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Occurrence of a *Cylindrospermopsis* bloom in Louisiana

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ABSTRACT

Cylindrospermopsis raciborskii occurs predominantly in tropical to subtropical freshwaters but appears to be spreading to temperate regions. After the hurricanes of 2005, a bloom of this organism took place in Lake Dauterive and Lake Fausse Pointe in Louisiana. The cyanobacterium dominated the phytoplankton community for three months. Of the three known morphotypes (straight, coiled and spiral) only coiled and spiral were found. In June 2006, 60% of the organisms were of the spiral morphotype but the relative abundance of this morphotype decreased dramatically within the month of June. However, the average density for both morphotypes remained the same until September. Densities (up to 160,000 cells/mL) significantly exceeded the threshold for toxicity. Because the sampled region offers optimal light and nutrient conditions, it is likely that *C. raciborskii* has been established in this region and future blooms can be expected. Therefore, a monitoring program should be implemented.

Introduction

Harmful Algae Blooms (HABs) have increased worldwide during the last decades (Hallegraeff, 1993). In freshwater environments, cyanobacteria are the main organisms responsible for HABs, and developments of these blooms depend upon several parameters, including agricultural run-off and dissolved organic matter containing low N/P ratio, which favor blooming forming cyanobacteria (Whitton and Potts, 2000). Cyanobacterial blooms are considered a nuisance because the water develops a foul odor and taste and can become toxic. Human poisonings from cyanobacterial biotoxins have been reported in Brazil, Africa, Europe, and Australia, as well as in the United States (Zilberg, 1966; Hindman et al., 1975; Hawkins et al., 1985; Turner et al., 1990; Jochimsen et al., 1998; Pouria et al., 1998). Poisoning may occur by ingestion, dermal contact, aspiration, or inhalation, or by consumption of organisms that have accumulated toxins. The most tragic case of human poisoning associated with cyanotoxins occurred in 1996 in Brazil, when more than 50 persons died after dialysis, with water containing cyanobacterial toxin (Jochimsen et al., 1998). Although such incidents do not occur frequently, the number of incidents is likely underestimated because of the lack of knowledge about the symptoms associated with cyanobacterial poisoning. Symptoms commonly include rashes, skin and eye irritation, allergic reaction, vomiting, diarrhea, tender abdomen, and headache.

Cylindrospermopsis raciborskii, which belongs to the order Nostocales, is a filamentous, nitrogen-fixing cyanobacterium. As many other cyanobacteria, it forms blooms and, when environmental conditions are unfavorable for growth, it produces resting cells (akinetes). This species can also produce hepatotoxins (cylindrospermopsin) and neurotoxins (saxitoxin), both of which can be lethal to animals and humans (St. Amand, 2002). Bioaccumulation of these toxins has been reported in vertebrates and invertebrates, including, fish, crayfish and zooplankton (Harada et al., 1994; Lagos et al., 1999; St. Amand, 2002); it has also been hypothesized that cylindrospermopsin may be killing alligators in Florida (Schoeb et al., 2002). *C. raciborskii* is the most widely distributed source of cylindrospermopsin in drinking and recreational waters worldwide; hence, understanding its distribution and ecology is of particular relevance to human health (Falconer, 2005).

This organism has been found in Australia, across central Asia, and Europe, including the Caspian Sea and southern Russia, South, Central and North America (Padisák, 1997; Hamilton et al., 2005), and Africa (Komarek and Kling, 1991). *C. raciborskii* was detected for the first time in the United States in Wooster Lake, Kansas, in 1955 (reported as *Anabaenopsis raciborskii* Woioszynska). Subsequently, it has been found in Minnesota, Texas, Wisconsin, Florida, Indiana, and Michigan (Chapman and Schelske, 1997; Padisák, 1997; Jones, 2001; Hong et al., 2006). *Cylindrospermopsis raciborskii* blooms have been a major concern in Florida, as this species can dominate phytoplankton communities in many lakes throughout the state, especially in the St. Johns River System, with bloom periods during late summer and fall

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(Leonard and Pearl, 2005). *Cylindrospermopsis raciborskii* was first detected in Louisiana in the Caernarvon Breton Sound (southeast of New Orleans) in 2003 (Rick and Rick, 2003), where a diversion from the Mississippi was built to counteract wetland loss. Since then, *C. raciborskii* has been found regularly in this area. The highest density was recorded during the summer of 2004 and exceeded the level of potential toxicity (20,000 cells/mL, McGregor and Fabbro, 2000). The species occurred in the mid to southern part of the area, where apparently favorable conditions ensure successful over-wintering of akinetes (Rick et al., 2007).

