PREFACE

It has been a consensus in the academic circles that global climate changes can alter irreversibly the face of Earth. Along with these changes, aquatic ecosystems may have its dynamic and functioning tremendously affected, with consequences not only for the aquatic communities, but also for the future human generations.

In this context, it is been reported that phytoplankton communities are also changing globally, with cyanobacteria becoming the dominant group of organisms in many latitudes [1-3]. Furthermore, species invasions are another important issue that may be influenced by global warming since tropical species are likely to migrate to temperate regions as temperature increases. An example of invasive cyanobacteria is the species *Cylindrospermopsis raciborskii*, a member of the Order Nostocales, originally described as a tropical/subtropical genus, which has been spreading fast throughout northern Europe and North America [3-5] and South America [6-10]. Its success rely on its ability to adapt to different mixing of water column and light regimes, high phosphorus storage and nitrogen fixing capacity, buoyancy regulation and shade tolerance [1,3,5].

The increase in frequency and duration of cyanobacterial blooms worldwide as a potential consequence of global warming is a phenomenon of great concern as several species are toxin producers. Cyanobacterial toxins, or cyanotoxins as they are commonly known, have been involved in several cases of wild and domestic animal poisoning [11] and also in human intoxication reports, including fatalities [12,13]. These cases can increase if increasing temperatures led to the development of more cyanobacterial toxic blooms, especially in undeveloped countries and semi-arid regions of the world, where treatment plants are not able to eliminate cyanotoxins and drought is a complicating factor.

In more than a century of research about this topic (see the reviews of Codd et al. [14] and Stewart et al. [11]), there are still gaps in the understanding of the role of cyanotoxins (see also reviews of Ibelings and Havens [15] and Ferrão-Filho and Koslowsky-Suzuky [16]). This book was conceived with the intent to bring some insights into this issue and also to discuss some aspects related to the "Ecology, Toxicology and Management" of cyanobacteria. The first two chapters are reviews devoted to the debate of the possible roles of cyanotoxins in species interactions, namely with their potential competitors (i.e. algae, bacteria and other cyanobacteria).

The third chapter is an extensive review on the role of *Nodularia spumigena* in the Baltic Sea food webs, its importance on the nitrogen cycle, the transfer of nodularin in the food web and its role as an anti-grazer defense. In this chapter the authors discuss also the effects of eutrophication and climate-driven changes in food webs and their effects on toxin production by *Nodularia spumigena*.

The fourth chapter is a review on the studies of ecology of *Cylindrospermopsis raciborskii*, a species with wide occurrence in Brazil [6-10]. In this chapter, using a large database (n=439 samples taken from 51 systems), the authors discuss the possible factors that favor *C. raciborskii* in Brazilian aquatic ecosystems. With those data, the authors show that *C. raciborskii* is able to colonize lakes and reservoirs comprehending a latitudinal gradient from Northern to Southern Brazil, with varying depths, light and mixing regimes and trophic status, emphasizing its high phenotypic plasticity and tolerance to a wide range of environmental conditions.

Chapter 5 (not placed by chance after chapter 4) is a case study of three reservoirs located in the Brazilian semi-arid, a region with great problems of water supply for local populations and with recurrent and long lasting blooms of cyanobacteria, especially of species *C. raciborskii*, *Microcystis aeroginosa* and *Planktothrix agardhii*. The authors show that there is an interchange in the dominance among these three species and that stratification of the water column and low concentrations of nitrogen associated with decrease in water transparency are the main controlling factors of cyanobacterial community in semi-arid ecosystems.

Chapter 6 is also a case study of a the abundance and community structure of pico-phytoplankton, heterotrophic bacteria and virus-like particles (VLP) along a natural, continuous salinity gradient in a South Australian temperate coastal lagoon. The authors used advanced techniques of flow cytometry (FCM) under epifluorescent microscopy (EM) to study these communities, which have been neglected in many studies. Their findings show a significant decrease in the number and species richness of cytometrically-defined sub-populations of heterotrophic bacteria and VLP with increasing salinity. These changes could reflect both a modification of phylogenetic composition and activity level within the bacterial community. In addition, the number and richness of cytometrically-defined picophytoplankton populations also decreased with increasing salinity, affecting both prokaryotic and eukaryotic organisms. Moreover, their results highlight the ability of cyanobacteria to tolerate and acclimate to a wide range of salinity and therefore to colonize extreme environments.

