large amount of undescribed *Halamphora* diversity unique to elevated conductivity inland waters. With an estimated 49% of the lakes in the prairie pothole region of North Dakota drained in the last 200 years (Dahl 1990) and the continued loss of small wetlands (Doherty *et al*. 2013), our continued study of the diversity present within these habitats is especially important.

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