After its detection in Carnarvon, several other watersheds in Louisiana were screened by light microscopy, and *C. raciborskii* was detected in Lake Fausse Pointe in 2006. Although not a large (>500 km^2) lake, Lake Dauterive and Lake Fausse Pointe are part of the Mississippi-Atchafalaya watershed system that includes Lake Ponchartrain, the swamps of the Atchafalaya river and numerous other lakes in South Louisiana. This fresh water system increases significantly during each spring in both volume and area, but is also subject to saltwater intrusion by hurricanes. Therefore, these fluctuating water dynamics represent a unique ecological and geographical system for harmful algal blooms. This study describes the dynamics of a *C. raciborskii* bloom recorded during 2006. The sampled lakes are not connected to the Caernarvon Breton Sound and the occurrence of *C. raciborskii* after hurricane Katrina suggests that this species has expanded its range and may have established itself in a large portion of Louisiana's wetlands. Observations indicate a strong relationship between bloom density and increasing temperature as well as a shift in morphotype not previously reported for this species.

Methods

Study site

Lake Fausse Pointe and Lake Dauterive form a single body of shallow water (maximum depth 3 meters) with a combined surface area of about 90 km^2 (USGS, 1971). The lakes are located along the

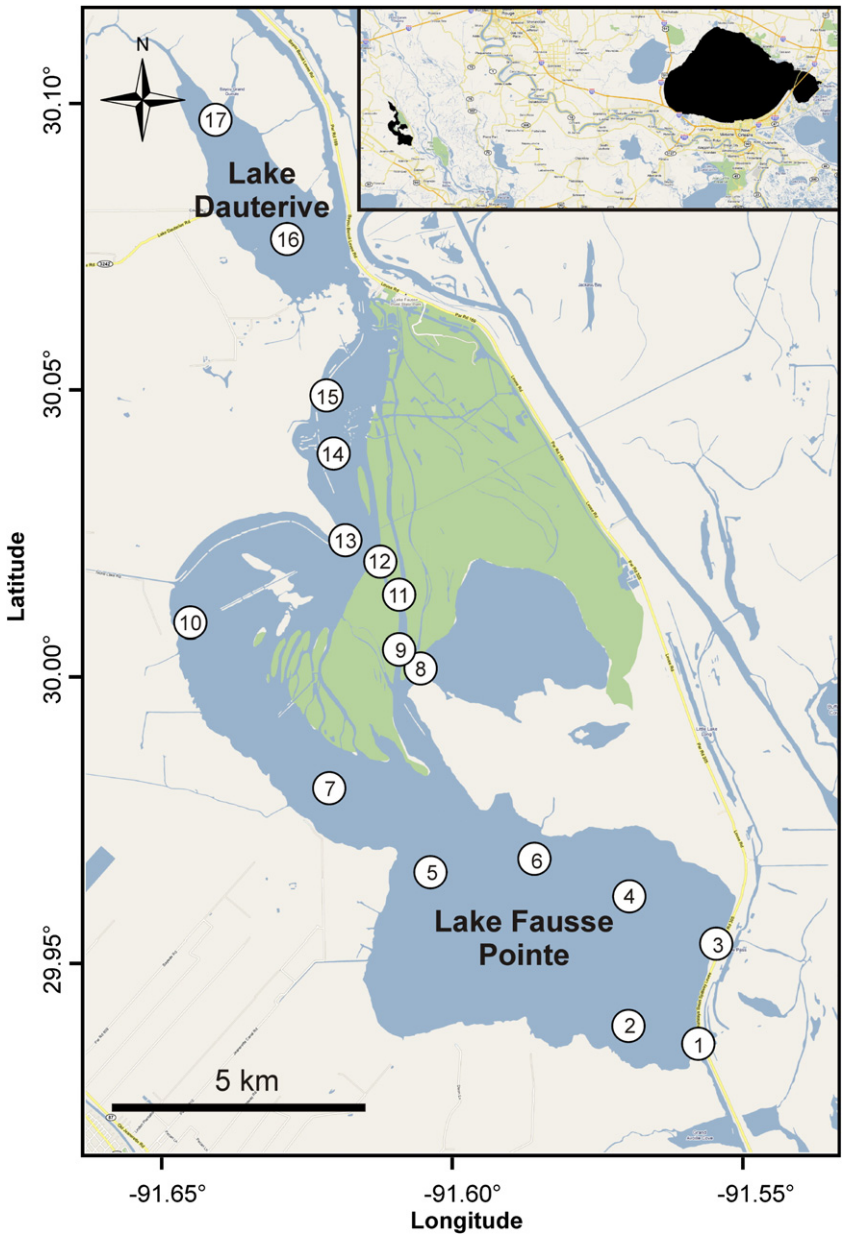

Fig. 1. Map of Lake Dauterive and Lake Fausse Pointe in Louisiana with labels that indicate the sampling sites used for this study. The sites are sorted according to their latitude; the inset shows the study site and Lake Ponchartrain.