NEWSLETTER OF THE LAKES OF MISSOURI VOLUNTEER PROGRAM

The Water Line

Volume 15 Number 1

BLUE-GREEN ALGAE

In late June 2011 the Grand River Dam Authority (GRDA) issued a press release warning of the dangers of exposure to blue-green algae and strongly discouraging people from swimming in Oklahoma's Grand Lake of the Cherokees. This warning fell short of being an official lake closure and came just before the busy and economically important 4th of July weekend. Some felt the GRDA was overreacting and that the economy of the lake region would be devastated, but the decision was justified when Oklahoma senator James Inhofe became, in his words, "deathly sick" after swimming in the lake.

The hot, dry weather of 2012 has been blamed for similar toxic algae events across the nation. Kansas has been hit particularly hard. As of this writing six Kansas lakes have posted warnings saying that they are closed for direct water contact and another six have posted advisories discouraging direct contact with the water because of blue-green algae. Closer to home, the threat of blue-green algae recently caused the city of Nevada, Missouri to issue an advisory urging individuals and their pets to avoid contact with the water at Radio Springs Lake.

This newsletter is entirely about blue-green algae and has been developed into a blue-green algae informational webpage at lmvp.org/bluegreen. Because of the many color photographs and even some videos, this newsletter is best viewed online (www.lmvp.org). If you currently receive the printed version and would like to switch to electronic only, let us know via an email to tony@lmvp.org.

IN THIS ISSUE

Above: A blue-green algae bloom. If you encounter something like this, stay out of the water!

Above: A warning sign used by the Massachusetts Department of Conservation and Recreation and Massachusetts Department of Public Health.

Background

First things first, blue-green algae are not algae at all; they are bacteria capable of photosynthesis. A commonly used term for blue-green algae is cyanobacteria, and while it's technically a more accurate name, we'll use the term blue-green algae in this article.

Billions of years ago, early blue-green algae formed dense mats in shallow seas and generated oxygen as a by-product of photosynthesis. This ultimately changed the atmosphere of the planet, allowing the evolution of oxygen-breathing organisms. Fossilized mounds of blue-green algae (called stromatolites) are quite common and can be found in Missouri. Today, there are about 3,000 species of blue-green algae on the planet, and they can be found nearly everywhere. Depending on the species, they can grow in water, on land and symbiotically inside and on other organisms. Some blue-green algae are even eaten by humans (e.g. Spirulina).

Nitrogen Fixation

Many blue-green algae are capable of pulling nitrogen from the atmosphere and making it biologically available, a process called nitrogen fixation. One species of nitrogen-fixing blue-green algae lives symbiotically with the aquatic plant Azolla. The Azolla plant gets the benefit of "free" nitrogen and the blue-green algae get carbon from the Azolla. This relationship is put to good use by rice farmers, who for thousands of years have cultivated Azolla (and the associated blue-green algae) to fertilize their paddies. Azolla is commonly found in Missouri.

Buoyancy Regulation

Many blue-green algae have the ability to move up or down in the water column. The benefit is that the cells can put themselves where they are likely to grow fastest. This is accomplished by the presence of gas vacuoles, or cavities, in the blue-green cells. While in the sunlight and photosynthesizing, all algae (and plants) are producing carbohydrates for respiration. As this happens, the pressure within the cell increases and the gas vacuoles collapse. Then the cells become more dense and start to sink toward the bottom of the lake. In the deeper, darker water the cells consume oxygen to break apart carbohydrate molecules for energy and release carbon dioxide and water (a process called respiration). As the carbohydrates are used up, pressure in the cell is reduced and the vacuoles fill up with gas, bringing the blue-green algae toward the surface again. Massive numbers of blue-green algae rising to the surface at once will lead to a noticeable bloom (as shown in the photo below).

