Arch. Biol. Sci., Belgrade, 63 (2), 507-510, 2011 DOI:10.2298/ABS1102507C

THE FIRST FINDING OF *CYLINDROSPERMOPSIS RACIBORSKII* (WOLOSZIŃSKA) SEENAYYA ET SUBBA RAJU, 1972 (CYANOPROKARYOTA) IN SERBIA

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Abstract – Within the framework of a detailed survey of the algal community in the salt marshes of the Vojvodina Province (northern Serbia), we found *Cylindrospermopsis raciborskii* (Woloszińska) Seenayya et Subba Raju in water samples from Slatina Pond near Opovo. This is, *de facto*, the first finding of *C. raciborskii* in Serbia. It is of particular importance given that *C. raciborskii* produces cyanotoxins and that available data show that in Serbia this alga is expanding its range of distribution, notably in carp ponds. The present paper is concerned with both the general and specific characteristics of the alga and the specific characteristics of the habitat in which the alga was found.

Key words: Cylindrospermopsis raciborskii, Cyanoprokaryota, Slatina Pond, salt marsh, Serbia

UDC 582.26/:27(497.11-17):574

INTRODUCTION

Salt marshes are for many reasons very specific fresh-water habitats in general, and in the Vojvodina Province (northern Serbia), separately. The salt marshes in Vojvodina are characterized by many specific characteristics as provided by Cvijan and Krizmanić (2009). Bearing this in mind, we can expect salt marshes to be distinguished by a particular biocenotic structure. For this reason, the Institute of Botany in Belgrade has launched a project concerned with research into the algae in the salt marshes of Vojvodina. A detailed survey of the salt marshes in the Vojvodina Province was carried out during 2003, 2004, and 2006.

MATERIAL AND METHODS

For the qualitative and quantitative analyses of algae and physicochemical analyses of the water of interest, samples were collected from the Slatina Pond on 18 July 2006. Samples of phytoplankton for qualitative analysis were collected by filtering water through a plankton net (mesh size of 25 μm). Epiphytes by were collected by scraping them off plants (*Phragmites australis* and *Typha latifolia*) or together with parts of the plants themselves. Microscopic processing and quantitative (according to Utermöhl, 1958) analysis of the algal samples were done at the Institute of Botany.

RESULTS AN DISCUSSION

Location and general characteristics of Slatina Pond

Slatina Pond is situated in the vicinity of the village of Opovo, about 30 km north of Belgrade and its water is characterized with very specific physicochemical properties (see Fig. 1 and Table 2 in Cvijan and Krizmanić, 2009). Slatina Pond is a fossil riverbed showing traces of the varying phases of shifting of the Tamiš River course. The water level in Slatina Pond depends on the level of the Tamiš River and that of phreatic waters (Ćurčić, 1996). Slatina Pond is therefore characterized by an unstable water level.

Some general and specific characteristics of Cylindrospermopsis raciborskii (Woloszińska) Seenayya et Subba Raju

The species *C. raciborskii* is trichous, unbranched alga. Trichomes are single, straight, mildly bent or spirally coiled. Trichomes are usually short though they may be as long as 300 μm. The cells are elongated-cylindrical, seldom almost square. The heterocysts are elongated-conical, elongated-egg-shaped and sometimes bent lengthwise. They are on the trichome ends. Akinetes are cylindrical or oval in shape, single or in pairs, located in the vicinity of terminal heterocysts. Otherwise, the morphological variations of different trichome features, even in genetically very similar isolates, greatly depend on various environmental factors, primarily on abiotic ones (Saker et al., 1999; Saker and Neilan, 2001; Shafik et al., 2003).

C. raciborskii usually inhabits tropical and subtropical regions worldwide. However, it has been found lately as an invasive species also in moderate regions. It is certain that climatic changes contribute to the expansion of this species range to moderate latitudes (Briand et al., 2004). Thus, in the last thirty years, its range of distribution has expanded to Europe, North and South America (Padisák, 1997) and Australia (see Moore et al., 2003). Of particular interest is the fact that the species *C. raciborskii* produce cyanotoxins, primarily of hepatotoxic cylindrospermopsin (CYN), as well as anatoxin and saxitoxin, which both act as paralytic shellfish neurotoxins (Schrembri et al., 2001). Therefore, this species by its development in freshwaters, especially if it is used for water supply, may significantly affect the health of humans and animals that drink it due to its hepatotoxic effect.

C. raciborskii exhibits an array of characteristics enabling it to adapt to many varied environmental conditions for the following reasons: the species is a diazotroph, using ammonia as a source of nitrogen, and it has a high affinity to phosphorus, being capable of absorbing it even when its concentrations are low (Shafik et al., 2001; Sprober et al., 2003); the relatively high phosphorus uptake affinity and storage capacity confer to it a competitive advantage both in deep lakes with nutrient stratification and in lakes with no such nutrient gradation (Istvanovics et al., 2000); it may develop in conditions of low light intensity (Antenucci et al., 2005; Buford et al., 2006); the alga possesses gas vacuoles which regulate its suspension and motion in the water column (Jones and Sauter, 2005); etc.

