THE GOOD, THE BAD & THE MANAGED:

How to Identify and Manage Algae Scums In Agricultural and Residential Ponds.

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Dedication

This guide is dedicated to the memory of Mary Kathryn Dickerson, District Coordinator for Boone, Kenton and Campbell Conservation Districts, who inspired the original "Field Guide to Pond Scums".

Here hunts the heron, queen of the pond,
that spears the fish
that swallows the frog
that gulps the bug
that nabs the nymph
that drinks the flea
that eats the algae, green and small
in the depths of the summer pond.

Sidman, Joyce. 2005. Song of the Water Boatman and Other Pond Poems.

Introduction

How to Use this Guide

The guide includes pictures and identification information for the most commonly seen organisms forming blooms or “scums” on ponds or lakes in Ohio, Kentucky, and Indiana, including aquatic plants, algae, and other microscopic organisms. However, most of the information in this guide pertains to the identification of algae.

The guide starts with the most commonly observed aquatic plants: the duckweeds, water meal, and water ferns. Although these are not technically algae, they are of concern because they can form scums that completely cover ponds. Algal groups are presented after the aquatic plants and include the following groups: blue-green algae, diatoms, euglenas, dinoflagellates, golden algae, and filamentous green algae. Algae with very similar characteristics are grouped in the same genus (pl. genera). This manual includes the most common algae genera found in the groups outlined above. These groups are also listed in Table 1, found on page 8. Any genus of algae capable of producing toxins is highlighted in **red**. Following the algae are photographs of bacterial, protozoan and zooplankton scums, which are caused by other types of organisms.

Because different types of organisms can form scums that look very similar, field identifications should ideally be verified using a microscope. Microscopic photographs of these organisms are provided for this purpose. This guide is intended to be used only as a “picture key”. Additional verification with more complete taxonomic keys is also recommended. This guide includes only the most common algae and other freshwater scums found in Kentucky, Ohio, and Indiana. It is not intended to be a comprehensive field guide for the United States.

At the end of the guide is a summary of common Best Management Practices (BMPs) that can be used by farmers, landowners and conservation professionals to manage healthy ponds and to control harmful algal blooms, as well as recommended resources and literature.

The GOOD and the BAD about Algae

A healthy pond is a living ecosystem that includes diverse communities of algae, aquatic plants, and animals. Algae and aquatic plants are producers that form the first link in aquatic food chains. They capture carbon dioxide and use energy from the sun during photosynthesis to create complex carbohydrates, which are stored as food reserves or used immediately for growth. Oxygen is created as a byproduct of this process and is released into the pond and into the air we breathe. Without algae, life would not exist in a pond, or on the earth!

Algae and aquatic plants are, in turn, eaten by crustaceans, insects, fish, and other wildlife (consumers), which create waste that is broken down into nutrients by bacteria and other decomposers in the water. Those nutrients are then recycled back into the aquatic ecosystem where they are taken up by aquatic plants and algae, starting the process over again.

Unhealthy ponds typically occur when the ecosystem is out of balance due to an influx of nutrients that favor only one or a few species. This influx of nutrients is what primarily fuels algal blooms and can cause an increase in nuisance plants. Algal blooms usually appear during the summer and fall in temperate regions. The sources of nutrients can be fertilizers, sewage, animal waste, and even some herbicides and pesticides.

Along with algal blooms can come oxygen deficits, as bacteria and other decomposers use up oxygen in the process of breaking down dead algae. Of significant concern are algal blooms that are capable of producing toxins that can be harmful, even lethal, to fish, pets, livestock, and wildlife. Some of these toxins are even harmful or carcinogenic to humans. Most of these toxins are secondary metabolites, produced only when a given species reaches very high population levels. These types of algal blooms are referred to as harmful algal blooms, or “HABs”. While there are many different types of algae that are capable of producing toxins, most HABs in freshwater ponds are caused by Cyanobacteria, also known as blue-green algae.

More about Algae and How They are Classified

The word “algae” refers to all simple organisms that lack roots, stems, or leaves, but like higher plants, have photosynthetic pigments, including chlorophyll a. This definition is very broad. Many organisms are lumped into this definition because they are small, green, photosynthetic, and are not considered plants or animals. This manual will separate out the six major groups of freshwater algae by their taxonomic classifications and unique features, which are summarized in Table 1. (page 8)

The blue-green algae **(Cyanobacteria)** are true bacteria that have photosynthetic pigments. They are like all other bacteria because they lack cell organelles and their DNA is not enclosed in a nucleus. The technical term for this is "prokaryotic". They are important because some species fix nitrogen from the atmosphere and make it available to the ecosystem, and under the right circumstances, some species can produce toxic harmful algal blooms (HABs).

The algae also include a variety of other simple organisms that, unlike bacteria, have organelles (a nucleus or chloroplast). They are "eukaryotic". Among these, the diatoms **(Bacillariophyta)** are characterized by having beautifully intricate cell walls made up of silica (glass). In many aquatic ecosystems, they are the most productive base of the food chain. The next three groups of eukaryotic algae are defined by the whip-like structures (flagella) they use to propel themselves through the water. The euglenas **(Euglenophyta)** lack cell walls and often have a flexible shape. They are important as scavengers, but they can also photosynthesize. They can also form toxin-producing HABs. The dinoflagellates **(Dinophyta or Pyrrophyta)** have two perpendicular flagella inside grooves in their cellulose cell wall. They are significant because they channel large amounts of energy into the food chain by both scavenging and photosynthesizing. However, they can form HABs known as red tide. The golden algae **(Chrysophyta)** have two unequal flagella and may have silica scales. These organisms are also a big part of the food chain and can generate HABs that kill fish.

The eukaryotic algae that are most closely related to higher plants are the green algae **(Chlorophyta)**. This is a very diverse group that has many forms. Some are filamentous branched, and unbranched, while others are single-celled. Some, like *Volvox*, are round and can form quite large colonies.

