

Foreword to the Themed Issue “Cyanobacteria”

Triantafyllos Kaloudis,¹ Jussi Meriluoto,^{2,3*} Ludek Blaha⁴

¹Department of Water Quality Control, Athens Water Supply and Sewerage Company, Athens, Greece; ²Biochemistry, Faculty of Science and Engineering, Åbo Akademi University, Tykistökatu 6A, 20520 Turku, Finland; ³Laboratory for Paleoenvironmental Reconstruction, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovica 2, 21000 Novi Sad, Serbia; ⁴RECETOX, Faculty of Science, Masaryk University, Kamenice 5, 62500 Brno, Czech Republic

*Corresponding author: jussi.meriluoto@abo.fi

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This Themed Issue results from international collaboration within COST Action ES1105 “CYANOCOST - Cyanobacterial blooms and toxins in water resources: Occurrence, impacts and management” (www.cyanocost.net) running from 2012 to 2016. The CYANOCOST Action is acknowledged for adding value to this work through networking and knowledge sharing with European experts. The Action has involved 32 countries. State of the art research and management capabilities in Europe on cyanobacteria have benefited from input from the basic and applied life sciences, the human and animal health sectors, water engineers, economists and planners. Many of these professional groups have been brought together and they interacted favourably within the framework of CYANOCOST. The general goals of the Action have been to widen awareness, spread relevant technical competence, and share risk management experience and expertise in the field. The Action has developed and provided tools to end-users (public health and environment authorities, water utilities, aquaculture, tourism and recreation sectors) by pooling and coordinating expertise from throughout Europe and has contributed to harmonizing methods and practices, thereby protecting public health, enterprises and investments.

The 13 papers published in this Themed Issue are grouped under six thematic topics and the contents of the papers are briefly explained below. The descriptions of the papers have been kindly compiled by the Guest Editors.

Cyanobacteria occurrence

Rare occurrence of nine Microcystis species (Chroococcales, Cyanobacteria) in a single lake (Lake Dojran, FYR

Macedonia) by Krstić, Aleksovski and Komárek presents an ecological and thorough taxonomic study of the plankton community in Lake Dojran. It revealed the co-existence of nine *Microcystis* species, provided detailed morphological features, and corroborated the necessity to change the accepted morphospecies concept into a separation of *Microcystis* taxa as distinct species.

Cyanobacteria and cyanotoxin environmental occurrence and monitoring

A comparative study of the metabolic profiles of common nuisance cyanobacteria in southern perialpine lakes by Cerasino, Capelli and Salmaso used target and non-target metabolite profiling to identify differences in the production of known cyanotoxins and other secondary metabolites, primarily non-ribosomal peptides, in 14 strains of 5 cyanobacterial species from several perialpine lakes.

Monitoring a newly re-born patient: Water quality and cyanotoxin occurrence in a reconstructed shallow Mediterranean lake by Gkelis, Panou, Chronis, Zervou, Christophoridis, Manolidi, Triantis, Kaloudis, Hiskia, Kagalou and Lazaridou discusses cyanobacterial abundance and diversity, toxin levels, physico-chemical and ecological characteristics in the recently reconstructed Lake Karla in Greece, showing immediately occurring problems with cyanobacterial water blooms, toxin production and degradation of ecological status.

Molecular detection of hepatotoxic cyanobacteria in inland water bodies of the Marmara Region, Turkey by Köker, Akçelaan-Albay, Albay and Neilan for the first time identifies production of the cyanobacterial hepatotoxins microcystin (MC) and nodularin (NOD) using PCR in combination with HPLC in bloom samples and cyanobacterial strains isolated from lakes in Marmara.

MC/NOD were associated with *Microcystis aeruginosa*, *Planktothrix rubescens* and *Nodularia spumigena* strains. MC/NOD were detected also in a *M. wesenbergii* strain, while *P. agardhii* strains and blooms were mostly negative for hepatotoxin production.

First report of cyanobacterial paralytic shellfish toxin biosynthesis genes and paralytic shellfish toxin production in Polish freshwater lakes by Savela, Spoof, Höysniemi, Vehniäinen, Mankiewicz-Boczek, Jurczak, Kokociński and Meriluoto is a broad study on the cyanobacterial community of 34 lakes in western Poland. It identified an established subpopulation of potential Paralytic Shellfish Toxin (PST) producers, through the analysis of PST biosynthesis genes by PCR and qPCR, and PST production by HPLC-FLD in environmental samples.

