Cyanobacteria In My Local Lake

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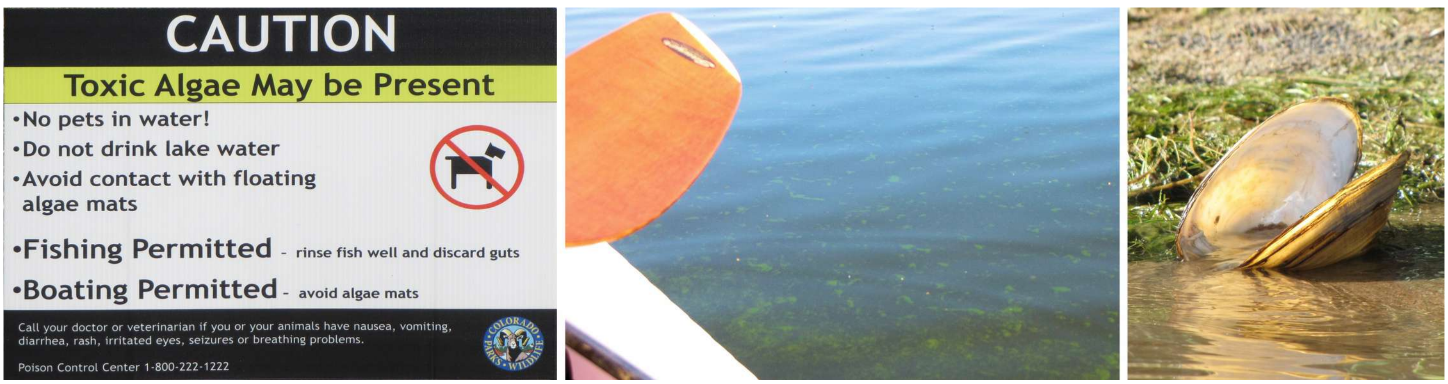
Introduction

It's summertime (in my hemisphere) and the living is easy. I visit the lake at nearby Cherry Creek State Park at dawn, paddle my kayak, and observe nature. Recently, there has been a little more nature than usual to observe. The sign in Figure 1A is posted along the shoreline warning of the potential for HABs, a public health acronym signifying **H**armful **A**lgal **B**loom. Three factors encourage the blooms: long hours of daylight, warm temperatures, and an abundance of nutrients from residential lawn fertilizer runoff. A variety of aquatic organisms are flourishing at this time, but the **cyanobacteria** are the ones causing problems. They produce several toxins that can become concentrated enough to be harmful – even fatal – to wildlife, humans, and pets. I collected a sample (Figure 1B), and made some temporary mounts to see what is in the water.



A B C

Figure 1. *A summertime bloom of cyanobacteria.* ***A.*** *Warning sign posted on the lake shore.* ***B.*** *The pale green floating blobs are a cyanobacteria bloom concentrated along the lee shore by wind.* ***C.*** *A possible victim of cyanobacteria poisoning: a very recently deceased freshwater filter feeding clam,* ***Anodonta****. Filter feeders concentrate whatever toxins are present in the water. The dead clam was very close to the cyanobacteria bloom in Figure 1B.*

Cyanobacteria

The old name for this group was "blue-green algae". The modern name reflects the fact that this group falls on the bacterial side of the great prokaryote/eukaryote divide, not on the algal side. Cyanobacteria are prokaryotes; they don't have the subcellular organelles, including a nucleus, that are features of the eukaryotes. They are single celled organisms that often form colonies. They photosynthesize, which is why they were originally classified as algae. They have a long history and played a role in making the earth what it is today. In the distant geologic past, stromatolite-forming cyanobacteria created enough free oxygen (O_2) from photosynthesis to change earth's atmosphere from oxygen-poor to oxygen-rich. That transformation allowed air-breathers such as ourselves to evolve, and at the same time, invented rust (oxidizing environment; first came banded ironstone formations in the oceans; later, red beds formed on land).

