

Supplementary Materials: Multi-Toxin Occurrences in Ten French Water Resource Reservoirs

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Table S1. Observed cyanobacterial taxa with known or suspected (in parenthesis) potential toxin production (detailed references are provided below).

Order	Species	MCs	ATX	PSP	CYN
Nostocales	<i>Anabaena aphanizomenoides</i>	+ [1]			
	<i>Anabaena flos-aquae</i>	+ [2]	+ [3]		
	<i>Anabaena plantonica</i>	+ [4]	+ [5]		
	<i>Anabaena spiroides</i>		+ [5]		
	<i>Anabaenopsis arnoldii</i>	+ [6]			
	<i>Aphanizomenon flos-aquae</i>		+ [7]	+ [8]	+ [9]
	<i>Aphanizomenon gracile</i>			+ [10]	+ [11]
	<i>Aphanizomenon issatschenkoï</i>		+ [12]	+ [13]	
	<i>Cylindrospermopsis raciborskii</i>			+ [14]	+ [15]
	<i>Raphidiopsis brookii</i>			+ [16]	
	<i>Raphidiopsis curvata</i>				+ [17]
Chroococcales	<i>Microcystis aeruginosa</i>	+ [18]	+ [5]	+ [19]	
	<i>Microcystis botrys</i>	+ [20]			
	<i>Microcystis flos-aquae</i>	+ [21]			
	<i>Microcystis ichtyoblae</i>	+ [22]			
	<i>Microcystis viridis</i>	+ [18]			
	<i>Microcystis weissenbergii</i>	+ [23]			
	<i>Woronichinia naegeliana</i>	+ [24]			
Oscillatoriales	<i>Limnothrix redekeii</i>	+ [25]			
	<i>Phormidium splendidum</i>	+ [26]			
	<i>Planktothrix agardhii</i>	+ [27]			
	<i>Planktothrix clathrata</i>	+ [20]			
	<i>Planktothrix rubescens</i>	+ [28]		+ [29]	
	<i>Pseudanabaena limnetica</i>	+ [30]		+ [7]	
	<i>Pseudanabaena mucicola</i>	+ [23]			

Reference

1. Sabour, B.; Loudiki, M.; Oudra, B.; Vasconcelos, V.; Oubraim, S.; Fawzi, B. Dynamics and toxicity of *Anabaena aphanizomenoides* (Cyanobacteria) waterblooms in the shallow brackish Oued Mellah lake (Marocco). *Aquat. Ecosyst. Health Manage.* **2005**, *8*, 1–10.
2. Sivonen, K.; Skulberg, O.M.; Namikoshi, M.; Evans, W.R.; Carmichael, W.W.; Rinehart, K.L. Two methyl ester derivatives of microcystins, cyclic heptapeptide hepatotoxins, isolated from *Anabaena flos-aquae* strain cya 83/1. *Toxicon* **1992**, *30*, 1465–1471.
3. Sivonen, K.; Himberg, K.; Luukkainen, R.; Niemelä, S.I.; Poon, G.K.; Codd, G.A. Preliminary characterization of neurotoxic cyanobacteria blooms and strains from Finland. *Toxicity Assess.* **1989**, *4*, 339–352.
4. Sant'Anna, C.L.; Azevedo, M.T.P.; Werner, V.R.; Dogo, C.R.; Rios, F.R.; de Carvalho, L.R. Review of toxic species of cyanobacteria in Brazil. *Algological studies* **2008**, *126*, 251–265.
5. Park, H.-D.; Watanabe, M.F.; Harada, K.-I.; Nagai, H.; Suzuki, M.; Watanabe, M.; Hayashi, H. Hepatotoxin (microcystin) and neurotoxin (anatoxin-a) contained in natural blooms and strains of cyanobacteria from Japanese freshwaters. *Nat. Toxins* **1993**, *1*, 353–360.
6. Mohamed, Z.A.; Al Shehri, A.M. Microcystin-producing blooms of *Anabaenopsis arnoldii* in a potable mountain lake in Saudi Arabia. *FEMS Microbiol. Ecol.* **2009**, *69*, 98–105.

