The Meaning of Harmful Algal Blooms (HABs)

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Think of sipping your favorite hot beverage, maybe a nice cup of coffee as you sit outside in the morning, looking out over the lake. A "sip" contains approximately 10-15 milliliters of hot beverage. A milliliter is a typical volume used to express densities of microscopic algae in the water. Most algae are organisms that you need a microscope to see, although the green tint of the water gives away the fact that they are there (Fig. 1). On average, depending on time of year, a milliliter of lake water contains anywhere from 50,000 to over 1,000,000 individual algae. A sip of lake water then may contain over 15 million algae cells! It might be good to keep your mouth closed during your next swim.

Fig. 1. Typical algae collected from a lake magnified under a microscope by 200 times

Algae are an important and normal part of any lake. They are a foundational part of the food chain. Algae feed zooplankton (microscopic animals), and zooplankton feed both insects and small fish, while insects and small fish feed…you guessed it…big fish! However, too many algae, or the wrong kind of algae, can cause problems from making the lake unappealing to look at or even unsafe to be in.

There are two basic kinds of algae. Those that are bacteria and those that are not. The kind that are bacteria are sometimes referred to as "blue-green algae" because they have an additional pigment besides chlorophyll, which is the pigment that makes nonbacterial algae green. Blue-green algae are sometimes, and probably more appropriately, called cyanobacteria ("cyan" is the color blue green). Cyanobacteria have both chlorophyll and another pigment that is called "phycocyanin" gives it a brighter green color with a hint of blue (Fig. 2).

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Fig. 2. A common type of blue-green algae bloom in a lake. Note that the color is actually more green than blue. The blue just tints the color.

One unique characteristic of cyanobacteria is that they have the potential to create and release toxins that in high enough concentrations can make humans and pets sick or in extreme cases cause death (Table 1). There are four main toxins produced by a broad range of different types of cyanobacteria. When cyanobacteria that are known to produce toxins form blooms during the summer, agencies and scientists will generally refer to them as "harmful algal blooms" or "HABs" for short.

Type	Toxin	Genera (Type of Cyanobacteria)	Short Term Health Effects	Long Term Health Effects
Hepatotoxin (Liver toxin)	Cylindrospermopsin	*Aphanizomenon, Cylindrospermopsis, Dolichospermum, and Raphidiopsis*	Gastrointestinal, liver inflammation, and hemorrage, pneumonia, or dermatitis	Malaise, anorexia, or liver failure
Hepatotoxin (Liver toxin)	Microcystin	*Anabaenopsis, Arthrospira, Aphanizomenon, Dolichospermum, Gloeotrichia, Microcystis, Nostoc, Oscillatoria, Phormidium, Planktothrix, and Woronichinia*	Gastrointestinal, liver inflammation, and hemorrage and liver failure, pneumonia, or dermatitis	Tumor promoter or liver failure
Neurotoxin (Nerve toxin)	Anatoxin	*Aphanizomenon, Dolichospermum, Microcystis, Oscillatoria, and Planktothrix*	Tingling, burning, numbness, drowsiness, incoherent speech, or respiratory paralysis	Cardiac arrhythmia
Neurotoxin (Nerve toxin)	Saxitoxin	*Aphanizomenon, Dolichospermum, Lyngbya, Microcystis,Oscillatoria, Phormidium, Planktothrix, Raphidiopsis, and Woronichinia*	Tingling, burning, numbness, drowsiness, incohrent speech, or respiratory paralysis	Unknown

Table 1. Cyanobacterial toxins, the types that can produce them (Paerl 2001, Fristachi et al. 2008), and human health effects (Harrness 2005, Falconer 2005).

Visual evidence of algae bloom that have a blue-green tint to them...should prompt caution about contacting water in lakes.

Within the last few weeks, we noticed a cyanobacteria bloom in Horseshoe Lake while out monitoring plant populations. We collected a water sample and determined it to be a bloom of the cyanobacteria Microcytis (Fig. 3). Microcystis is one type of cyanobacteria that can produce both microcystin and anatoxin toxins. That same sample had low densities of Aphanizomenon, Anabaenopsis, and Dolichopermum, all potentially toxigenic types. The observance of the bloom was not necessarily unusual as these come and go during the year.
Visual evidence of algae bloom that have a blue-green tint to them at any point during the year should prompt caution about contacting water in lakes.

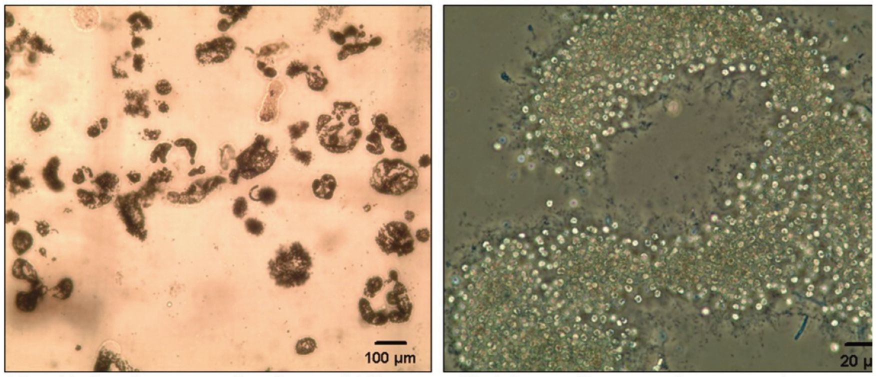

Fig. 3. A microscopic view of Microcystis bloom from water sample collected on Horseshoe Lake during August 2023. Shown left is the bloom at 40X and on the right is a close-up at 200X. Each of the round cells represents one individual. Each colony contains thousands of cells. Other potentially toxic genera in lower densities identified in the sample included Aphanizomenon, Anabaenopsis, and Dolichospermum. There was a virtual absence of nonbacterial types present

While microscopic assessment by trained workers is required to determine whether a particular algae is capable to producing toxins, you can perform simple tests to determine whether certain blooms of algae are toxic forming groups by using the "jar" test and the "stick" test as pictured in Fig. 4 below.