Maximizing the Good and Minimizing the Bad in the Pond

The best way to manage healthy populations of algae in a pond is to employ Best Management Practices (BMPs) that control the influx of nutrients. These are discussed in detail, beginning on page 24. Chemical treatment methods are not recommended for eliminating algal blooms or scums because they can be toxic to aquatic life. Some algae are also capable of using phosphate-based ingredients in commonly-used aquatic herbicides as a nutrient, which may ultimately fuel more growth. Luckily, there are many effective methods for managing ponds and algal blooms that do not involve chemicals.

A healthy pond ecosystem is a constantly changing marvel. As the seasons change, so will the algal composition of the pond. A properly managed pond can be a long-lasting source of beauty in your landscape, a habitat for wildlife, and with a microscope, a source of new discoveries in the world of microalgae!

Table 1. Freshwater Algae Classification

Algae Group	Good	Bad
Domain Bacteria		
Blue-green Algae (Cyanobacteria)	Produce oxygen for the atmosphere. Some contain bioactive compounds for potential medical use. Some used as biofertilizers. *Spirulina* and *Arthrospira* used as food supplements and antioxidants.	Many genera can produce toxins, including hepatotoxins (liver toxins), neurotoxins, cytotoxins (cell toxins), dermatoxins (skin toxins), respiratory and olfactory irritant toxins. Some cause allergic reactions. Some produce taste/odor compounds that are problematic for drinking water treatment.
Domain Eukarya		
Euglenas (Euglenophyta)	Some contain anticancer agents. Contain paramylon, a complex carbohydrate used to boost the immune system and treat arthritis.	*Euglena sanguinea* can produce ichthyotoxins (fish toxins). Can be indicators of organic pollution.
Golden Algae (Chrysophyta)	Some used in agriculture as feed supplements.	Some produce taste and odor compounds. *Prymnesium* can produce toxins.
Diatoms (Bacillarophyta)	Most important in aquatic food chain. Produce Omega-3 fatty acids. Used in biofuel production and bioremediation efforts.	Some clog filters during drinking water treatment. *Pseudonitzschia* can produce neurotoxins (in salt/ brackish water only).
Dinoflagellates (Dinophyta or Phyrrophyta)	Produce Omega-3 fatty acids. Some have antifungal compounds.	Some cause “red tides” and produce ichthyotoxins, neurotoxins and dermatoxins.
Green Algae (Chlorophyta)	Found in may food supplements and contain antioxidants. *Chlorella and Haematococcus* are sources of the antioxidant astaxanthin. Most are sensitive to pollution, so they indicate good water quality.	Blooms can still cause problems for healthy pond systems as they decay.

Floating Macroscopic Plants

The "Duckweeds", Watermeal and Water Ferns


A. Lemna, Spirodella and Wolffia


B. Lemna


C. Lemna


D. Wolffia

Free-floating duckweeds (*Lemna, Spirodella)* and watermeal *(Wolffia)* can attain nuisance levels in ponds (**A**). Duckweeds and watermeal often occur together. Their leaves are disc-like, 2-5 cm long, with small roots on their underside. *Lemna* (**B**, **C**) is most common. *Wolffia* (**D**) is the smallest flowering plant in the world. *Spirodella (not shown)* has a red underside. They require quiet, nutrient-rich water. They reproduce by a very rapid method called "budding", allowing them to cover ponds in a few weeks under summer conditions. Blooms can be reduced by aeration and nutrient reduction.

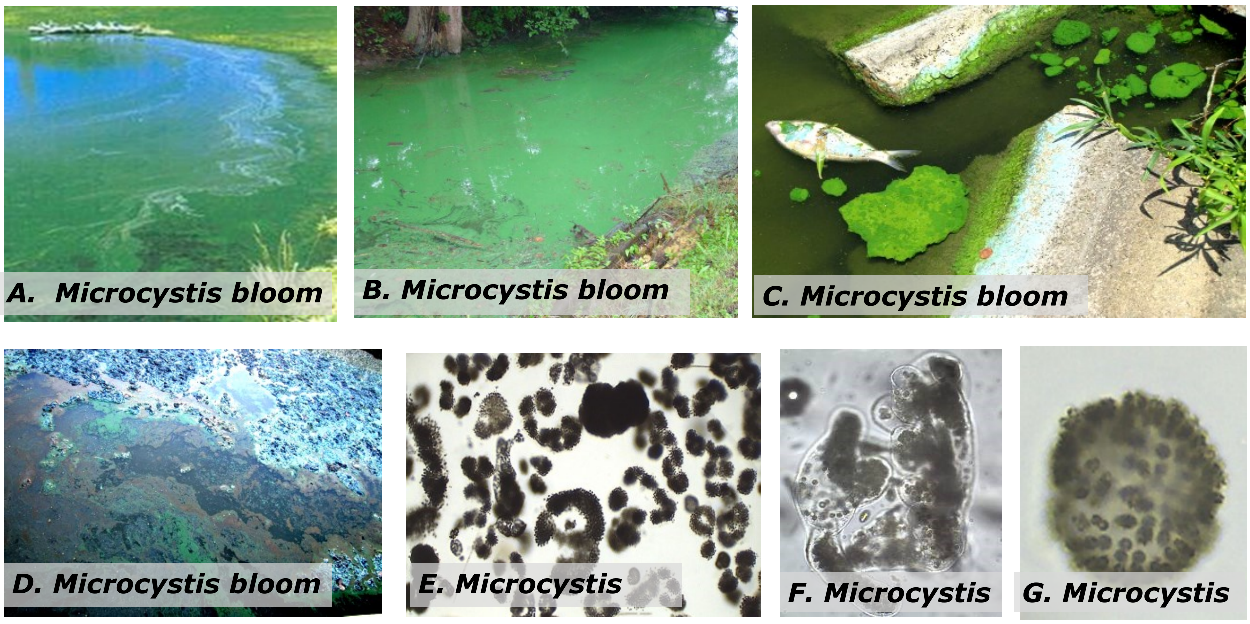

E. Azolla


F. Azolla

Water fern (*Azolla)* is also known as mosquito fern, duckweed fern or fairy moss. It covers farm ponds with reddish, scale like leaves (**E**, **F**). Roots hang in the water and have a symbiotic relationship with the blue-green algae *Anabaena azollae* that fixes atmospheric nitrogen. In Asia, it is often used as a biofertilizer for rice paddies. It cannot survive freezing temperatures.