Toxins produced by cyanobacteria include the neurotoxins anatoxin-a and saxitoxin and the liver toxin microcystin. These toxins are dangerous in high concentrations, but concentrations in my local lake are not high. Fish, crayfish, turtles, frogs, various water birds, and muskrats are all leading normal lives in the water without visible effects from the cyanobacteria blooms. The unfortunate filter feeding clam in Figure 1C might be an exception.

The Sample

Two kinds of cyanobacteria colonies are present in the sample I collected (Figure 2). The most abundant colony is ***Aphanizomenon flos-aquae*** which forms clumps and mats. The other is ***Dolichospermum*** which forms coiled chains; this genus was called ***Anabaena*** before taxonomic revisions shuffled and renamed some genera and species.

Figure 2. *This overview with a 4x objective shows the two types of cyanobacteria colonies in the sample. On the left is **Aphanizomenon flos-aquae** which forms clumps and mats and resembles "grass clippings". On the right is a **Dolichospermum sp.** which forms coiled chains.*

*A bonus mystery item is visible behind the **Aphanizomenon** mat. It resembles a colony of the golden algae **Cyclonexis annularis**, although the expected flagella are not visible. I'm not sure what it is.*

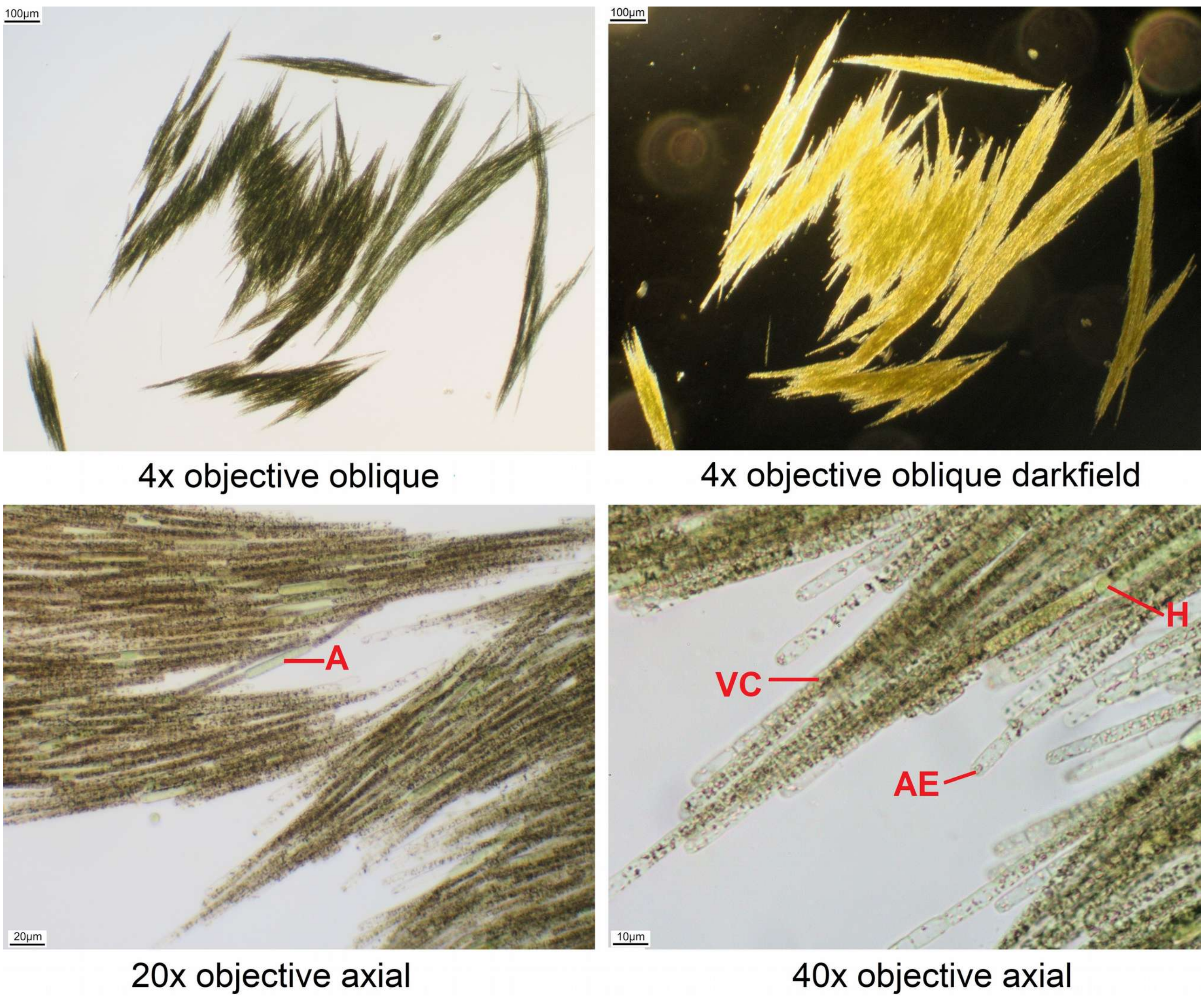


Figure 3. Aphanizomenon flos-aquae. *Key: **A**=akinete (resting cell). **AE**=aerotope vacuole (flotation mechanism). **H**=heterocyte (nitrogen fixing). **VC**=vegetative cell (photosynthesis). This species produces four toxins: saxitoxin, anatoxin-a, cylindrospermopsin, and lypopolysaccharides.*