7. Osswald, J.; Rellán, S.; Gago-Martinez, A.; Vasconcelos, V. Production of Anatoxin-a by cyanobacterial strains isolated from Portuguese fresh water systems. *Ecotoxicol.* **2009**, *18*, 1110–1115.
8. Liu, Y.; Chen, W.; Li, D.; Shen, Y.; Li, G.; Liu, Y. First report of aphantoxins in China-waterblooms of toxicogenic *Aphanizomenon flos-aquae* in lake Dianchi. *Ecotoxicol. Environ. Saf.* **2006**, *65*, 84–92.
9. Preußel, K.; Stüken, A.; Wiedner, C.; Chorus, I.; Fastner, J. First report on cylindrospermopsin producing *Aphanizomenon flos-aquae* (Cyanobacteria) isolated from two German lakes. *Toxicon* **2006**, *47*, 156–162.
10. Ballot, A.; Fastner, J.; Wiedner, C. Paralytic shellfish poisoning toxin-producing cyanobacterium *Aphanizomenon gracile* in Northeast Germany. *Appl. Environ. Microbiol.* **2010**, *76*, 1173–1180.
11. Kokocinski, M.; Mankiewicz-Boczek, J.; Jurczak, T.; Spoof, L.; Meriliuoto, J.; Rejmonczyk, E.; Hautala, H.; Vehniainen, M.; Pawelczyk, J.; Soininen, J. *Aphanizomenon gracile* (Nostocales), a cylindrospermopsin-producing cyanobacterium in Polish lakes. *Environ. Sci. Pollut. Res. Int.* **2013**, *20*, 5243–5264.
12. Wood, S.A.; Rasmussen, J.P.; Holland, P.T.; Campbell, R.; Crow, A.L.M. First report of the cyanotoxin anatoxin-a from *Aphanizomenon issatschenkoii* (Cyanobacteria). *J. Phycol.* **2007**, *43*, 356–365.
13. Pereira, P.; Onodera, H.; Andrinolo, D.; Franca, S.; Araújo, F.; Lagos, N.; Oshima, Y. Paralytic Shellfish toxins in the freshwater cyanobacterium *Aphanizomenon flos-aquae*, isolated from Montargil reservoir, Portugal. *Toxicon* **2000**, *38*, 1689–1702.
14. Lagos, N.; Onodera, H.; Zagatto, P.A.; Andrinolo, D.; Azevedo, S.M.F.Q.; Oshima, Y. The first evidence of paralytic shellfish toxins in the freshwater cyanobacterium *Cylindrospermopsis raciborskii*, isolated from Brazil. *Toxicon* **1999**, *37*, 1359–1373.
15. Hawkins, P.R.; Runnegar, M.T.C.; Jackson, A.R.B.; Falconer, I.R. Severe hepatotoxicity caused by the tropical cyanobacterium (blue-green alga) *Cylindrospermopsis raciborskii* (Woloszynska) Seenaya and Subba Raju isolated from a domestic water supply reservoir. *Appl. Environ. Microbiol.* **1985**, *50*, 1292–1295.
16. Soto-Liebe, K.; Méndez, M.A.; Fuenzalida, L.; Krock, B.; Cembella, A.; Vásquez, M. PSP toxin release from the cyanobacterium *Raphidiopsis brookii* D9 (Nostocales) can be induced by sodium and potassium ions. *Toxicon* **2012**, *60*, 1324–1334.
17. Li, R.; Carmichael, W.W.; Brittain, S.; Eaglesham, G.K.; Shaw, G.R.; Liu, Y.; Watanabe, M.M. First report of the cyanotoxins cylindrospermopsin and deoxy cylindrospermopsin from *Raphidiopsis curvata* (Cyanobacteria). *J. Phycol.* **2002**, *37*, 1121–1126.
18. Shirai, M.; Ohtake, A.; Sano, T.; Matsumoto, S.; Sakamoto, T.; Sato, A.; Aida, T.; Harada, K.-I.; Shimada, T.; Suzuki, M.; Nakano, M. Toxicity and toxins of natural blooms and isolated strains of *Microcystis* spp. (Cyanobacteria) and improved procedure for purification of cultures. *Appl. Environ. Microbiol.* **1991**, *57*, 1241–1245.
19. Sant'Anna, C. L.; de Carvalho, L.R.; Fiore, M.F.; Silva-Stenico, M. E.; Lorenzi, A.S.; Rios, F.R.; Konno, K.; Garcia, C.; Lagos, N. Highly toxic *Microcystis aeruginosa* strain, isolated from Sao Paulo-Brazil, produce hepatotoxins and paralytic shellfish poison neurotoxins. *Neurotoxicity Res.* **2011**, *19*, 389–402.
20. Henriksen P. Toxic cyanobacteria/blue-green algae in Danish fresh waters. Ph.D. Thesis, Dept. of Phycology, Botanical Institute, University of Copenhagen, Denmark, **1996**.
21. Gkelis, S.; Lanaras, T.; Sivonen, K. Cyanobacterial Toxic and Bioactive Peptides in Freshwater Bodies of Greece: Concentrations, Occurrence Patterns, and Implications for Human Health. *Mar. Drugs* **2015**, *13*, 6319–6335.
22. Nguyen, V.L.A.; Tanabe, Y.; Matsuura, H.; Kaya, K.; Watanabe, M.M. Morphological, biochemical and phylogenetic assessments of water-bloom-forming tropical morphospecies of *Microcystis* (Chroococcales, cyanobacteria). *Phycological Res.* **2012**, *60*, 208–222.
23. Oudra, B.; Loudiki, M.; Vasconcelos, V.; Sabour, B.; Sbiyyaa, B.; Oufdou, Kh.; Mezrioui, N. Detection and quantification of microcystins from cyanobacteria strains isolated from reservoirs and ponds in Morocco. *Environ. Toxicol.* **2002**, *17*, 32–39.
24. Oberholster, P.J.; Botha, A.-M.; Cloete, T.E. Toxic cyanobacterial blooms in a shallow, artificially mixed urban lake in Colorado, USA. *Lakes Reservoirs Res. Manage.* **2006**, *11*, 111–123.
25. Pineda-Mendoza, R.M.; Olvera-Ramirez, R.; Martinez-Jeronimo, F. Microcystins produced by filamentous cyanobacteria in urban lakes. A case study in Mexico City. *Hidrobiologica* **2012**, *22*, 290–298.
26. Aboal, M.; Puig, M.A.; Asencio, A.D. Production of microcystins in calcareous Mediterranean streams: The Alharabe River, Segura River basin in south-east Spain. *J. Appl. Phycol.* **2015**, *17*, 231–243.

