Identification of cyanobacteria populations using characteristic absorbance spectra

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Introduction

Cyanobacterial harmful algal blooms (CHABs) are sudden, massive growths of cyanobacteria in an aquatic environment. CHABs are a growing nuisance around the world because they can pollute sources of irrigation and drinking water. Some CHABs are capable of producing toxins that can harm or kill animals. CHABs are currently monitored by satellite and by field sampling, but satellite imagery cannot detect CHABs in small bodies of water and field sampling is inadequate for large-scale monitoring. What is needed is a system of buoys with sensors that can detect a CHAB and determine the taxonomic composition of the CHAB.[1]

The BreveBuster is a device already being used to detect the presence of *Karenia brevis*, the organism that causes red tide in the Gulf of Mexico. **The goal of this project is to determine how well the BreveBuster can differentiate between different genera of cyanobacteria.**

Objectives

•Develop a "library" of characteristic absorbance spectra for four different genera of cyanobacteria

•Perform statistical analyses on the absorbance spectra to determine whether or not the genera can be differentiated by the BreveBuster

The BreveBuster analyzing a sample

Procedure

•19 different cyanobacteria samples from four genera (Anabaena, Microcystis, Cylindrospermopsis, and Oscillatoria) were taken from the USDA Horticulture lab in Ft. Pierce, FL.

•Samples were grown under various light and temperature conditions

•The BreveBuster measured the absorbance spectra of each of the samples 3 times. One measurement was thrown out due to machine malfunction, resulting in 56 measurements.

•Chlorophyll *a* concentration was determined using HPLC.

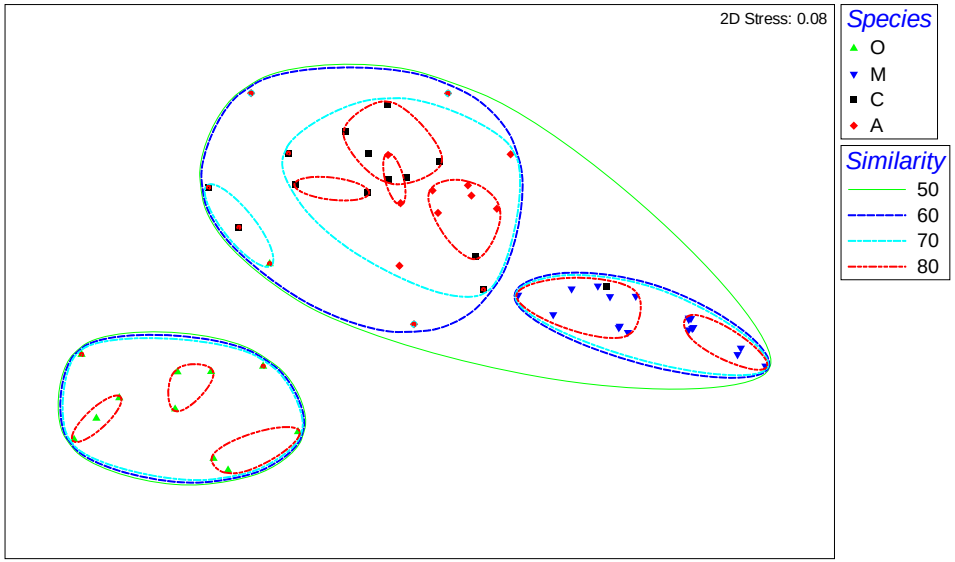
•A 56 x 56 similarity matrix was constructed by calculating the similarity index between each of the 56 measurements. The similarity index used in this project is described by Kirkpatrick et al. (2000).[2]

•A multi-dimensional scaling was performed to visualize the differences and similarities among the groups

•An Analysis of Similarities (ANOSIM) was performed on the 56 x 56 matrix.

Results – Visualizing similarity using MDS

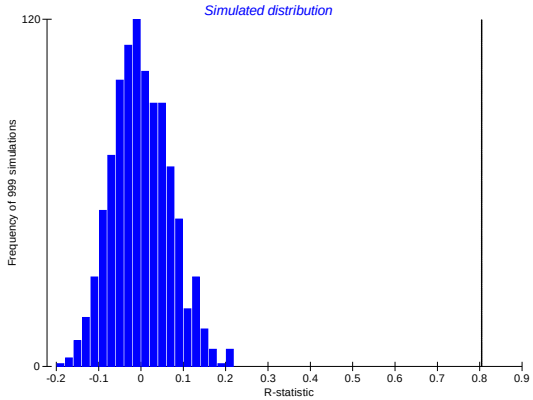
The 2-D Multi-dimensional scaling below shows the relative distance between each point as a difference in similarity—for instance, two points that are close to each other would have a high similarity, but any two points far away from each other have a low similarity. This graph shows that the Microcystis and the Oscillatoria samples are clearly differentiated from each other, but there is less of a clear distinction between Anabaena and Cylindrospermopsis.



A graph of the Multi-dimensional scaling technique generated by the PRIMER-E software package.

Results - ANOSIM

An Analysis of Similarities (ANOSIM) was performed on the 56 x 56 similarity matrix to verify that the differences between samples is statistically greater than the differences among measurements of the same sample. The null test statistic is R = 0, but the ANOSIM showed a test statistic of R = 0.82 with a significance level of p = 0.001. This verifies that the BreveBuster measured real differences between our cyanobateria samples.



Simulated distribution of the test statistic R under the hypothesis that the BreveBuster cannot detect any difference between cyanobacteria samples. Notice how none of the 999 randomnized simulations are greater than the actual R statistic.

Conclusion

From the results of the MDS and the ANOSIM, it was shown that the BreveBuster has the ability to differentiate between different genera of cyanobacteria grown in cell culture. This work suggests that it may be feasible for a BreveBuster to monitor CHABs in freshwater environments.

Literature Cited:

[1] Hudnell HK, Dortch Q, 2008. A Synopsis of Research Needs Identified at the Interagency, International Symposium on Cyanobacterial Harmful Algal Blooms (ISOC-HAB). In Hudnell, HK (ed.), Cyanobacterial Harmful Algal Blooms: State of the Science and Research Needs, pp. 17-43. New York, Springer.

[2] Kirkpatrick GJ, Millie DF, Moline MA, Schofield O, 2000. Optical discrimination of a phytoplankton species in natural mixed populations. Limnology and Oceanography 45: 467 – 471.