Floating Cyanobacteria (Blue-Green Algae)

Microcystis



A. Microcystis bloom
B. Microcystis bloom
C. Microcystis bloom
D. Microcystis bloom
E. Microcystis
F. Microcystis
G. Microcystis

Microcystis is the most common cause of harmful algal blooms (HABs) in freshwater ecosystems. Blooms often appear like spilled green paint (**A,B**), or pea soup in the water. *Microcystis* blooms can appear suddenly or scattered (**C**) due to gas vesicles that allow colonies to regulate buoyancy and migrate throughout the water column. Some species produce liver toxins (microcystins), that can be lethal to livestock, fish, and humans, and have been linked to liver cancer. They can also cause skin irritation. The toxins are released when cells lyse (break apart). At that time, the bloom appears as a blue-green oily scum (**D**) and has a pig pen odor.

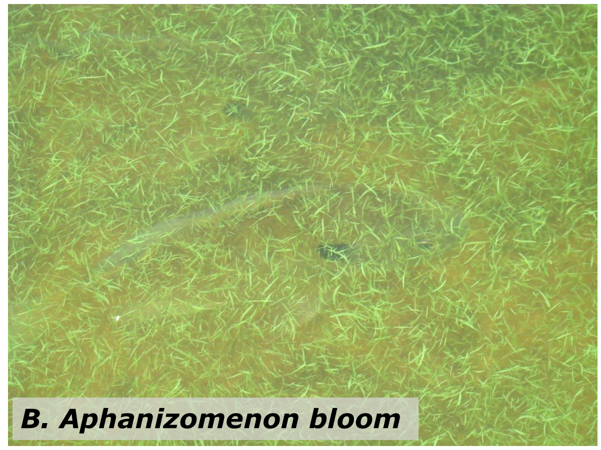
One home owner described it as follows; "*It's Baaaaack!!....So, the Microcystis went away but it came crawling back up the pond yesterday. It was interesting to watch. At 2:30 everything looked normal and at 3:30 I glanced out and the whole lake looked white and soapy like someone threw detergent in it. Then at 4:30 it was bright green again. This morning it is as smelly as ever...*"

Under the microscope, *Microcystis* consists of small round cells surrounded by a gelatinous envelope **(E-G)**. The most common morpho-species, *Microcystis aeruginosa,* forms irregularly shaped colonies that can appear black, due to the optical effects of the gas-filled vesicles **(E).** Other morpho-species can be differentiated by the amount of gel surrounding the colony **(F,G)**.

Floating Cyanobacteria (Blue-Green Algae)