27. Luukkainen, R.; Sivonen, K.; Namikoshi, M.; Färdig, M.; Rinehart, K.L.; Niemelä, S. Isolation and identification of eight microcystins from thirteen *Oscillatoria agardhii* strains and structure of a new microcystin. *Appl. Environ. Microbiol.* **1993**, *59*, 2204–2209.
28. Briand, J.-F.; Jacquet, S.; Flinois, C.; Avois-Jacquet, C.; Maisonneuve, C.; Leberre, B.; Humbert J.-F. Variations in the microcystin production of *Planktothrix rubescens* (Cyanobacteria) assessed from a four-year survey of lac du Bourget (France) and from laboratory experiments. *Microb. Ecol.* **2005**, *50*, 418–428.
29. Viaggiu, E.; Melchiorre, S.; Volpi, F.; Di Corcia, A.; Mancini, R.; Garibaldi, L.; Crichigno, G.; Bruno, M. Anatoxin-a toxin in the cyanobacterium *Planktothrix rubescens* from a fishing pond in northern Italy. *Environ. Toxicol.* **2004**, *19*, 191–197.
30. Maršálek, B.; Bláha, L.; Babica, P. Analyses of microcystins in the biomass of *Pseudanabaena limnetica* collected in Znojmo reservoir. *Czech Phycol.* **2003**, *3*, 195–197.