Bacterial control of cyanobacteria

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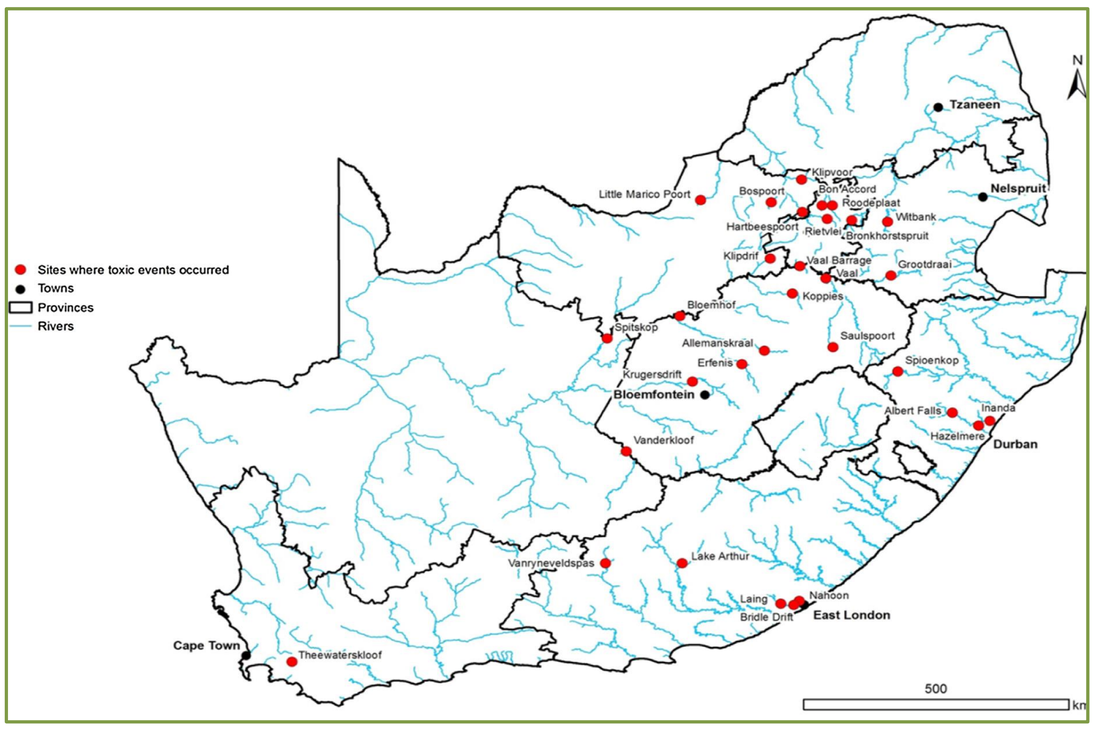
Value of study

With the effects of climate change, harmful algal blooms (HABs) have become a global concern, with serious implications in water scarce countries and vulnerable continents such as Africa

A need exists for low-cost, environmentally feasible treatment which can be up-scaled for managing toxic cyanobacterial blooms, especially in countries like South Africa, which is water scarce and has had reports of blooms of *Cylindrospermopsis*, *Oscillatoria*, *Anabaena* and *Microcystis* across the country.



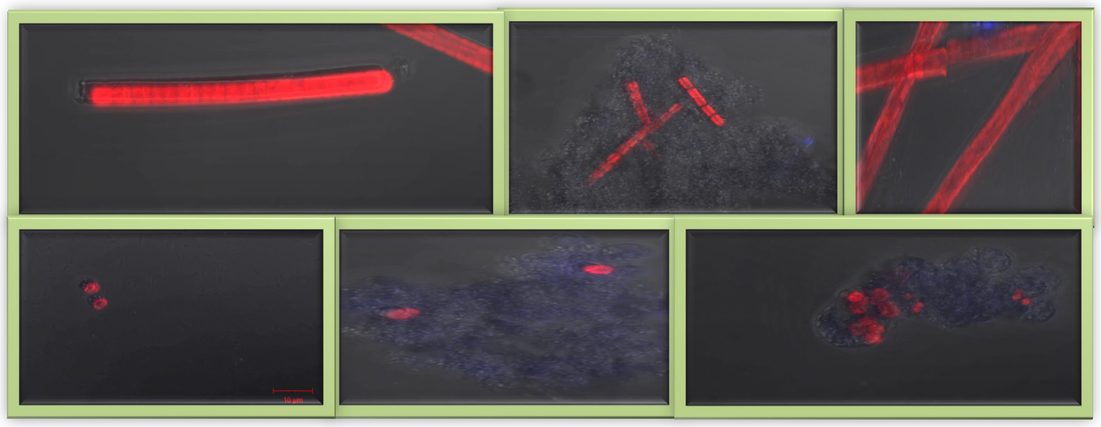
Reports of cyanobacterial blooms across South Africa, most major water sources have been affected (Ndlela et al., 2016)

Materials and methods

Non-axenic *Microcystis* and *Oscillatoria* sp. cyanobacterial isolates were collected from South African bloom waters and grown in BG-11. Bacterial cultures from bloom waters showing cyanobacterial inhibition by the plaque assay (Gumbo et al., 2010), were randomly selected, purified and grown under ambient temperature in nutrient broth (Merck). Volumes of 0.25 g wet weight of cyanobacteria cells were sub-cultured in 100ml BG-11 volumes for two weeks. Pure cultures of selected bacteria were added to these cyanobacteria, based on the cell counts and chlorophyll of *Microcystis* sp. After 4 days, cyanobacterial cell changes were measured through microscopy. HPLC was conducted to measure intracellular toxicity changes, in comparison to healthy cyanobacterial cells.

