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New and Interesting Diatoms (Bacillariophyta) from Blue Lake Warm Springs, Tooele County, Utah

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Abstract

Blue Lake Warm Springs is a system of brackish lakes and marshes in western Utah, USA with a unique diatom flora that has been previously documented. Here we reexamine select taxa in greater detail, erecting two new genera and six new species from this system, and describing two additional species not observed in prior studies of the Blue Lake flora. *Naviculonema stagnora* gen. nov., sp. nov. and *Williamsella angusta* gen. nov., sp. nov are a new naviculoid genus and new pennate diatom genus lacking a raphe, respectively. Other new species of diatoms from Blue Lake Warm Springs, representing a broad range of diatom diversity, are *Cyclotella utahensis* sp. nov., *Ulnaria tooelensis* sp. nov., *Pseudostaurosira moralesii* sp. nov., *Envekadea vanlandinghamii* sp. nov., *Mastogloia variabilis* sp. nov., and *Lunella excentrica* sp. nov. The report of *Envekadea* is the first of the genus from inland USA waters, and the report of *Lunella* is the first from the USA. In addition to describing new taxa in this study, we also closely examine two known taxa, *Fallacia pseudolitoricola* and *Nitzschia vitrea*, with scanning electron microscopy, in order to better understand their morphology and biogeography. Presence of euryhaline or salt tolerant taxa in this inland ecosystem may be due to introductions by humans, either via escaped aquaculture species or transport by recreational SCUBA diving.

Key words: Utah, warm springs, Blue Lake, *Cyclotella*, *Envekadea*, *Fallacia*, *Lunella*, *Mastogloia*, *Naviculonema* gen. nov., *Pseudostaurosira*, *Ulnaria*, *Williamsella* gen. nov, scanning electron microscopy, new species, brackish, inland, valve morphology

Introduction

The diatoms of hot springs have received attention in systems around the world. Lists of commonly occurring species, or complete floras, have been developed for springs in North America (Hobbs *et al*. 2009, Villeneueve & Pienitz 1998, Ekins & Rushforth 1986, St. Clair & Rushforth 1977, Stockner 1968, 1967), South America (van der Vijver & Cocquyt 2009, Hustedt 1953), Europe (Dell'Uomo 1986, Krasske 1938, Bilý 1934), Africa (Mpawenayo *et al*. 2005, Compére & Delmotte 1988, Schoeman & Archibald 1988), Asia, especially Japan (Kobayashi 1957a, b) & New Zealand (Owen *et al*. 2008; Cassie & Cooper 1989). A comparison of hot springs across geographic space (Canada, Japan, and Iceland) has suggested that similar ecological settings do not support the same flora (Villeneueve & Pienitz 1998). Nikulina & Kociolek (2011) have surveyed the study of hot springs diatoms with a focus on systems in eastern Russia.

A special case of inland hot springs occurs when the geothermal area rests in proximity to areas that previously supported inland seas and waterways. In these cases, the current inland aquatic system with elevated temperatures can have high levels of salt, compared to the freshwater systems that surround it. This ecological setting may be rare worldwide, but occurs throughout the western United States, where over 1500 localities have been identified (Berry *et al*. 1980).

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Cyclotella utahensis is distinguishable but still morphologically similar to other *Cyclotella* taxa and might represent a relatively recent speciation event from other *Cyclotella* populations, or even an endemic taxon. The significant morphological differences between *Ulnaria tooelensis*, *Mastogloia variabilis*, and *Lunella excentrica* and taxa in their respective genera might indicate that certain lineages have persisted in reproductive isolation longer in Blue Lake than others, long enough to speciate greatly from seed populations.

However, there are other phenomena that could contribute to the perceived high diversity and novel species of Blue Lake. Unfortunately, coastal diatom floras are not heavily studied. Witkowski *et al*. (2000) present a large flora of such habitats mainly in Europe and the Middle East, but we found very little taxonomic or morphological overlap between their flora and the flora of Blue Lake. The coastal floras of North America and other continents require further attention, and taxa present in Blue Lake could later be identified in such localities as well. In addition, some Blue Lake taxa can be easily confused with known taxa because the species are morphologically very similar; *Envekadea vanlandinghamii* (Witkowski *et al*. 2000, Kaczmarska & Rushforth 1983) and *Cyclotella utahensis* are examples of species that are very similar to known taxa and likely to not be recognized as new. *Lunella excentrica* is a very small, lightly silicified, and rare diatom that could be easily overlooked in the microscope (this taxon was not observed by Kaczmarska & Rushforth, 1983). *Williamsella angusta* appears like a typical member of *Fragilaria* (Krammer & Lange-Bertalot 1991) until it is observed with scanning electron microscopy.

Our description of two new genera based on scanning electron microscopy emphasizes the importance of electron microscopical investigations in diatom taxonomy. Description of six new species adds to our understanding of diatom diversity in inland brackish water bodies. In addition, the identification of two known taxa living in Blue Lake provides information regarding the biogeography of brackish non-planktonic diatom species.

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