

ALGAE, CYANOBACTERIA AND WATER QUALITY

March 2002

INTRODUCTION

Algae and cyanobacteria are tiny organisms that occur naturally in saltwater and freshwater. Individual organisms can often only be seen under a microscope, although with some species, individuals can join together to form colonies visible to the naked eye. It is important to understand the similarities and differences between algae and cyanobacteria as both groups can have distinct impacts on surface water quality.

ALGAE

Algae belong to a large group of organisms called eukaryotes - a Latin word meaning 'true nucleus'. They store their genetic material in a tiny, membrane-bound structure called a nucleus. Algae are divided into groups that reflect the colour most commonly exhibited by members, although not all will be the definitive colour. For example most green algae are green, but some are brown, red, orange, or yellow. Although there are many types of algae, only some groups are important in terms of the impact they can have on freshwater supplies.

Table 1- Groups of algae commonly occurring in freshwater systems:

Scientific Name	Common Name
Chlorophytes	Green algae
Cryptophytes	Cryptomonads
Dinophytes	Dinoflagellates
Euglenophytes	Euglenoids
Bacillariophytes	Diatoms
Chrysophytes	Yellow-green algae

CYANOBACTERIA

Cyanobacteria are members of a group known as eubacteria or true bacteria. For a long time they were not recognized as bacteria, more often being referred to as blue-green algae. All bacteria belong to a group of organisms known as prokaryotes, a Latin word meaning 'before nucleus'. Bacteria have no organized nucleus. Cyanobacteria are classified as bacteria, not algae, since their genetic material is not organized in a membrane-bound nucleus. Unlike other bacteria, they have chlorophyll and use the sun as an energy source. They are often referred to as 'blue-greens', since the first cyanobacteria identified were blueish-green in colour. However, not all members are this colour. Some are olive or dark green, and others are even purplish in colour.

WHY ARE THEY IMPORTANT?

As mentioned, both algae and cyanobacteria occur naturally in surface waters. Although their size is usually microscopic, when conditions are ideal, both can undergo a phenomenon known as **bloom**. This results when the algae reproduce rapidly and the individuals form clumps visible to the naked eye. Heavy blooms can overtake water bodies, and even choke out portions of streams or rivers.

It is difficult to predict when a bloom will occur. However, all blooms require light, nutrients, and oxygen. Some species bloom only in spring, others more frequently in the fall. These organisms can bloom in flowing or standing water. Blooms may even occur under ice in the middle of winter. Large, nuisance blooms commonly form following periods of hot, calm weather when the water is warm. They

are also more likely to occur when water nutrient levels, and in particular phosphorus, are high. Heightened nutrient levels result when water bodies receive runoff or leaching from such sources as: fertilized fields, lawns, poorly managed manure, storm drain discharges, poorly contained septic systems, or soil and sediment transport in runoff water.

EFFECTS ON WATER QUALITY

Large blooms of algae and cyanobacteria can clog intake pipes and filter lines, and are aesthetically unappealing. When blooms of algae or cyanobacteria die and decay, the dead cells often produce objectionable odours as a result of oxygen depletion in the surrounding water. When a bloom dies in a pond or shallow lake, severe oxygen depletion can even cause fish kills.

Algae do not produce substances that are toxic to humans or animals. In contrast, some cyanobacteria produce substances that are extremely toxic, and are capable of causing serious illness or even death if consumed. These substances are called **cyanotoxins**. There are currently over 70 different cyanotoxins, which are grouped by their method of toxicity (Table 2). One cannot tell if a cyanobacterial bloom is producing toxins simply by looking at the bloom. Instead, you should assume toxins are present and avoid using the water.