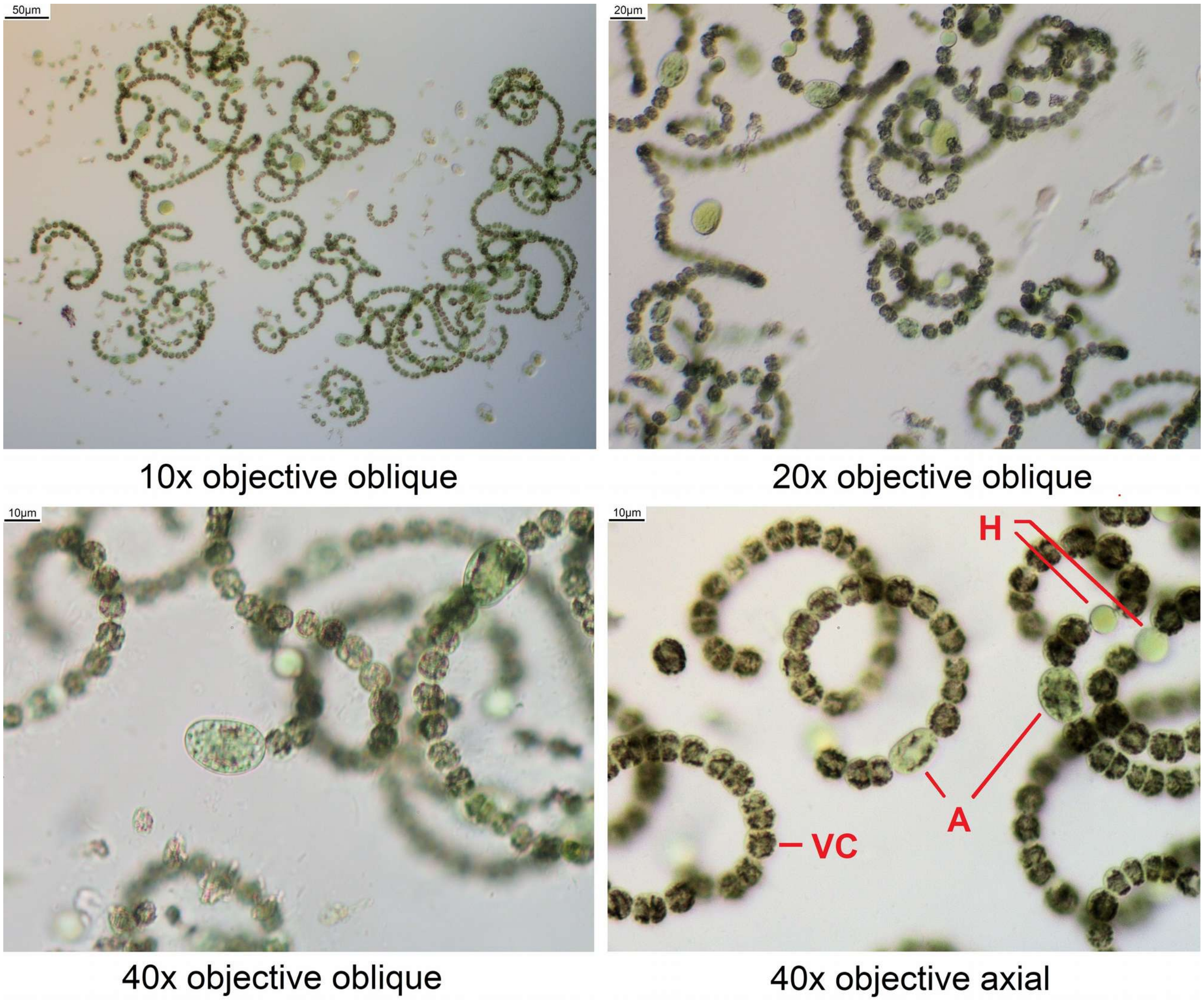


Figure 4. Dolichospermum sp. *(formerly called* ***Anabaena****). Key:* ***A****=akinete (resting cell).* ***H****=heterocyte (nitrogen fixing).* ***VC****=vegetative cell (photosynthesis). This is a toxin producer, making anatoxin-a, saxitoxin, microcystin, and lipopolysaccharides.*

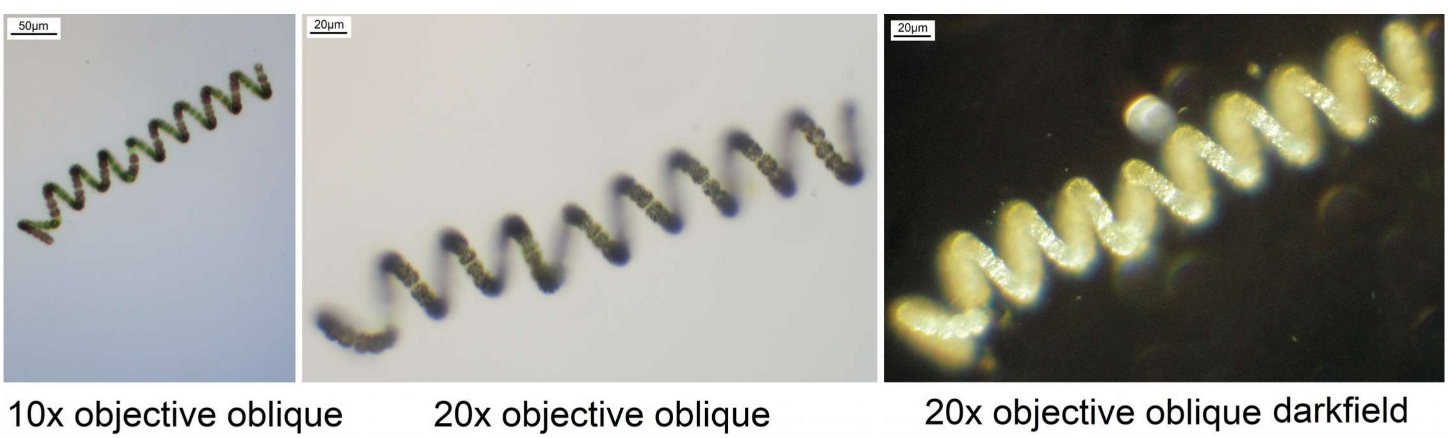


Figure 5. Dolichospermum sp. *This uniformly and tightly coiled specimen may be another form of the species in Figure 4. The oblique darkfield image shows the granularity of the cells, a characteristic of prokaryotes.*

This quick look at one water sample revealed two common cyanobacteria. The references at the end of the article have links to some online identification guides I found useful. Many cyanobacteria species have world-wide distribution, so these guides can be a useful starting point to identify your own local cyanobacteria.