Analyses of algal samples collected from the water of Slatina Pond revealed the presence of a great number of algal taxa. Out of 10 taxa of the division Cyanoprokaryota (the division's name is according to Komárek and Anagnostidis, 1998), *C. raciborskii* (Fig. 1.) was, *de facto*, found for the first time in Serbia.

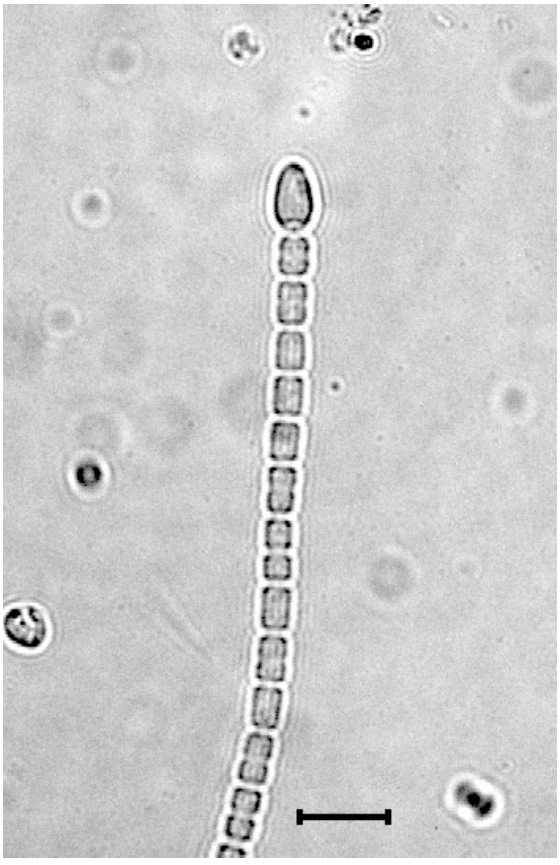

Fig. 1. *Cylindrospermopsis raciborskii* found in Slatina Pond (Serbia), (Photo took on October 23rd, 2007, and is in the photo library of the Chair for Algology, Mycology and Lichenology of the Faculty of Biology, of the Belgrade Unversity)

Table 1. Important morphological features of *C. raciborskii* recorded in Slatina Pond (Vojvodina, Serbia)

Trichome with (μm)	Cell length (μm)	Size (lenght x with) (μm) - heterocysts-	-akinets-	Average trihome length (μm)	Form of trichoms
2.7-3.5	2.3-6.5	5.7-6.7 x 3.2-4.4	absent	107	straight

Important morphological features of the *C. raciborskii* are presented in Table 1.

Quantitative analysis of algae from the water of Slatina Pond showed that the *C. raciborskii* in plankton was represented by a very small number of individuals (about 960 trichomes/L) from which it might be concluded that it developed under conditions which did not fully suit it. Nonetheless, the absence of akinetes suggests the opposite conclusion. However, *C. raciborskii* was also found in the Ponjavica River (Subakov-Simić and Ćirić, unpublished data) and in two small carp ponds of the Kapetanski Rit fish farm in Serbia (Ćirić et al., 2010).

The physicochemical properties of the water of Slatina Pond differ significantly when compared with those in the Ponjavica River and fish ponds. This also indicates a high level of adaptability of *C. raciborskii* to different physicochemical factors in Serbia. Accordingly, the species really has a marked ability to continue with the further expansion of its range of distribution in Serbia.

CONCLUSIONS

A detailed survey of the salt marshes in Vojvodina Province (Northern Serbia) was carried out during 2003, 2004 and 2006. Analysis of algal samples collected from the water of Slatina Pond near Opovo on 18 July 2006 revealed the presence of *Cylindrospermopsis raciborskii* (Woloszińska) Seenayya et Subba Raju. It is, *de facto*, the first finding of *C. raciborskii* in Serbia. However, *C. raciborskii* has also been found in the Ponjavica River and in two small carp ponds in Serbia. It is of special interest considering that the species is known as producer of cyanotoxin. As the physicochemical properties of the water of Slatina Pond are very specific, they generally differ significantly in comparison with the same in the Ponjavica River and fish-ponds. This points to the high level of adaptability of *C. raciborskii* to various physicochemical factors in Serbia. Thus, the species really has a marked ability to continue with further expansion of its range of distribution in Serbia.

Acknowledgment – Financial support was provided by the Ministry of Science and Environmental Protection of the Republic of Serbia (Projects No. 1538 and No. 037009).

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