Toxin Production

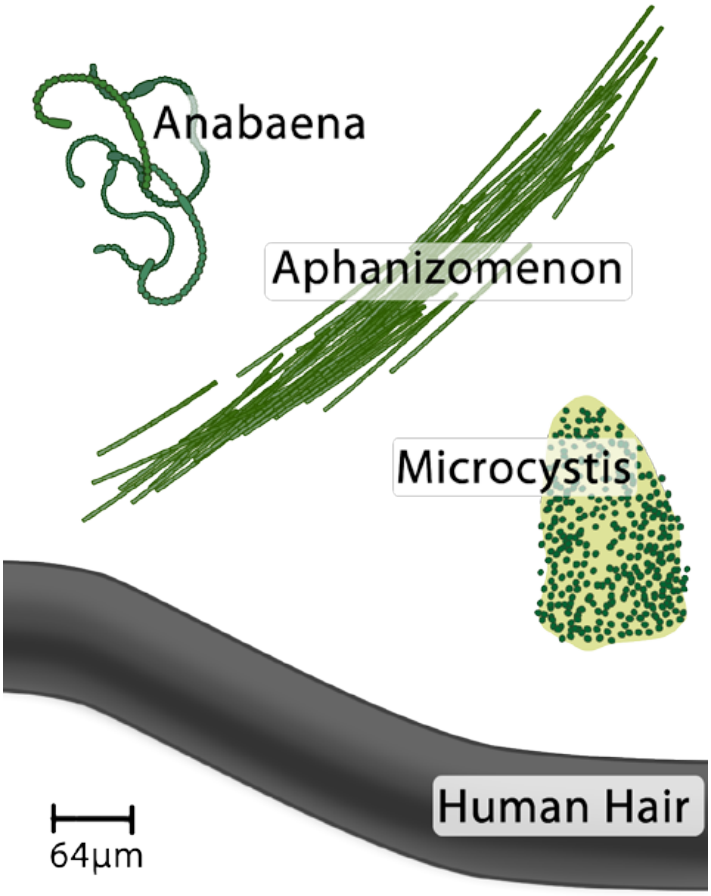
Another interesting ability of some blue-green algae species is the ability to produce toxins, a characteristic that has captured the attention of agricultural, environmental and human health groups across the world. While human fatalities are rare, livestock and wildlife are more com-

Above: Azolla in a Missouri lake. This is an aquatic plant, but has (non-toxic) blue-green algae living symbiotically within it.

Above: A 64 µm net sampling a blue-green algae bloom at Binder Lake, Iowa.

monly affected. Depending on the species of blue-green algae, toxins produced can affect the liver, nervous system or skin. Humans typically experience gastrointestinal problems, nausea or skin irritation when exposed to blue-green algae toxins. Not all species produce toxins, and those that can produce toxins only do so under certain environmental conditions. Because a laboratory test is required to check for the presence of cyanotoxins, it's best to stay out of any waterbody that is experiencing an algae bloom.

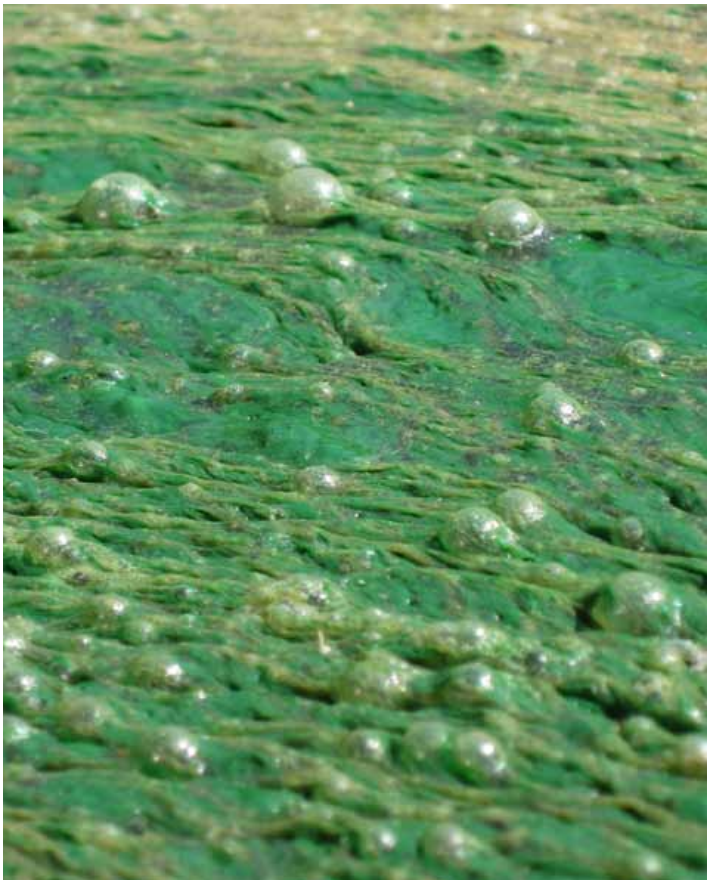
The toxin-producing blue-green algae tend to form colonies that are somewhat large (see illustration below). When large colonies are present the probability is high that toxins will also be present. One simple test involves passing water through a 64 µm mesh net. Small individual cells will pass through the net while larger colonies and aggregated cells will be caught in the mesh. A University of Missouri study showed that *in lakes where blue-green colonies larger than 64 µm were collected*, 98% had detectable microcystins (a common blue-green algal toxin). The study found that microcystin concentrations were generally low across Missouri, but could occasionally cause concern. The World Health Organization recommends that drinking water have less than 1 µg/L of microcystin-LR, the most common blue-green toxin. When detected, maximum concentrations in the Ozarks were 0.05 µg/L, 0.2 µg/L in Missouri's western plains and 2.9 µg/L in its northern plains.



