SECOND EDITION

Toxic Cyanobacteria in Water

A Guide to Their Public Health Consequences, Monitoring and Management

edited by
Ingrid Chorus
Martin Welker

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Foreword

The way we manage our waterbodies determines the extent to which cyanobacteria proliferate. While for some waterbodies the past decades have seen some progress in controlling the excessive nutrient loads that result in eutrophication and cyanobacterial blooms, pressures on many others are increasing, through population growth, urbanisation, changes in agricultural land use and climate. In this context, the 2030 Agenda for Sustainable Development includes Sustainable Development Goal 6, which recognises the importance of protecting and restoring water-related ecosystems (target 6.6), improving ambient water quality (target 6.3) and safe (and affordable) drinking-water for all (target 6.1).

Cyanobacterial blooms have been recognised as an environmental concern since they began to occur widely in many countries in the 1960s. An awareness of their public health significance grew during the 1980s as their toxicity became increasingly understood, including as cause of the deaths of exposed livestock, pets and wild animals, and cases of human illness were attributed to exposure to cyanotoxins following recreational activities or drinking-water consumption.

In 1999, the World Health Organization (WHO) developed its first drinking-water guideline value for a widely occurring cyanobacterial toxin, microcystin-LR. The WHO also published the first edition of *Toxic Cyanobacteria in Water*, largely written by the pioneers of cyanotoxin science. Since then, this document has been widely used by regulators for the development of national policies for managing cyanotoxin risks, by local public health services in implementing measures to protect public health and by academia for teaching and planning research. Since 1999, cyanotoxin research has grown exponentially, and the new knowledge generated in these two decades has improved our basis for assessing the health risks caused by toxic cyanobacteria. We now know more about the range of cyanotoxins – from their occurrence to potential health effects – and thus can set priorities more effectively. This enabled the WHO to develop guideline values for further cyanotoxins, including for short-term and for recreational exposure. The approach of developing site-specific Water Safety Plans, initially promoted by WHO in

2003 in the Guidelines for Safe Recreational Environments and 2004 in the Guidelines for Drinking-water Quality, now provides a platform for bringing together the wide range of expertise and stakeholder interests needed to understand the causes of blooms and to develop the most effective and sustainable context-specific strategy for controlling them.

Such a joint effort requires communication between managers, stakeholders and experts from a range of fields and with diverse backgrounds. This second edition of *Toxic Cyanobacteria in Water* brought together a correspondingly wide range of expertise of authors from many countries, with experience from very different types of waterbodies harbouring toxic cyanobacterial blooms. This book resulting from this collective effort strives to facilitate communication between those developing strategies to prevent blooms and human exposure through water by providing the necessary tools, background and guidance. This book includes an introduction to the basics about cyanobacteria and their toxins, an overview of human exposure routes, guidance for assessing risks to human health and preparing for short-term responses to prevent human exposure, as well as guidance on effective management and monitoring from catchment to the end user.

It is hoped that readers find this second edition of *Toxic Cyanobacteria in Water* useful for developing longer-term, sustainable approaches bridging environmental management and public health, as countries strive towards the realisation of their commitments under the 2030 Agenda for Sustainable Development.

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Ingrid Chorus completed her PhD at the Technical University, Berlin, supporting a collaborative ecosystem study of a highly eutrophic urban lake, and in the 1980s, she studied the restoration of heavily eutrophicated lakes. In 1991, Ingrid became head of the German Federal Environment Agency's unit on drinking-water resources and began her focus on cyanotoxin research and management. From 2007 until 2018, she led the agency's Department for Drinking-Water and Swimming-Pool Hygiene. A key focus of her work was developing and implementing the WHO Water Safety Plan approach, particularly towards catchment and waterbody management.

Martin Welker started his career as a plankton ecologist at the Institute of Freshwater Ecology, Berlin. His PhD thesis focused on cyanobacteria and their toxins, with a particular emphasis on the release and degradation of microcystins by biotic and abiotic processes. As a postdoc at the Technical University of Berlin and Institute Pasteur, Paris, he explored the diversity of cyanobacterial metabolites and their biosynthesis. In 2006, Martin joined AnagnosTec, contributing to the development of microbial identification systems for clinical diagnostics. In 2010, Martin joined bioMérieux as senior scientist where he works on clinical microbiological diagnostics and research.