Why Cyanobacteria Dominate the World: Ecological Strategies

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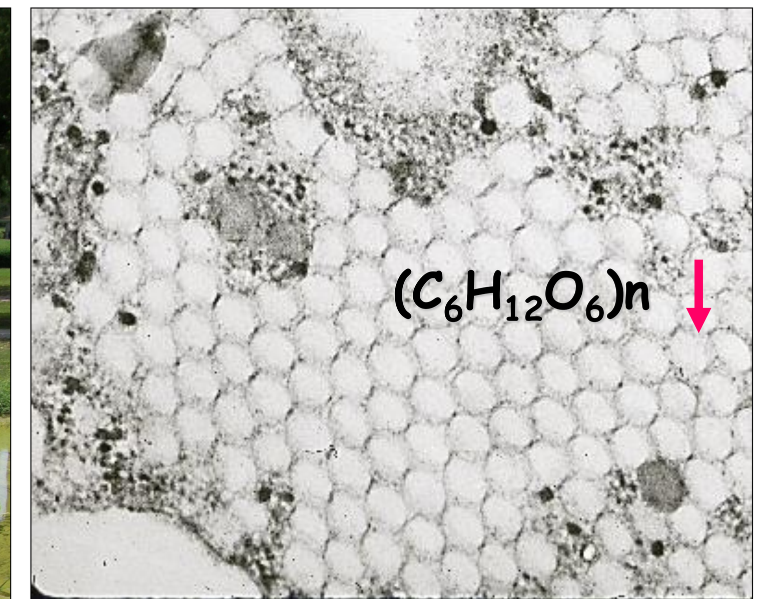
Abstract

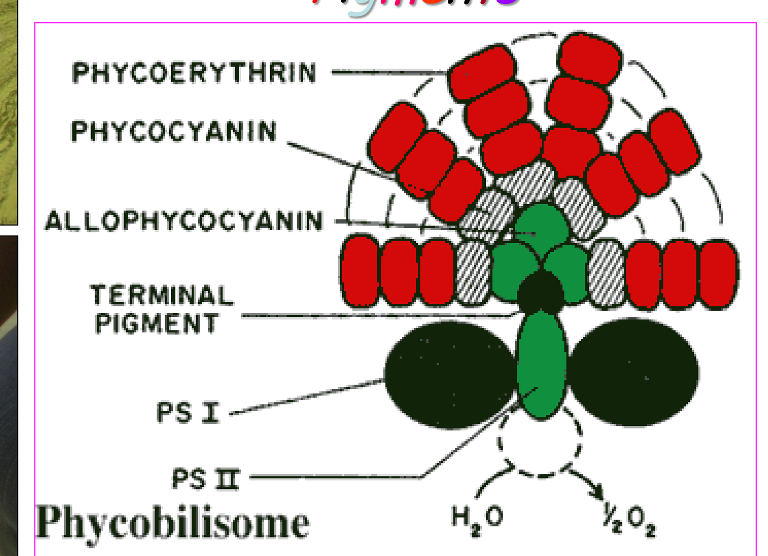
Cyanobacteria, also commonly called blue-green algae, have numerous physiological and structural features that allow them to thrive and often out-compete other organisms. These advantages can lead to massive accumulations of cells, commonly called blooms, that impact aesthetics, water quality and the ecological health of the aquatic system. One advantage that promotes cyanobacterial blooms in planktonic species is the ability to regulate buoyancy. An internal structure, the gas vesicle, accumulates air which leads to upward migration, allowing the organisms to have greater to light for photosynthesis. Once cells accumulate photosynthate, they sink in the water column and take advantage of the nutrients release by sediments. Cyanobacteria have a full array of photosynthetic and auxiliary pigments that adjust to light quantity and quality as they migrate in the water column. As cells accumulate at the surface of water body, commonly called scums, they can cause dire consequences because many species produce cyanotoxins, compounds that are harmful to domesticated animals, wildlife and humans if ingested or inhaled. Several species of cyanobacteria have other advantages, such as the ability to fix atmospheric nitrogen. In water bodies that have limited supplies of nitrogen, traditionally in the form of nitrate, nitrite, and urea, the nitrogen-fixing cyanobacteria can dominate. Nitrogen fixation is performed by the nitrogenase enzyme complex, which is inhibited by oxygen. To overcome this problem, the cyanobacteria have this enzyme complex in a specialized cell, the heterocyst. The heterocyst has a special external cell wall that prevents oxygen from seeping into the cells. Another key nutrient for cyanobacteria is phosphorus and blooms are often an indicator of eutrophication as a consequence of phosphorus availability. Cyanobacteria have the ability to store phosphorus internally when it is abundant, luxuriant uptake, which can be used by cells when this nutrient is no longer available. A final example of a cyanobacterial ecological strategy is their thermal tolerance, commonly thriving at temperatures above 30°C where other organisms reach their thermal limits. Water bodies experiencing warm peak temperatures and for greater durations will likely see an increased frequency and intensity of cyanobacterial blooms.

