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NOTE

Occurrence of the Toxin-producing Cyanobacterium *Cylindrospermopsis raciborskii* in Mona and Muskegon Lakes, Michigan

Ying Hong[1], Alan Steinman[1*], Bopaiah Biddanda[1], Richard Rediske,[1] and Gary Fahnenstiel[2]

[1]*Annis Water Resources Institute*
Grand Valley State University
740 West Shoreline Drive
Muskegon, Michigan 49441

[2]*Lake Michigan Field Station*
NOAA Great Lakes Environmental Research Laboratory
1431 Beach Street
Muskegon, Michigan 49441

ABSTRACT. *The bloom-forming and toxin-producing cyanobacterium* Cylindrospermopsis raciborskii *was observed in Muskegon and Mona lakes, drowned river-mouth tributaries of Lake Michigan. Morphological features of the taxon were similar to those described elsewhere. The species was observed only in late summer; elevated bottom water temperature, and perhaps phosphorus concentration, appears to be implicated in its appearance. Maximum abundances at any given site reached 393 and 0.9 trichomes/mL in Mona Lake and Muskegon Lake, respectively. Although these concentrations are low relative to other reports, the presence of this species in these two lakes from adjacent watersheds adds to a growing body of literature that suggests the distribution of* C. raciborskii *is on the increase in northern latitudes.*

INDEX WORDS: *Toxic cyanobacteria,* Cylindrospermopsis raciborskii*, Mona Lake, Muskegon Lake, Lake Michigan.*

INTRODUCTION

Cylindrospermopsis raciborskii is an invasive species (Chapman and Schelske 1997) that has been observed in many tropical, subtropical, and recently, temperate regions. This cyanobacterium is toxin-producing and thrives in eutrophic to hypereutrophic, high-temperature environments. It can tolerate a wide range of both light and temperature by increasing its production of polyunsaturated fatty acids (Varkonyi *et al.* 2000), and can withstand short-term unfavorable conditions by forming resting spores (akinetes; Moore *et al.* 2005). *Cylindrospermopsis* is also able to take up and store phosphorus efficiently (Istvanovics *et al.* 2000) and has the capacity to fix atmospheric nitrogen. These specific features enhance its competitive advantage over other phytoplankton species under variable environmental conditions (Biddanda *et al.* 2006).

Toxin-producing invasive species are one of the greatest threats to global freshwater resources today. *C. raciborskii* is able to produce multiple toxins, and was implicated in one of Australia's worst cases of human poisoning (Falconer 2001). At least three distinct toxins can be produced by *Cylindrospermopsis* (Chorus and Bartram 2004): cylindrospermopsin, which targets primarily the liver and kidneys, and anatoxin-a and saxitoxin, which are both neurotoxins. Because of its potential to produce these toxins and its highly adaptable growth, this genus ranks near the top of the watch list of toxic cyanobacteria for water managers (WHO 1999).