Cyanobacterial dynamics and toxins concentrations in Lake Alto Flumendosa, Sardinia, Italy by Stefanelli, Scardala, Cabras, Orrù, Vichi, Testai, Funari and Manganello presents the long-term characterization of a cyanobacterial community and MC production in Lake Alto Flumendosa (Sardinia). The research demonstrated the predominance of *P. rubescens*, *Microcystis botrys* and *Woronichinia naegelianae*, and the significant persistence of toxic populations.

Cyanobacteria and cyanotoxins in drinking water – occurrence, monitoring, removal methods

Can cyanobacteria infect underground water sources? Indications from small scale monitoring of a natural drinking water source (short note) by Gkelis and Vlamis presents the results of a small scale monitoring program in a Greek water company demonstrating for the first time the presence of cyanobacteria in bottled natural mineral drinking water. The results indicate a potential hazard in this kind of product.

Cyanobacteria and microcystin contamination in untreated and treated drinking water in Ghana by Addico, Hardege, Kohoutek, deGraft-Johnson and Babica shows frequent occurrence of cyanobacteria and MCs in non-treated water in treatment plants in Ghana. Water treatment significantly eliminated both cyanobacteria and MCs but toxins (maxima around 0.8 microgram per liter) were still found in approximately 15-20% samples of the treated water.

Chlorination and ozonation differentially reduced the microcystin content and tumour promoting activity of a complex cyanobacterial extract by Sovadinová, Babica, Adamovský, Alpatova, Tarabara, Upham and Bláha

demonstrated that ozone effectively removed all MCs from an extract of *Microcystis* sp., and significantly reduced the overall tumour promotional potency of the sample. Chlorination was much less effective and high doses of chlorine further produced toxic by-products.

Cyanotoxin detection techniques

Non-competitive ELISA with broad specificity for microcystins and nodularins by Akter, Vehniäinen, Meriluoto, Spoof and Lamminmäki reports the development of an easy-to-perform assay for generic detection of MCs and NOD. The recombinant anti-immunocomplex antibody based non-competitive ELISA was capable of detecting eleven toxin variants (MC-LR, -dmLR, -RR, -dmRR, -YR, LA -LY, -LF -LW, -WR, and NOD-R) below the WHO guideline concentration for MC-LR.

Cyanobacteria and cyanotoxins long term monitoring/reviews for specific geographical regions

Assessment of cyanoprokaryote blooms and of cyanotoxins in Bulgaria in a 15-years period (2000-2015) by Stoyneva-Gäertner, Descy, Latli, Uzunov, Pavlova, Bratanova, Babica, Maršálek, Meriluoto and Spoof presents a summary of results from studies carried out on 120 water bodies in Bulgaria, where the cyanoprokaryote diversity was quite high (210 taxa of 60 genera). Blooms were recorded in 14 and cyanotoxins were detected in 16 water bodies including 3 drinking water reservoirs.

Review of 130 years of research on cyanobacteria in aquatic ecosystems in Serbia presented in a Serbian Cyanobacterial Database by Svirčev, Tokodi and Drobac presents an overview of the unique database concerning cyanobacterial distribution, cyanotoxin production and associated biological effects in different types of water bodies throughout the Republic of Serbia.

Review/synoptic paper of CYANOCOST research and activities

Toxic cyanobacteria and cyanotoxins in European waters – recent progress achieved through the CYANOCOST Action and challenges for further research presented by 21 authors is a review summarising the outcomes of recent European research concerning toxic cyanobacteria and cyanotoxins, with an emphasis on developments within the framework of CYANOCOST. It highlights achievements and challenges for the phyecological and ecological studies, analytical and detection approaches, toxicological research, management of toxic blooms as well as practices for cyanotoxin removal.

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We would like to express our sincere thanks to all the Themed Issue authors. We knew the CYANOCOST community has potential for scientific work of the very highest quality but we were still positively surprised when we saw the great interest for this Themed Issue expressed by numerous authors across Europe. We believe that many of the articles will have long-lasting usefulness for the CYANOCOST community as well as for a broad audience of international researchers and experts.

We want to acknowledge and congratulate the four Guest Editors of this Themed Issue, Pavel Babica, Camilla Capelli, Damjana Drobac and Spyros Gkelis, for their highly professional editorial work. The Co-Editor-in-Chief of *Advances in Oceanography and Limnology* Nico Salmaso is cordially thanked for his help and goodwill in realising the Themed Issue.

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Triantafyllos Kaloudis
Chairman of CYANOCOST

Jussi Meriluoto
Working Group 1 Leader of CYANOCOST

Ludek Blaha
Vice-Chairman of CYANOCOST



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