Chapter 7 is a review about the accumulation and phytotoxicity of microcystins (MCs) in vascular plants. The authors approach the uptake and accumulation of MCs in both aquatic and terrestrial plants, giving emphasis to the uptake and biotransformation of MCs in agricultural plants, which are exposed to cyanobacterial toxins through irrigation practices. This is a theme of great importance for risk assessment and public heath, since vegetables can be an exposure route for humans to MCs through their diets.

In chapter 8, the author reviews several aspects related to the health hazard and risk assessment of cyanotoxins, especially related to humans. This chapter also critically approaches some drawbacks in the regulation measures and guidance values for cyanotoxins, pointing out to the need for correct evaluation of risks based on the diversity and quantity of cyanotoxins rather than to rely only on cell numbers, the need to consider carcinogenicity in order to express valuable safety levels, the need for better estimation of covalently-bound MC and the need to take into account the synergistic ability of some of the main toxins to enhance their damage when present together. Moreover, this chapter highlights important management measures to prevention and treatment recommendations after human exposure to cyanotoxins.

The last three chapters are devoted to aspects of management, such as bioremediation, monitoring technologies and ecological control of cyanobacteria. In Chapter 9, the authors show the application of confocal laser scanning and electron microscopic techniques as powerful tools for determining the *in vivo* effect and sequestration capacity of metals in cyanobacteria. Using both natural populations and filamentous cyanobacteria strains isolated from microbial mats in the Ebro Delta, a polluted river in Spain, the authors showed that these microorganisms are able to sequester and accumulate high amounts of lead both externally in extrapolymeric substances and internally, in polyphosphate inclusions. This is particularly interesting from the point of view bioremediation of polluted watersheds and shows indeed that cyanobacteria are not all "bad guys".

In chapter 10, the authors show data from the Pampulha Reservoir, a eutrophic reservoir in Southwest Brazil, with recurrent blooms of cyanobacteria. They used a new technology to monitor chlorophyll concentrations that makes it possible to gather a very large and fine-scale amount of spatial data concerning the subsurface concentrations of this pigment. The proposed method consists of an integrated use of a highly sensitive fluorescent probe, coupled to a high-precision D-GPS that provides geographical coordinates with sub-metric precision. The structure can be easily mounted on every kind of small boat. A new software program was also created, to precisely synchronize the data files delivered by two different devices. The final result is the production of a detailed thematic chart that shows the spatial pattern of chlorophyll in great detail. This makes it possible for local managers to initiate measures to mitigate or even prevent the wider spread of an algae bloom soon after the first signs of this undesired phenomenon are detected. The methodology was validated using traditional measure of chlorophyll-a (Lorenzen method), giving a good correlation.

Finally, chapter 11 is a commentary about "Ecological control of toxic cyanobacterial blooms in aquatic ecosystems". In this short review the authors explore some aspects related to studies using biomanipulation: the manipulation of higher trophic levels (adding piscivores or removing planktivores) to increase the size, abundance, and grazing pressure of herbivorous zooplankton to reduce algal abundance. Based on field experimental evidence, the authors argue that cyanobacteria may serve as a beneficial food resource for zooplankton, that ecological control of cyanobacterial blooms is practical for some systems, and that greater attention should be placed on direct biomanipulation of zooplankton communities (e.g., stocking *Daphnia*) in conjunction with the manipulation of higher trophic levels. They also highlight the need for more data documenting zooplankton-cyanobacteria interactions in tropical freshwater ecosystems, whose biological, chemical, physical, and geological characteristics vary remarkably from their temperate counterparts, which could limit the use of biomanipulation.

It is worth of note that research on cyanobacteria in Brazil has increased in quantity and quality, resulting of a lot of investments from scientific financial agencies in the last decade. Since the incident in Caruaru (Pernambuco State, Brazil), in which several renal patients died after a hemodialysis section and the incontestable evidence of the involvement of hepatotoxins in this event [13], health and environment authorities have paid more attention to the problem of toxic cyanobacterial blooms in water supplies and this has being a driving force in the development of a scientific background for the basis of regulation policies and managements efforts to create safety guidelines for the use of supply water. These efforts have been responsible for the development of several excellence research groups and the publication of a reasonable, high quality literature. Two International Congresses on Toxic

Cyanobacteria have occurred in Brazil, one in 2001 and the other in 2007, both coordinated by Dr. Sandra M.F.O. Azevedo from the Federal University of Rio de Janeiro. She was directly involved, together with her colleague Dr. Wayne Carmichael, in the discovery that MCs was the main causing agent of the "Caruaru Syndrome". She has been responsible for formation of some generations of high qualified Brazilian scientists, to which I am proud to be part of (her second Ph.D. student, from 1994-1998).

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