C. raciborskii was recently reported in Canada

*Corresponding author. E-mail: steinmaa@gvsu.edu

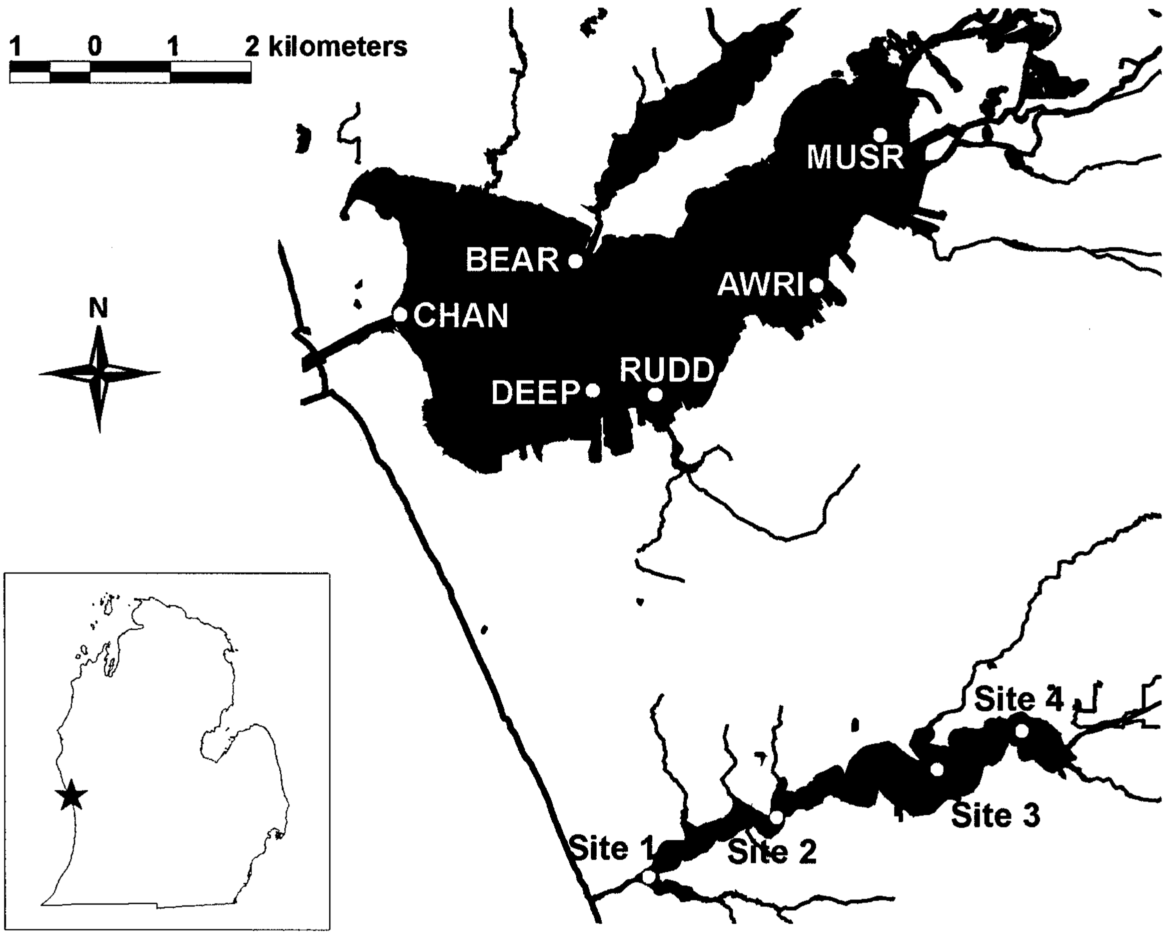

FIG. 1. Inset: Map of the State of Michigan, showing location of Mona Lake and Muskegon Lake. Blow up: Muskegon Lake (top) and Mona Lake (bottom) showing sampling locations and channels draining directly to Lake Michigan.

(Hamilton *et al.* 2005), but documentation of this taxon within the Great Lakes basin has primarily occurred in non-peer reviewed literature (Ann St. Amand, PhycoTech, Inc., pers. comm.). Our report documents the presence of *C. raciborskii* in Muskegon and Mona lakes, drowned river-mouth lakes located in the lower peninsula of Michigan, both of which connect directly to southeastern Lake Michigan. The objective of this study was to document the occurrence and abundance of *Cylindrospermopsis* throughout the ice-free period in these lakes, relate its presence to limnological conditions, and describe its morphological characteristics.

METHODS

Phytoplankton samples were obtained from both Mona and Muskegon lakes, two drowned river mouth systems located in adjacent watersheds in west Michigan (Fig. 1). In Mona Lake, phytoplankton were analyzed from surface samples collected at four sites in May, July, August, and September of 2002 and May, July, and August of 2003. In Muskegon Lake, phytoplankton were analyzed from surface and near-bottom samples collected at six sites in late April/May, July, and September of 2003 and 2005 (Steinman and Ogdahl 2004). Mona and Muskegon lake samples were collected using Van Dorn bottles. Subsamples were fixed with either formalin or Lugol's solution. Phytoplankton species were identified and enumerated utilizing a Nikon Eclipse TE200 inverted microscope (Utermöhl 1958). Most of the identifications were made using magnifications of 450 and 1,000× with phase contrast illumination. In all the samples, 200–300 algal units (cells or filaments) were counted. The