Not All Algal Blooms Are Toxic

Many organisms are blooming in the lake in addition to cyanobacteria. To the naked eye, some of these blooms look more ominous than the cyanobacteria blooms, but most are harmless. Figure 6 shows a second water sample that looks bad macroscopically, but contains no toxin-producing species. It is, in fact, an example of the "pond life" micro zoo and botanic garden that is so popular with microscope enthusiasts.

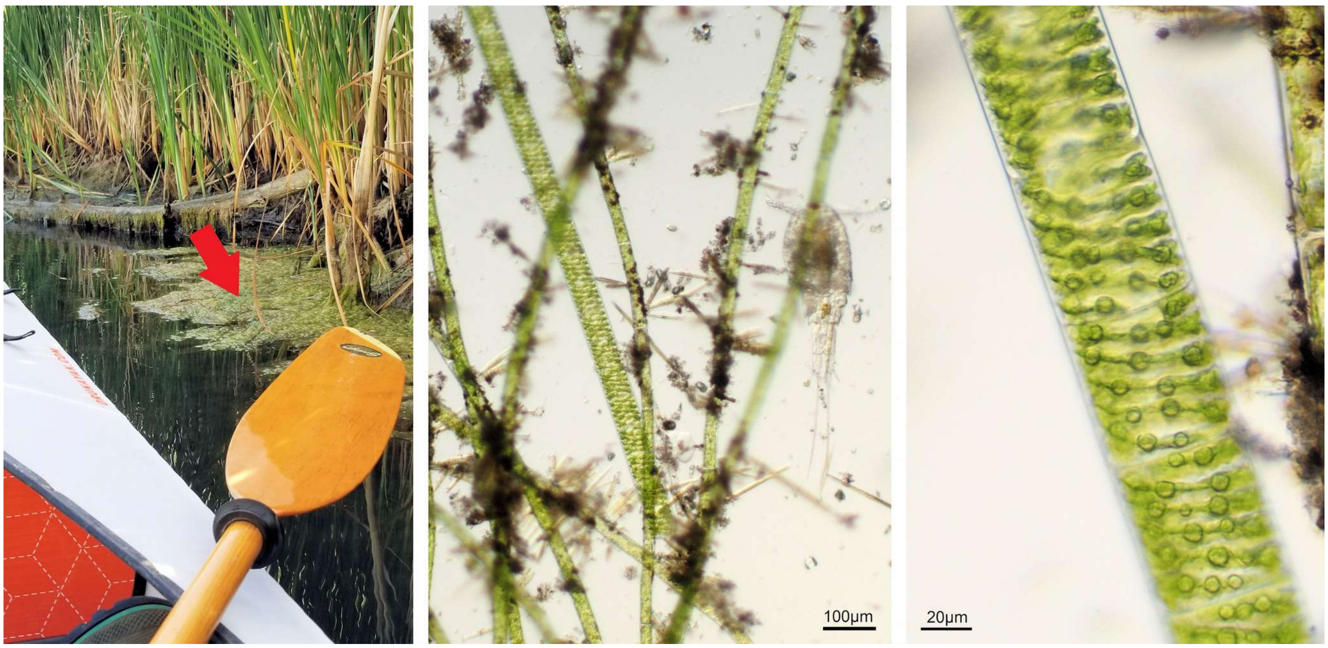


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Figure 6. *For comparison: a nontoxic green algae mat along the edge of a cattail marsh.* **A.** *Red arrow shows sample site.* **B.** *An overview with the 4x objective shows two kinds of filamentous algae, including* ***Spirogyra****; the freshwater copepod* ***Cyclops****; and various diatoms attached to the algal filaments.* **C.** *20x objective closeup of* ***Spirogyra*** *showing the spiral chloroplasts containing bead-like pyrenoids that fix carbon dioxide for use in photosynthesis.*

Follow Up

A week after the two water samples were collected, the cyanobacteria bloom has abated. Cyanobacteria are still present, but are not forming the concentrated clumps shown in Figure 1B. The green algae mat in the cattail marsh is unchanged.

References

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