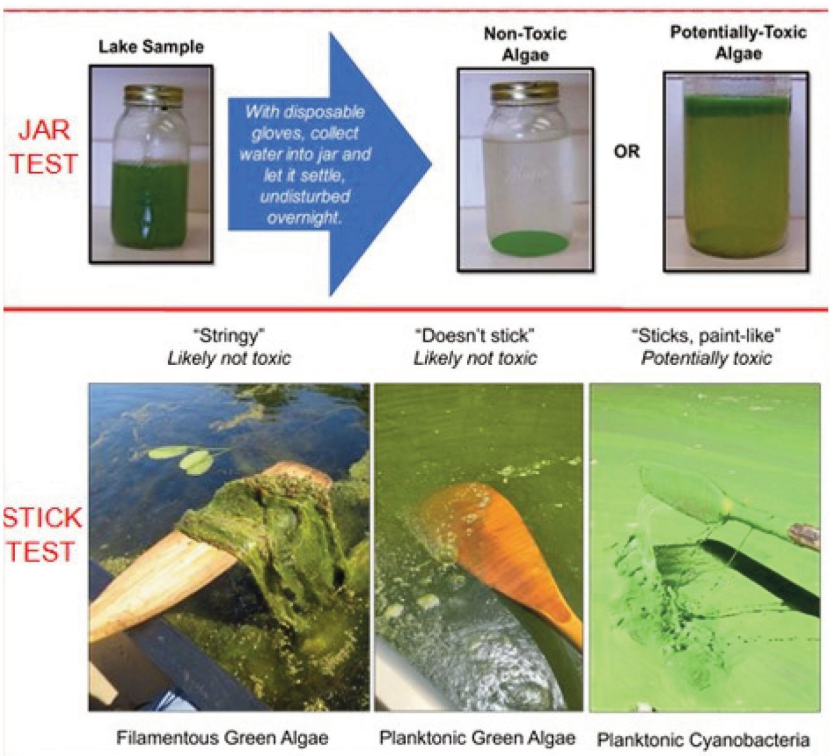

Fig. 4.

To determine likelihood that an algal bloom is potentially toxic,. collect a sample of the bloom, being sure to wear disposable gloves and place in a refrigerator overnight. If when checking the jar after 24 hours, there is a clear layering at the bottom, it is likely not toxic. If the layer floats to the top, it is potentially toxic. If the lake sample does not produce layering, transfer a small amount of the water to a new jar and fill with regular water to dilute it. Repeat until you see layering. The "stick (or paddle) test" (bottom) to determined whether a surface scum of algae is potentially toxic. If the algae pulled up stays on the stick and hangs off, it is likely non-toxic. If the stick moves through the scum and you pull it out and no algae sticks to the stick, it is likely nontoxic. If you pull it through the water and it appears to be covered like a paint, it may be toxic.

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Just because you have a cyanobacteria bloom in the lake at a given time, it does not necessarily mean it is producing toxins. Sometimes they produce toxins and other times they do not. Scientists are still working out why this is the case, but so far have not been able to come up with a satisfactory answer. For this reason, we say that types of cyanobacteria that can produce toxins are potentially toxigenic. There are test sticks you can buy online specific for the toxins that can give you some indication of whether there are toxins in the water at any time in high enough concentration to cause problems.
Under most conditions, nonbacterial algae outcompete cyanobacteria, and you have more of the former compared to the latter. Nonbacterial algae are better at using nutrients in water and getting to light when compared with cyanobacteria under most conditions. Three main conditions lead to cyanobacteria outcompeting non-bacterial algae, which can lead to blooms.

First, cyanobacteria will bloom under prolonged still-water conditions. With little to no water movement, nonbacterial algae will begin to sink while the cyanobacteria will use their gas vacuoles to float to the top. Still conditions will occur in wind-sheltered areas of the lake and during prolonged periods of heat with little wind. During these periods or in these locations, creating some water movement such as with an Aquathruster or other aeration system may help with keeping the cyanobacteria down. Second, cyanobacteria will outcompete nonbacterial algae if nitrogen levels in the water become temporarily reduced. This does not happen often but can occur for short periods of time as the nonbacterial algae gobbles up all available nitrogen. Cyanobacteria can actually use nitrogen from the air, something nonbacterial algae cannot do. Third, in lakes with zebra mussels, zebra mussels preferentially eat the nonbacterial algae and leave Cynobacteria behind. Cyanobacteria are not palatable to them. As a consequence, lakes with zebra mussels often see a reduction in nonbacterial algae with an increase in frequencies of cyanobacteria blooms. As zebra mussels have arrived in the Chain of Lakes recently, the future may show an increased rate of cyanobacteria blooms.
I realize this all may seem a little scary but keep a few things in mind. First, cyanobacteria have always been part of lakes worldwide and a variety of them are always in the water at low levels. This is not necessarily a new threat. If you have not seen the consequences to this point, it is likely that will continue to be the case going forward. Second, even if cyanobacteria can potentially produce toxins, they may not, even when they are dense. Finally, known sicknesses and/or death of pets much less human is not highly reported. So, while cyanobacteria have the potential to cause problems, it does not seem to happen often. Nonetheless, the general adage of "When in doubt stay out!" is a good one to live by.

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