Table 2 - Cyanotoxins and their occurrence in freshwater

Scientific Name	Type of Toxin	Occurrence in freshwater
Saxitoxin/Neosaxitoxin	Neurotoxin	not common
Anatoxin-a/ Anatoxin-a(s)	Neurotoxin	not common
Microcystin	Hepatotoxin	common
Nodularin	Hepatotoxin	not common

**Note - Neurotoxins affect the nervous system
Hepatotoxins affect the liver

TELLING THEM APART

Algae and cyanobacteria can be identified using a microscope. However, a microscope is not always available to someone standing at the edge of a water body. Blooms of algae or cyanobacteria are often confused with

one another. It is important to recognize how each group blooms. Blooms assume either **planktonic** or **filamentous** forms in water. The following test can be used to distinguish between the two forms:

- Scoop a handful of the bloom with your fingers spread slightly apart. Let the water drain through your fingers and examine what remains in your hand. If long, stringy masses are left dangling from your fingers, it is a **filamentous** form, and most likely a bloom of green algae. If after straining through your fingers all that's left are a few bits sticking to your skin, it's a **planktonic** form and most likely a cyanobacterial bloom. Wash your hands with soap and hot water following the test.

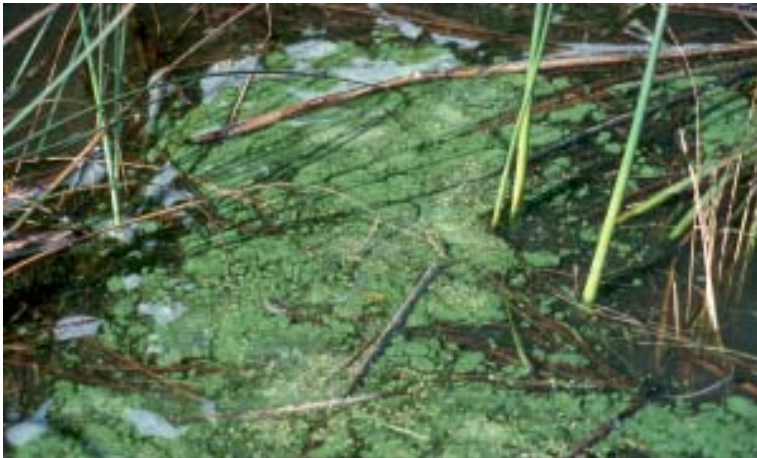
****CAUTION:** this is not a fail-safe method of identification. A qualified person should always be consulted for positive bloom identification. A misdiagnosis could have serious repercussions.



Top: Example of filamentous green algae bloom
Bottom: Example of planktonic cyanobacterial bloom

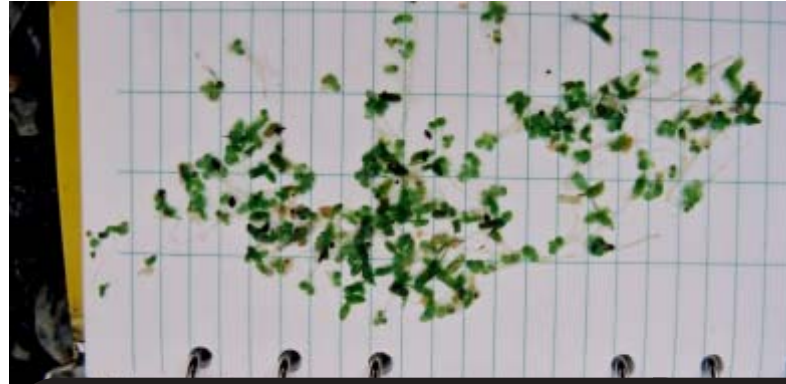
Whereas algae blooms may assume either form, cyanobacterial blooms are almost always planktonic. Therefore if a bloom is filamentous, it is most likely an algae bloom. No toxin-producing cyanobacterial blooms are filamentous. Heavy cyanobacterial blooms often make the water look like pea soup. When cyanobacterial blooms are very large, they tend to form solid looking clumps. A slight swishing with the hand will break up the clump, and the bloom will still easily pass through the open fingers of a cupped hand.

Some species of algae can produce planktonic blooms. An example is diatoms that usually bloom in the spring, colouring the water shades of brown. A film of brown sludge on river rocks in early spring is usually left by diatom colonies. Euglenoids create a powdery film on the water's surface; some can turn the water bright green, similar to that of antifreeze. In intense light, euglenoid blooms shift from bright green to bright red, a pigment response to ultraviolet light stimulation.



Cyanobacteria often clump together, particularly under calm conditions

Occasionally duckweeds are mistaken for algae. Duckweeds are actually small, floating plants, and can sometimes grow to cover entire water surfaces. They are identified by the tiny white root that hangs from their lower surface into the water column. Duckweeds do not produce the pea soup blooms characteristic of cyanobacteria, or produce toxins. Duckweeds are beneficial plants that remove phosphorus from the water, and can dominate over cyanobacteria and algae if conditions are suitable.