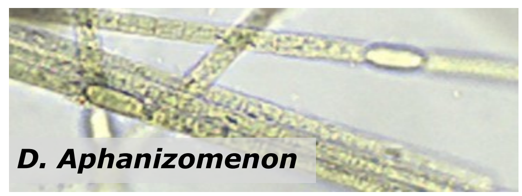
Aphanizomenon

***A. Aphanizomenon* bloom**

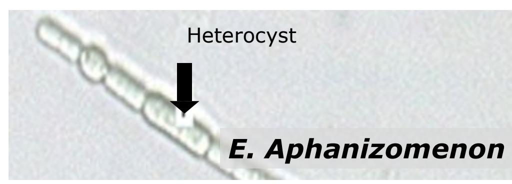


***B. Aphanizomenon* bloom**

C. Aphanizomenon



D. Aphanizomenon



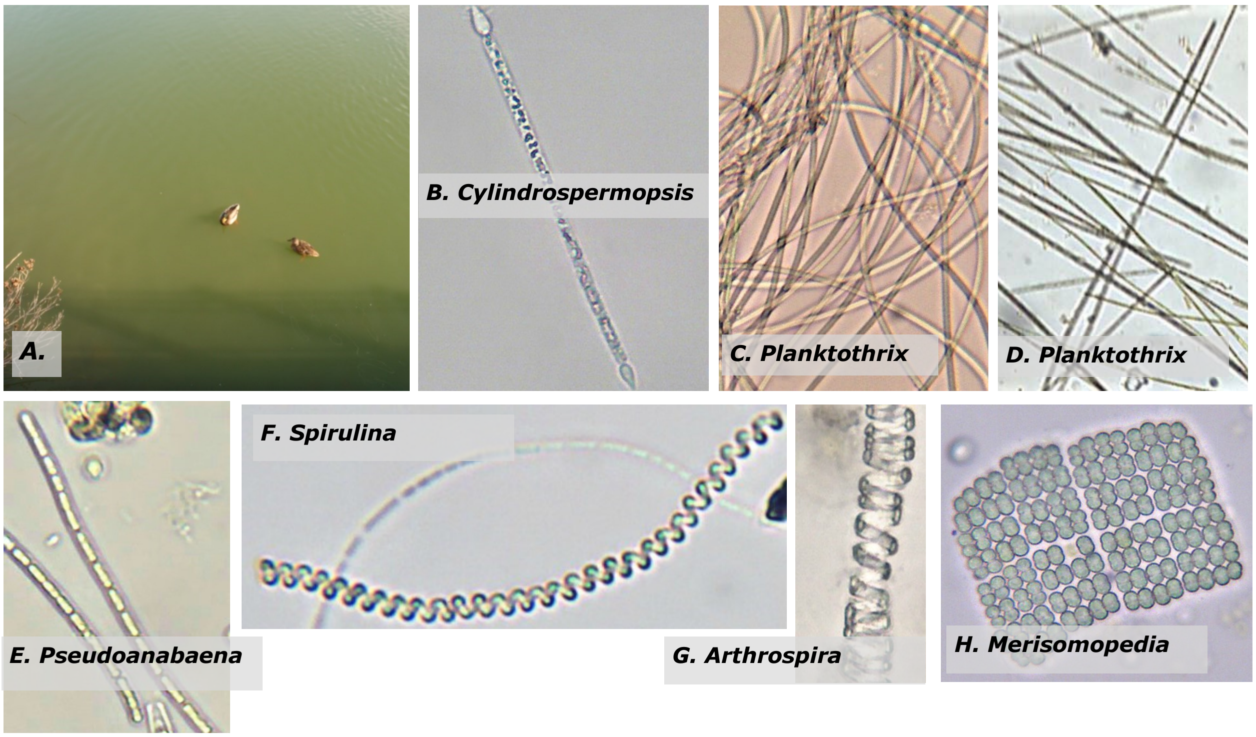
E. Aphanizomenon

Aphanizomenon filaments often clump together on the surface of the water and can look like grass clippings (**A**, **B**) . The filaments have gas vesicles that allow them to regulate buoyancy and migrate throughout the water column. Some species can produce a neurotoxin called saxitoxin, similar to the paralytic shellfish poison that is found in marine environments. *Aphanizomenon* also has been reported to cause skin irritation. The blooms found in North America appear so far to be non-toxic, and some species are sold as a food supplement in natural health food stores.

Colonies under the microscope may appear almost black due to the optical effects of the gas filled vesicles (**C**). *Aphanizomenon* often occurs with *Microcystis* and blooms may alternate. This is because *Aphanizomenon* has heterocysts (**D, E**), specialized cells that fix nitrogen. As Aphanizomenon fixes nitrogen, it can be used by *Microcystis* to gain an advantage over *Aphanizomenon*. When all of the nitrogen is used up, the advantage goes to *Aphanizomenon*.

Floating Cyanobacteria (Blue-Green Algae)

Cylindrospermopsis, *Planktothrix*, *Pseudoanabaena*, *Spirulina*, *Arthrospira*, and *Merismopedia*



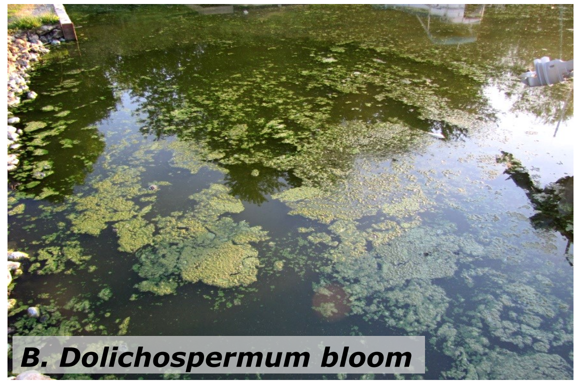
All of these species of blue-green algae color the water brownish-green or dark green when they bloom (**A**).

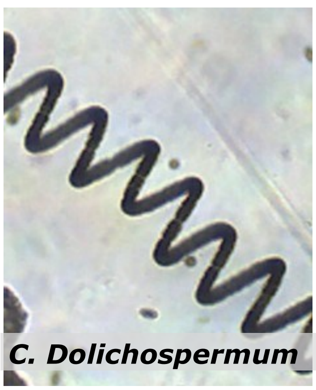
Cylindrospermopsis **(B)** is an invasive species now spread all over the world. It has gas vesicles that allow it to regulate buoyancy and migrate throughout the water column. It produces liver toxins (cylindrospermopsins) and neurotoxins (saxitoxins). It can be identified by a tear-drop shaped heterocyst (nitrogen-fixing cell) found at one or both ends of the filament. *Planktothrix* ***(C,D)*** can produce both liver toxins (microcystins) and neurotoxins (anatoxins). The filaments do not have heterocysts, but may have gas vesicles. *Pseudoanabaena* (**E**), is distinguished by the cylindrical cells that have deep cross-wall constrictions, but filaments do not have heterocysts or sheaths. *Spirulina and Arthrospira* **(F,G)** both have corkscrew-shaped filaments that do best in high salt environments. *Spirulina* filaments lack cross walls, while *Arthrospira* filaments have crosswalls. *Arthrospira platensis* is sold as a food supplement, usually under the name of *Spirulina*. *Merismopedia* **(H)** is distinguished by elliptical cells that are arranged in rows to form a singular square or rectangular plate. Although all cyanobacteria have a potential endotoxin lipopolysaccharide (LPS) in their cell walls, *Pseudoanabaena, Spirulina, Arthrospira* and *Merismopedia* are considered non-toxic.

Floating & Attached Cyanobacteria (Blue-Green Algae)