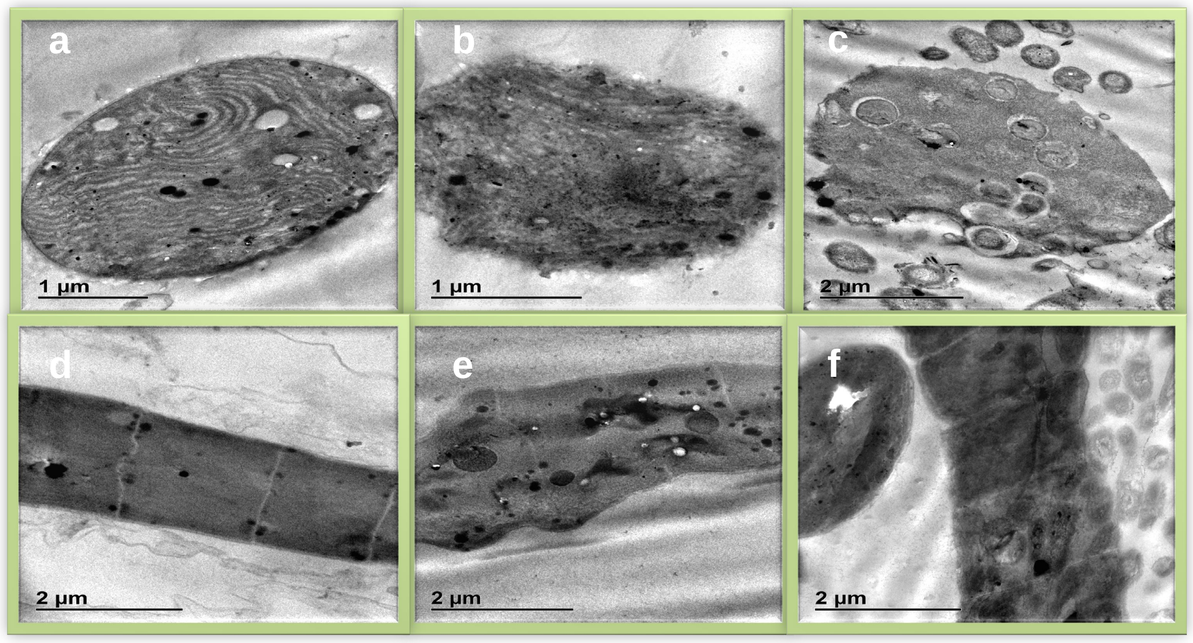
Bacteria as biocontrol agents- Results so far

Using *Bacillus* sp. as a reference, isolate 1 was exposed to non axenic *Microcystis* and *Oscillatoria* in BG-11 over 4 days and observed under fluorescence microscopy, based on chlorophyll.



Examples of fluorescence changes, after healthy (far left) cells were exposed to *Bacillus* and Isolate 1 (middle and far right). Bacteria showed blue fluorescence around the red cyanobacteria.

Electron microscopy findings



Transmission electron micrographs of cell structure changes in *Microcystis* sp. (a, b, c) and *Oscillatoria* sp. (d, e, f) before (a, d) and after treatment with *Bacillus* sp. (b, e) and Isolate 1 (c, f), after 4 days under ambient temperature at 60 rpm in 100ml volumes of BG-11

Treatment	Microcystin R-R	Microcystin Y-R	Response type
***Microcystis* control**	**436.7**	**7.8**	
Microcystis + *Bacillus*	<3	<0.3	**Suppressed toxicity**
Microcystis + Isolate 1	<3	<0.3	**Suppressed toxicity**
***Oscillatoria* control**	**<3**	**<0.3**	
Oscillatoria +*Bacillus*	<3	<0.3	**Not determined**
Oscillatoria + Isolate 1	<3	4.9	**Increased toxicity**

An example of intracellular toxin changes with the addition of bacterial isolates 1 and *Bacillus* sp. to non-axenic *Microcystis* and *Oscillatoria cultures* sp., after 4 days at ambient temperature at 60 rpm.

Potential Outcomes and applications

- So far, based on HPLC, there seems to be a typical stress response indicated by increased microcystin Y-R when *Oscillatoria* is exposed to Isolate 1. Both isolates however, seem to reduce intracellular toxicity in *Microcystis*.
- Fluorescence microscopy shows increased bacterial populations and reduced fluorescence of *Microcystis* and *Oscillatoria* upon addition of both bacteria.
- Electron microscopy indicates that both bacteria impact cells at a structural level. The mode of biological control appears to be direct contact.

- Ndlela, L. L. *et al.* (2016) 'An overview of cyanobacterial bloom occurrences and research in Africa over the last decade', *Harmful Algae*, 60
- Gumbo, J.R. *et al.* (2010) The Isolation and identification of Predatory Bacteria from a Microcystis algal Bloom.. African Journal of Biotechnology, 9.

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