Duckweeds are not algae or cyanobacteria. Duckweeds can be identified by the tiny white root that hangs from their lower surface into the water column

TREATMENT OPTIONS

The first treatment step should always be bloom prevention. Natural surface water will occasionally bloom regardless of the best efforts at prevention, but the frequency and severity of the bloom can be reduced by using good management practices. Runoff should be controlled to minimize fertilizer and/or waste inputs, and livestock should not be permitted to water directly from surface water sources. Water should be kept as nutrient-free as possible.

Aeration can also be a valuable tool in combating blooms. Good aeration keeps the water moving and maintains a more constant temperature from top to bottom. This helps to prevent extremely warm layers of water from forming at the surface during the hot summer months. Aeration also prevents severe oxygen depletion initiated by the death and decay of an algal bloom. Although algae may still bloom with aeration, cyanobacteria do not thrive in moving water. Cyanobacteria tend to bloom under warm, calm conditions. Proper aeration helps to prevent these conditions from occurring.

If a bloom begins to form in a surface water source, determine the size and type of the bloom. If it is a filamentous bloom, there are a few options. Small filamentous algal blooms close to shore can be removed with a rake or hoe and placed away from the watershed area to prevent re-entry of the dead bloom into the water. Filamentous algae decompose easily, and can be used for compost if combined with other materials to increase air circulation.

Large blooms of planktonic or filamentous organisms are more difficult to handle. If the situation is severe, there are a number of chemical options available for treating surface water. Be aware that no chemical treatment is completely effective for long term control. Cyanobacteria can build up tolerance to repeated chemical applications. Chemical application should only be used as a last resort, not as routine maintenance.

Chemical treatment options commonly include one of the following four compounds:

- copper sulphate
- lime (as quicklime, or calcium hydroxide)
- alum (as aluminum sulphate)
- ferric chloride

Lime, alum and ferric chloride are all coagulants - they bind with suspended and dissolved particles to form clumps that settle to the bottom of the dugout. This includes binding with algae and cyanobacteria. Copper sulphate, also known as bluestone, kills cyanobacteria, yet is only marginally effective on algae. Following treatment, the dead cells settle to the bottom. There are advantages and disadvantages to each method of chemical control. If the dugout to be treated contains fish, great care should be taken when applying any chemical.

TREATMENT RESULTS

When treating a bloom, one should assume that cells in the bloom have burst and released their contents. If the cells are algae, there will be no toxic contents. **However, if the cells are cyanobacteria it is safe to assume that toxins were released into the water. A minimum two week period between chemical treatment and water consumption allows time for the released toxins to degrade. People, livestock, and any family pets should avoid drinking the water during this time.** It is not possible to test for all toxins. Microcystin LR is one common toxin that can be tested at some laboratories.

AUTHORED BY: N. SCOTT, PFRA

FUNDING: Strategic support and funding for this project has been provided by the Canada-Saskatchewan Agri-Food Innovation Fund (AFIF).

ENDORSEMENT: This report should not be taken as an endorsement by PFRA or Agriculture and Agri-Food Canada of any of the products or services mentioned herein.

THE BIG PICTURE

Both algae and cyanobacteria are commonly found in surface water. Although both groups bloom naturally, the size and number of blooms increase with certain human and agricultural activities. Cyanobacterial blooms pose a larger health threat due to the possibility of them producing potent toxins. When cyanobacteria are present, assume the water has toxins and do not use it for domestic or livestock purposes. Careful planning and management practices will help limit repeat, nuisance blooms. A good management plan will include items such as restricted livestock access, careful monitoring, aeration, and chemical control as a last resort.

For further information on rural water quality and treatment technology:

- read the other publications in PFRA's **Water Quality Matters** series;
- visit the PFRA Web site at www.agr.gc.ca/pfra ;
- read *Prairie Water News*, available from PFRA or on the Internet at www.quantumlynx.com/water ; or
- **contact your local Prairie Farm Rehabilitation Administration Office** (PFRA is a branch of Agriculture and Agri-Food Canada).