Buoyancy Regulation

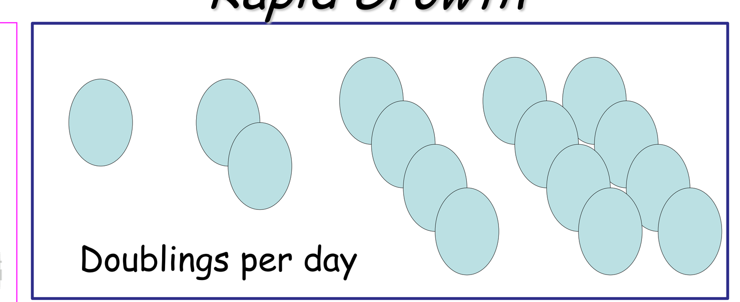


Nutrient Storage

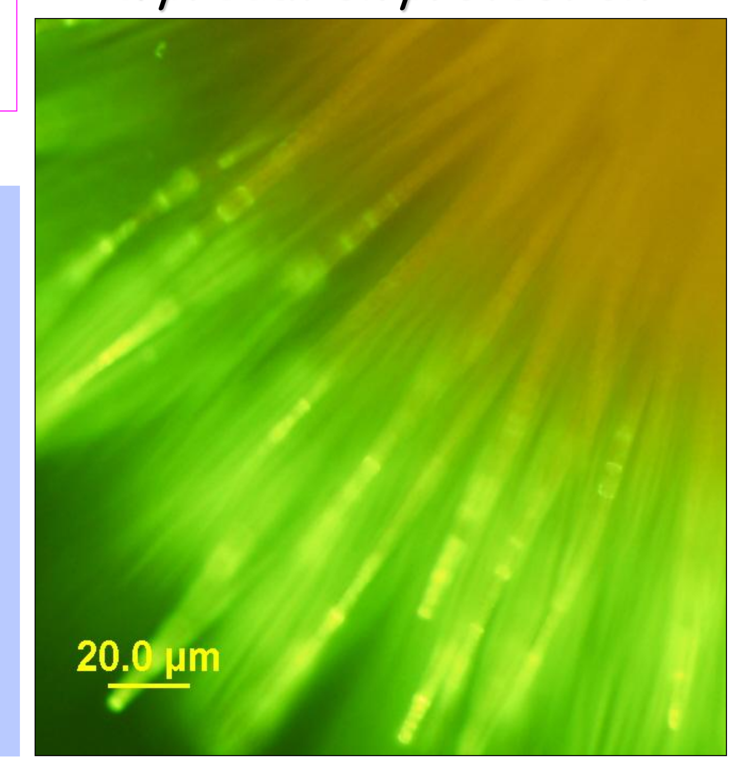
Pigments