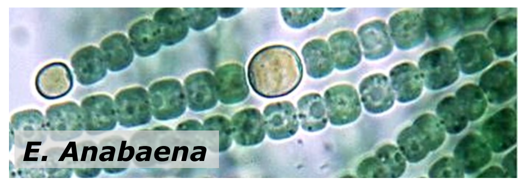
Dolichospermum and Anabaena

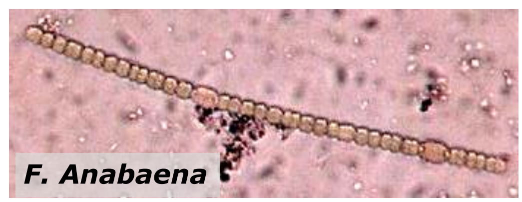

A. Anabaena bloom


B. Dolichospermum bloom


C. Dolichospermum


D. Dolichospermum


E. Anabaena


F. Anabaena

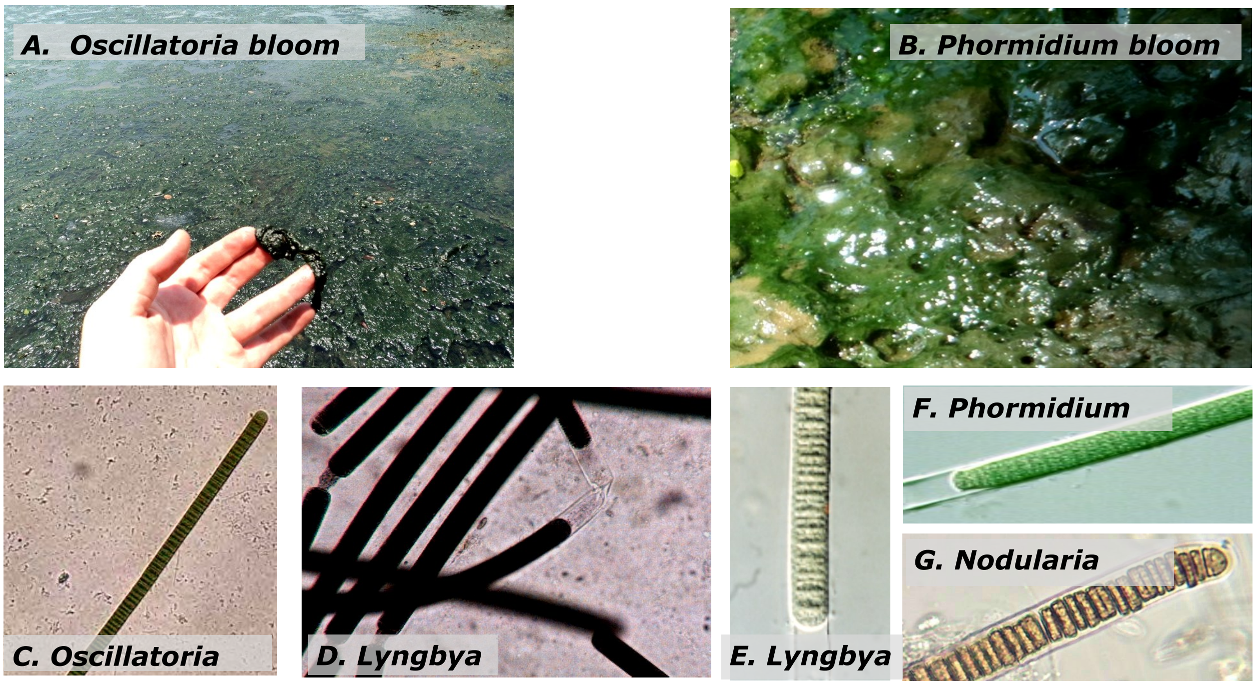
Blooms of *Anabaena* (**A**) *or Dolichospermum* **(B)** may superficially resemble *Microcystis* blooms as the pond may look like pea soup. However, both algae are filamentous, so the bloom is often less dispersed than *Microcystis*. Blooms may give off a pig pen odor. *Dolichospermum* has gas-filled vesicles and can migrate through the water column. *Anabaena* is benthic and therefore usually attached to rocks and other surfaces on the bottom of the pond. It lacks gas-filled vesicles, so it cannot migrate.

Many species of *Dolichospermum* are capable of producing toxins including anatoxin, a neurotoxin, and microcystin a liver toxin. There have been many reports of deaths of pets, wildlife and livestock as a result of *Dolichospermum* blooms. The blooms often occur in phosphorus-rich waters.

Under the microscope, both genera consist of chains of round or sometimes barrel-shaped cells with distinct heterocysts, specialized cells that fix atmospheric nitrogen (**C**,**D**,**E**,**F**). They have a thicker wall than the other cells and are not pigmented. *Dolichospermum* can be straight or spiral-shaped, and often appears black under the microscope due to the optical effects of the gas filled vesicles **(C,D).** *Anabaena* chains are usually straight (**E,F**). (Note: *Dolichospermum* was previously considered to be in the genus *Anabaena*.)

Attached Cyanobacteria

Oscillatoria, Lyngbya, Phormidium, Nodularia



Oscillatoria, *Lyngbya,* and *Phormidium* are found in floating mats, as loose filaments, or attached to rocks. Blooms can range in color from dark blue-green to dark red, brown, green-black or purple (**A**). *Oscillatoria* and *Lyngbya* frequently occur together. *Phormidium* forms thin, tough sheets as compared to the "hairy" films of *Oscillatoria* and *Lyngbya*. However, filaments can best be distinguished under the microscope.

Oscillatoria filaments (**B**) lack a sheath, are not branched, and have no heterocysts, which are specialized cells that lack pigment and fix nitrogen. They may show an oscillating movement. Some species of *Oscillatoria* can produce microcystins, liver toxins and anatoxin-a, which is a neurotoxin.

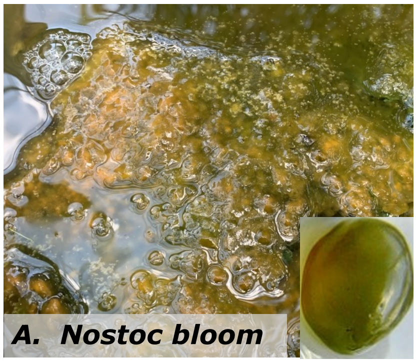
Lyngbya looks very similar to *Oscillatoria* but has a clear sheath (**C**, **D**). It is more likely to be found loosely entangled among shore vegetation. Some *Lyngbya* toxins cause dermatitis.

Phormidium (**E, F**), like *Lyngbya*, has a sheath. It is distinguished from *Lyngbya* by the shape of the terminal cells and the growth form of the macroscopic colony. It usually forms mats that are attached to rocks or vegetation or are "carpeting" the bottom of very shallow ponds or slow-flowing streams.

