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Dynamics of the toxin cylindrospermopsin and of its producer, Aphanizomenon ovalisporum, in Karaoun Reservoir, Lebanon

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Cyanobacterial toxins threaten human and environmental health and the usages of many lakes and reservoirs throughout the world. Except in Lake Kinneret, toxins produced by cyanobacteria are poorly documented in lakes and reservoirs in the Middle East. The hepatotoxin cylindrospermopsin is produced by several cyanobacterial species, amongst which the widely distributed Aphanizomenon ovalisporum. Its gas vacuoles enable it to migrate in stratified conditions between surface layers with high light availability and deeper layers with higher nutrient concentrations. We investigated the physicochemical factors controlling the growth of this cyanobacterium and the occurrence and vertical distribution of cylindrospermopsin.

Our study site is Karaoun Reservoir, also known as Qaroun, Qaraoun or Qarun, the largest water body in Lebanon. It was built for irrigation and hydropower production. The reservoir is eutrophic. Its volume varies by 75 % every year. The only cylindrospermopsin-producing cyanobacterium in Lake Karaoun, Aphanizomenon ovalisporum, was first reported in 2009.

We conducted sampling campaigns around midday at 0.5 m depth from May to November 2012 and at 0.5, 5 and 10 m depths from March to August 2013. Phytoplankton microscopic counting and toxin quantification (ELISA) were performed within 24 hours.

Aphanizomenon ovalisporum was observed in late winter (March 2013), spring (May and June 2012), early summer (July 2013) and autumn (October and November 2012), both during periods of stratification and mixing, in a wide range of water levels (10 – 28 m), daily average irradiances (100 - 260 W/m2) and water temperatures (13 - 25 °C). Aphanizomenon ovalisporum bloomed in 2012. The highest biovolume, 9.8 mm3/L, was observed under the surface in October, at a water temperature of 22 °C, while the reservoir was weakly stratified (difference of 0.9 °C in the water column). In 2013 however, its biovolume did not exceed 0.3 mm3/L.

No correlation existed betweeen orthophosphate concentrations and Aphanizomenon ovalisporum biovolumes. Heterocysts were only observed in March 2013, at low N-NO_3 concentrations, 0.15 mg/L.

Cylindrospermopsin was detected in all samples, except in June and July 2013. The concentrations ranged from 0.5 to 1.7 μg/L in 2012, and from 0 to 1.7 μg/L in 2013. Aphanizomenon ovalisporum biovolumes and cylindrospermopsin concentration were poorly correlated (n = 31, r2 = -0.07). This agrees with the fact that the cyanobacterium liberates the larger fraction of the cylindrospermopsin it produces into the extracellular medium. Looking in more detail, the progressive deepening of the vertical maximum of the toxin concentration in the profiles of May 2013 suggests that the toxin may have been dragged towards the lake bottom by settling particles. This happened right after the disappearance of Aphanizomenon ovalisporum.

The waters of Karaoun Reservoir will be used for drinking water production in the future. However, the maximum cylindrospermopsin concentrations are higher than the WHO drinking water guideline value of 1 μg/L. Since cylindrospermopsin concentrations remain high even after Aphanizomenon ovalisporum disappears, a regular monitoring of the toxin is required to avoid health problems.