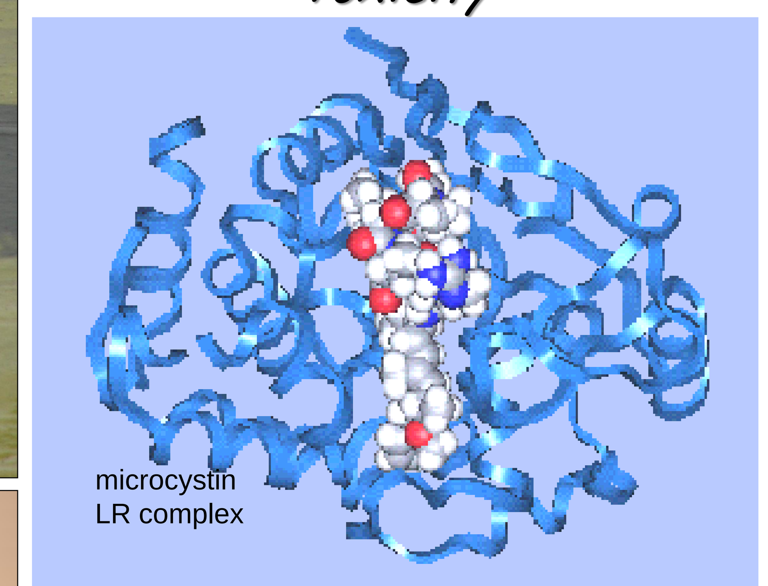
Rapid Growth



Morphology: floatation & predation protection



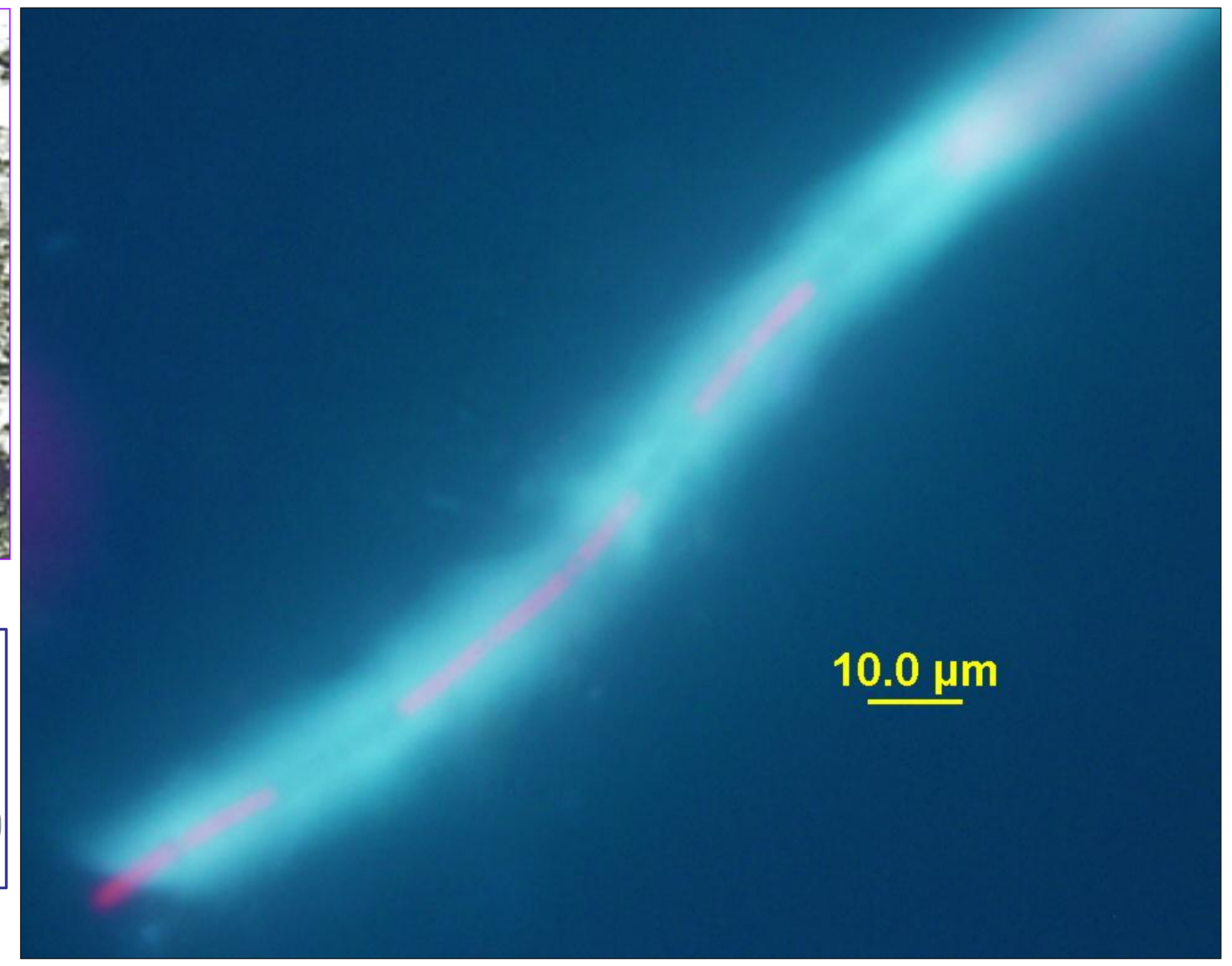
Toxicity