This illustration shows 3 of the most common genera of toxin-producing blue-green algae. While the individual cells are quite small, the colonies and aggregated colonies are considerably larger. For comparison, a human hair is shown at a width of 80 µm.

If colonies of blue-green algae larger than 64 µm are present, it is very likely that toxins are present.

The toxins are released as the cells break apart, or lyse. In-lake chemical treatments will reduce the number of blue-green algae cells, but could ultimately increase the amount of toxin in the water by destroying the cells. Most drinking water filtration plants can remove the toxins at the water plant using activated charcoal. Boiling and other home treatment methods don't work and may actually increase the water's toxicity by breaking apart the blue-green algae cells.



CYANOTOXINS

The toxins produced by blue-green algae are called cyanotoxins. There are many different cyanotoxins, but most fall within the following two categories:

- Neurotoxins (affect the nervous system)
- Hepatotoxins (affect the liver)

Human Health Concerns

Drinking water concerns are largely addressed through treatment at the water treatment plant. The effect of toxins on swimmers is of greater concern. If a lake or river appears to be experiencing an algae bloom of any kind, don't swim in it. It's also a good idea to shower off after swimming in any natural water body.

Pet Health Concerns

Because they don't hesitate to drink and swim in waters experiencing blooms, pets and livestock are more susceptible to blue-green toxins than humans. In some cases, death can come quickly, within minutes. The best protection for your animal is to keep it away from water with visible blooms and to bathe it immediately after suspected exposure to blue-green algae.

Human exposure to cyanotoxins can result in:

- Skin rashes, red skin, hives or blisters
- Irritation of the eyes and nose, sore throat, earaches and breathing problems
- Abdominal cramping, diarrhea, vomiting, headache, fever, muscle weakness. In extreme cases, pneumonia, liver damage and kidney failure have been reported.

How to treat people or animals that have been exposed to cyanotoxins:

- If you do come into contact with contaminated water, rinse off with clean, fresh water as soon as possible.
- Pets that have been swimming in an area with an algae bloom may ingest significant amounts of toxins by licking their fur after leaving the water. Thoroughly rinse off your pets with clean, fresh water.
- Seek medical treatment ASAP if you think you, your pet, or your livestock might have been poisoned by toxic blooms.
- Remove people from the exposure and treat the symptoms.

Courtesy the Ohio Department of Natural Resources

Left: A blue-green algae bloom near the University of Missouri in Columbia

ALGAE BLOOMS

A diverse environmental community is composed of many different species living together and competing for resources in a "checks and balances" arrangement. Sometimes one species will gain an advantage over its competitors and flourish. Numbers of that species will increase until some resource becomes limiting and the population eventually returns to normal. For species that grow and reproduce slowly, humans for example, this process can take a rather long time. For fast growing organisms like true algae or blue-green algae, this can seem to happen overnight. We see this often on Missouri lakes. One day the lake will be beautiful and the next day the lake is green. It usually takes a few days or weeks for the lake to return to normal. Algae blooms will subside when a nutrient becomes limiting or if there's a strong enough wind to mix the top thermal layer of the lake (epilimnion). Viruses are also important in algal bloom regulation.

Both true algae and blue-green algae are capable of blooming and in some lakes may do so multiple times during a year. Green algae tend to be more prominent in the spring and early summer, while blue-green algae blooms are most common in the summer. Either type of algae is capable of blooming during any season, however. In Missouri, blooms of blue-green algae have been observed through fissures in lake ice.

Blue-green blooms are often accompanied by a film or scum on the surface of the water. Water with surface scums or films should be avoided by humans and pets. Blue-green algae blooms are typically green and often make the water look like pea soup or as if someone has spilled green paint on the water. Some blue-green blooms look like green curds floating in the water, others look like burgundy wine. Often, blue-green blooms will be accompanied by an "earthy" odor similar to freshly cut grass.

The dangerous toxins produced by some species of blue-green algae can be difficult to detect. A microscope is often required to determine if a particular bloom is composed of blue-green algae, and chemical tests to determine if toxins are present are traditionally expensive and time-consuming. Improvements are being made as the demand for inexpensive, simple analyses increases.

Even experts need tools to determine if lake water is safe to swim in during an algae bloom. The best plan is to play it safe.

When in doubt, STAY OUT!

Left: This photo of a winter bloom of the blue-green algae *Planktothrix rubescens* was taken near Kansas City. The algae formed red flower shapes as it seeped through fissures in the ice.

US Environmental Protection Agency Region VII, through the Missouri Department of Natural Resources, has provided partial funding for this project under Section 319 of the Clean Water Act.

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