Nodularia (**G**) also has a sheath. The filaments appear "knobby" and tapering, with cells always wider than tall. Heterocysts appear slightly larger than other cells, sometimes as translucent bubbles in the filament. Some species produce nodularins that are liver toxins.

Attached Cyanobacteria (Blue-Green Algae)

Nostoc


A. Nostoc bloom


A. Nostoc bloom


B. Nostoc

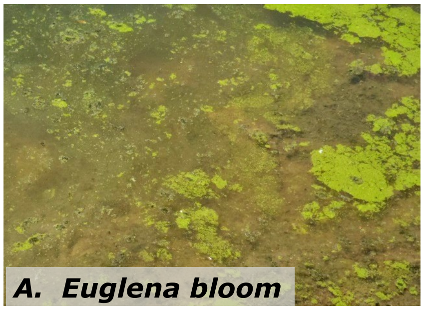
Nostoc forms large, dark green, yellow-green or blue-olive-green jelly-like mats or balls, making it the easiest cyanobacteria to identify macroscopically (**A**). The balls can grow to several centimeters in diameter, and the algae has been called “freshwater grapes”. It can grow in moist soil, cracks in cement, or in the bottoms of ponds, lakes or streams.

Recently, a species of *Nostoc* has been reported to produce liver toxins (microcystins) under laboratory-induced light and nutrient stress conditions. However, *Nostoc* is generally considered non-toxic and is even sold as a food supplement in naturalistic food stores.

Under the microscope, it reveals to be formed of filaments of spherical cells containing heterocysts, which are specialized cells that lack pigment and fix nitrogen (**B**).

Flagellated Algae

Euglena, *Phacus*, *Dinobryon*, *Dinoflagellates*, and *Prymnesium*


A. Euglena bloom

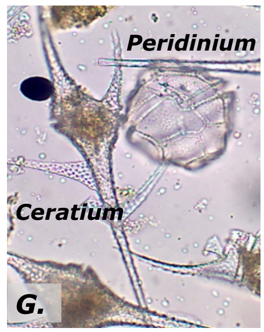

B. Euglena bloom


C. Euglena bloom


D. Euglena


E. Euglena


F. Phacus



G.


H. Dinobryon


I. Prymnesium

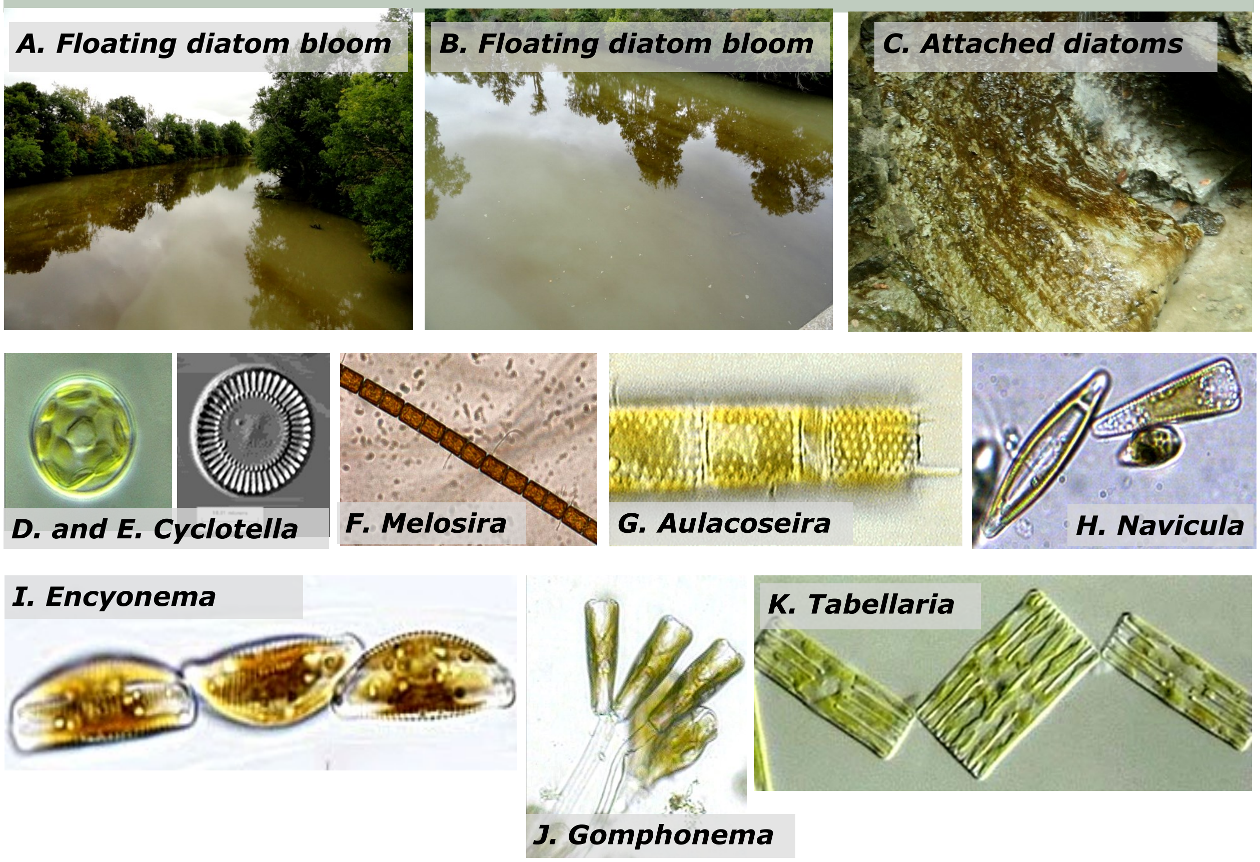
Photo *Prymnesium* by C. Contraras

Euglena are single-celled organisms that can form scums that appear grass-green, red, or mixed red and green (**A**, **B**, **C**). Sometimes they appear, in whole or part, metallic green as a bright green foam or sharply delimited as a surface film. *Euglena* is an indicator of organic pollution. One species (*Euglena sanguinea)* produces a euglenophysin, a neurotoxin that which is similar in structure to fire ant venom. It also has herbicidal properties and can kill fish.