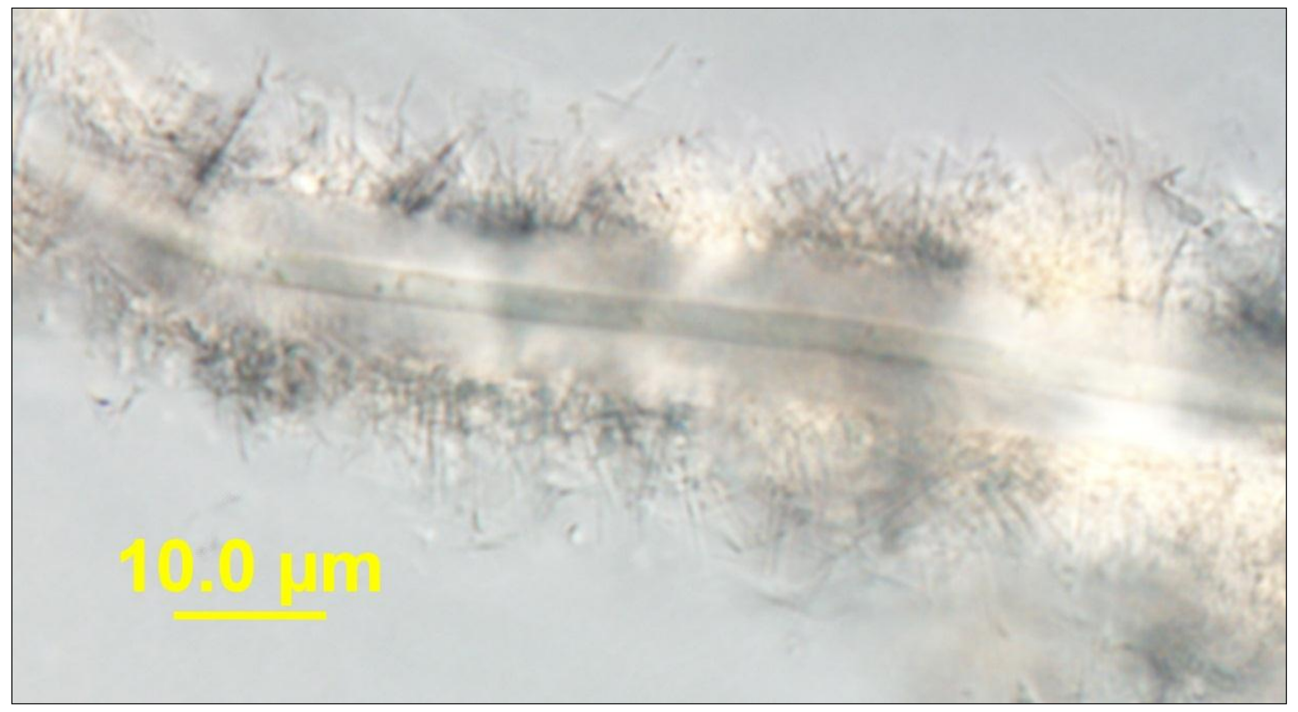


Nitrogen Fixation

Desiccation Tolerance

Mineralization





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