Cyanobacteria: Friend and Foe

By Jill Emerson

Cyanobacteria (or "blue green algae") have been getting a lot of attention recently – and with good reason. Large uncontrolled growths, referred to as blooms, have been popping up more and more across the country, thanks in large part to increasingly warmer waters and runoff from large storm events. Cyanobacteria have the ability to produce highly toxic compounds broadly referred to as cyanotoxins, of which there are many different types. Typically, the highest amount of toxins are released upon cell death. During bloom events when there are many bacteria growing and dying, there can be an extremely high level of toxins present in the water. These cyanotoxins can have a wide range of variability to them, making testing for them all problematic, time consuming, and costly (and potentially impossible to test for them all). Therefore, it's safest to consider that all bloom events are toxic, and the best thing to do if you see a bloom is to stay away from it, as interesting or innocent as it may appear.

While awareness of cyanobacteria is increasing, its existence is nothing new. Like 3.5 billion years ago nothing new. Fossils date cyanobacteria back to the Archean Eon, and the organism is largely credited for switching Earth from a carbon dioxide atmosphere to a more oxygen rich one, thanks to cyanobacteria's photosynthetic capabilities (1). Over its billions of years of survival, cyanobacteria evolved into many different species that have many different shapes and structures. Some can appear as small spotty cells, some like

Variation in cyanobacteria shapes (Microcystis, Oscillartoria, and Dolichospermum, respectively). Credit: cyanos.org

blades of grass, while others resemble beaded bracelets.

In cases, cyanobacteria have also evolved to form symbiotic (mutually beneficial) relationships with some plants and fungi. A common example of this is lichens, which are part fungi and part bacteria found commonly on rocks and trees. In this relationship, the fungi get both carbohydrates and nitrogen from the cyanobacteria; meanwhile, the cyanobacteria get protection from the sun's UV rays due to a protective coating the fungi release (2). This codependence also allows both organisms to flourish in places where alone neither would be very successful. In fact, cyanobacteria have had such successful symbiosis with other lifeforms that our modern day plants actually evolved from cyanobacteria taking up residence inside another organism, providing food in return for protection. Thus the chloroplast (the part of the plant that houses the chlorophyll and performs photosynthesis) was born.

While evolutionarily, we have much to be thankful for about cyanobacteria, its potent toxins pose a significant problem in nature. In one well reported case, cyanobacteria's symbiotic relationship with plants led to a curious finding on the island of Guam (3). Here, the native Chamarro people once had an incidence rate of 100 times higher than anywhere else in the world of amyotrophic lateral sclerosis/parkinsonism-dementia complex (AL-SPDC), a neurodegenerative disorder that has elements of ALS, Parkinson's disease, and Alzheimer's disease. Many sufferers of AL-SPDC on Guam had higher levels of a toxin called BMAA, a type of cyanotoxin. Researchers were able to find that the cyanobacteria had formed a symbiotic relationship with the root system of the cycad trees, which produces a fleshy seed eaten by a bat known as a flying fox. This bat, in turn, is consumed by the Chamarro people during cultural celebrations. Most interestingly, at each step in the food chain – cyanobacteria to cycad to bat – the level of BMAA increased (0.3 µg/g, 37 µg/g, 3,556 µg/g respectively).

These findings showcased a natural biomagnification of toxins that can happen when cyanobacteria are part of a food web. This, coupled with the persistence of the toxins, are why it is important to never irrigate crops with waters that are actively experiencing or have recently experienced a bloom.

Cyanobacteria from a scientific perspective are wildly fascinating, but are clearly an environmental, economical, and health and safety issue. If you think a water body near you is experiencing a bloom, snap a picture of the affected area (if safe to do so!) and call your local state government for assistance. We want everyone to stay safe this summer, so please check local government listings for noted cyanobacteria blooms happening in your area, and if you see something unusual growing in the water this summer, it's best to stay away from it and report it.

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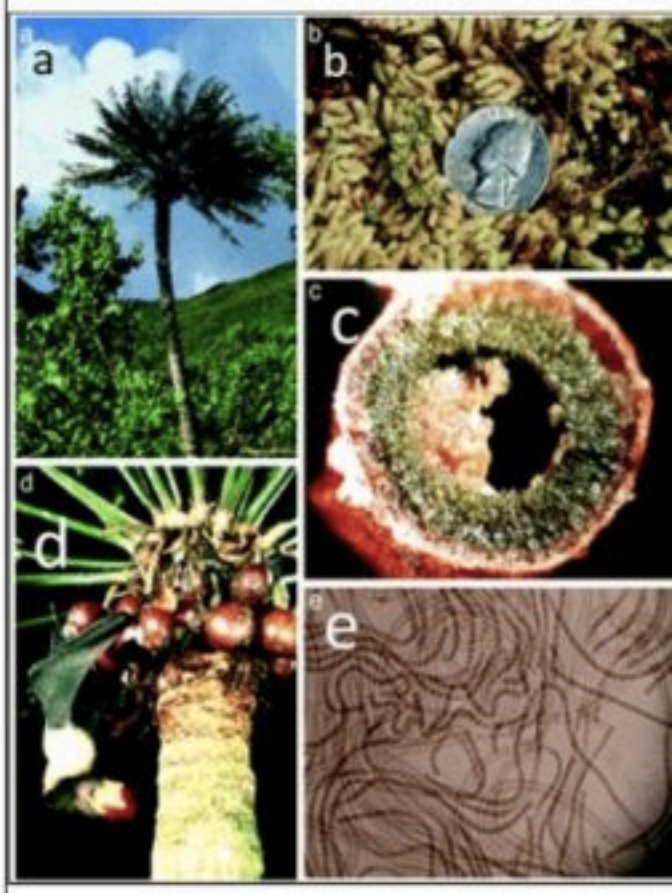

From the Guam study: C. micronesica Hill. (a) Habit in South Guam as a 4-m-tall unbranched tree. (b) Positively geotropic coralloid roots with tips cut to show zone of cyanobacterial invasion. (c) Cross section of coralloid root showing green ring of cyanobacterial growth. (d) P. mariannus feeding on fleshy sarcotesta of seed (photo courtesy of Merlin Tuttle, Bat Conservation International). (e) Cyanobacteria of the genus Nostoc cultured from the coralloid roots. Credit: Cox et al. 2003 PNAS

Citations:

1. Mazard S., Penesyan A., Ostrowski M., Paulsen I.T., Egan S. Tiny Microbes with a Big Impact: The Role of Cyanobacteria and Their Metabolites in Shaping Our Future. Marine Drugs. 2016 May; 14(5): 97 doi: 10.3390/md14050097
2. Vidyasagar A. What are Lichens? Live Science. 2016 June. www.livescience.com/55008-lichens.html
3. Cox P.A., Banack S.A., Murch S.J. Biomagnification of cyanobacterial neurotoxins and neurodegenerative disease among the Chamorro people of Guam. PNAS. 2003 November;100 (23) 13380-13383