Under the microscope, *Euglena* consists of single, elongated cells with one visible flagellum (**D**, **E**). They lack cell walls but have a flexible pellicle (thin membrane) covering the cell. As the cell moves, one can see it changing shape, appearing almost round at times. A red, light-receptive eye spot is visible in each cell. *Euglena* is an indicator of organic pollution. *Phacus* (**F**) is a close relative of *Euglena* that can be found with *Euglena* scums.

Other flagellates usually do not produce distinct scums, but may color the water yellowish-brown or red. Dinoflagellates (Dinophyta or Pyrrophyta), such as *Ceratium* and *Peridinium* (**G**), have two perpendicular flagella inside a groove in the cell. A few can produce toxins. In marine systems, they are the cause of red tides. Golden algae (Chrysophyta) such as *Dinobryon* (**H**) are notorious for producing taste and odor compounds that pose challenges for drinking water treatment plants. Pond water may smell like cat's urine or have a fishy odor when *Dinobryon* blooms. *Prymnesium* (**I**) is mainly a saltwater organism, but recently has been reported in ponds in Pennsylvania and West Virginia. It is notable because it produces a very fast-acting fish toxin, as well as liver toxins and neurotoxins.

Diatom Blooms



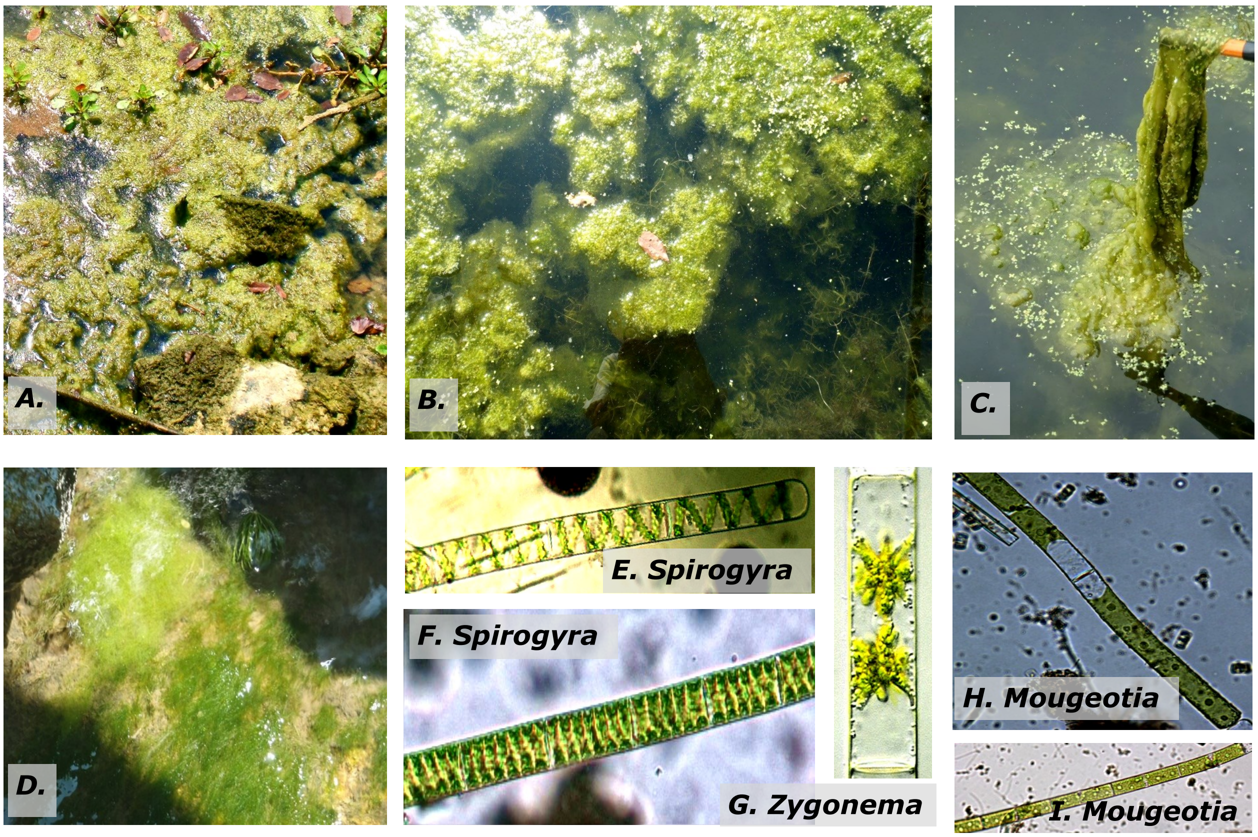
Floating diatom blooms (**A**, **B**) form a brown scum or film, often glistening, on the bottom or the surface of the water, coloring the water. Rarely is this scum evenly distributed. Most commonly, diatoms are found attached to rocks or other surfaces where they appear as a glistening brown or a golden-brown, gelatinous mass (**C**).

Under the microscope, diatoms show a great diversity of shapes and sizes (**D-L**). They have characteristic cell walls made of silica (glass). Some, like *Cyclotella*, appear round **(D,E)**. Some genera form long, cylindrical colonies (**F - K**). Others have long mucilaginous stalks with which they attach to substrates (**I**, **J**). Diatoms store their food as oils that help them to float. Many species have a slit in the cell wall through which they secrete a mucilage that allows them to glide along rocks and other surfaces. This slit is called a raphe.

Diatoms form the basis of aquatic food chains since they are high quality food for zooplankton, which are small, microscopic animals. Different species of diatoms are used by scientists as valuable water quality indicators.

Filamentous Green Algae

Spirogyra, Mougeotia and Zygnema

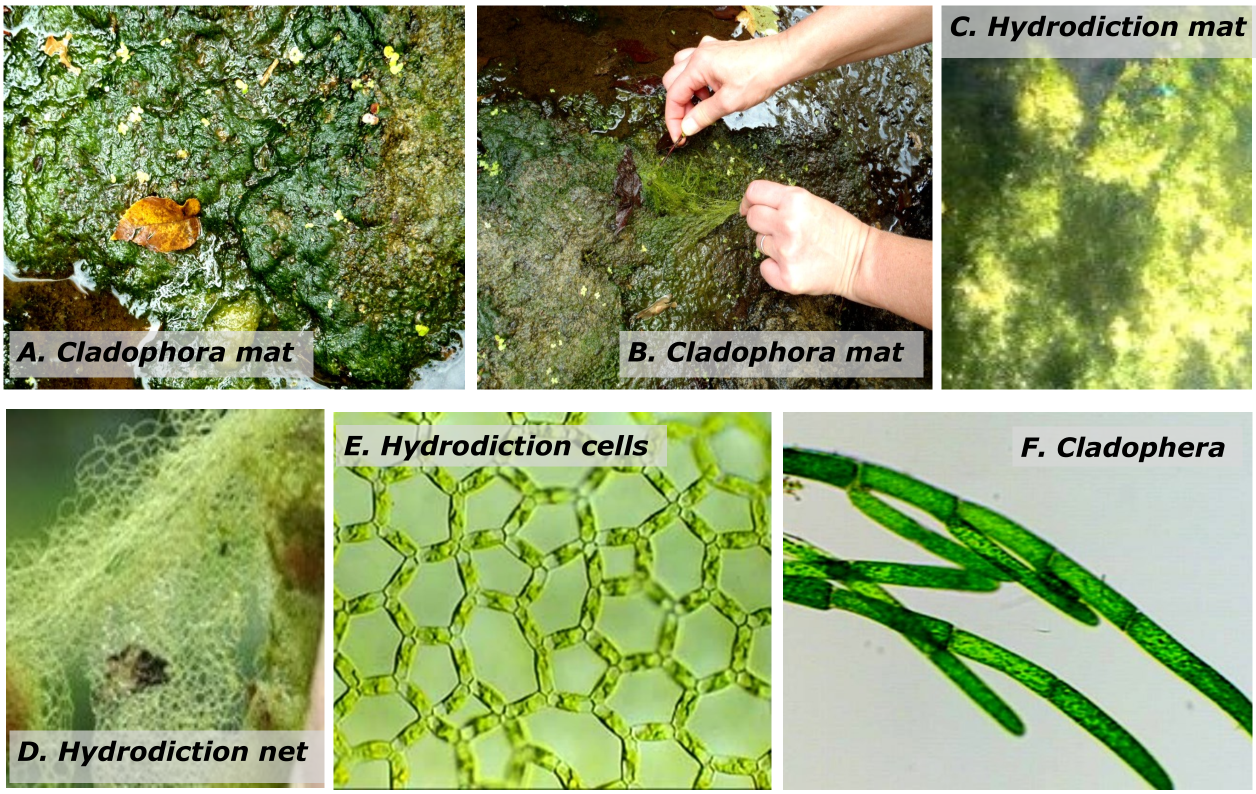


Filamentous green algae are very common in ponds. They form stringy, silky, slippery masses that feel slimy to the touch, and often have trapped air bubbles **(A-D)**. The filaments of all three genera featured on this page are unbranched.

One of the most common filamentous algae found in ponds is *Spirogyra*. It is often mixed with *Mougeotia* and *Zygnema*. They can be distinguished under the microscope by the shape of the chloroplasts. *Spirogyra* have spiral chloroplasts (**E, F**). *Zygnema* has star-shaped chloroplasts (**G**). *Mougeotia* has ribbon-shaped chloroplasts with centrally located starch-storing granules called pyrenoids (**H,I**).

Branched Filamentous Green Algae

Cladophora and Hydrodictyon



A. Cladophora mat
B. Cladophora mat
C. Hydrodiction mat
D. Hydrodiction net
E. Hydrodiction cells
F. Cladophera

Cladophora and *Hydrodiction* are both species of branched, filamentous green algae. Cladophora is commonly found in running water such as streams, rivers and waterfalls. It grows attached to rocks and other substrates. The stringy mats are usually dark green, although it can appear yellow-brown to orange when the mat starts to die. When picked up, it feels coarse and "webby", and the tufts of branches are evident. When squeezed, it looks like green cotton (**A**, **B**).

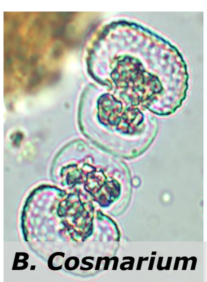
Hydrodictyon, known as water net, is also common in running water, although it is also found in hard-water lakes and ponds where it can form thick mats (**C**). It requires water with high alkalinity. The growth is light green and formed by filaments that are joined to form net-shaped colonies. When the water is squeezed out it clearly appears like a net (**D**).

Under the microscope, the net-like arrangement of cells that distinguishes *Hydrodiction* from most other types of green algae becomes even more apparent **(E)**. *Cladophora* branches are clearly visible and are shorter than the main stem of the algae. The chloroplast covers most of the cell (**F**).

Common Planktonic Algae in Well-Managed Ponds

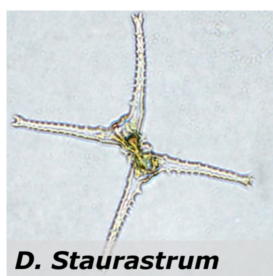
Cosmarium, Closterium, Staurastrum, Pediastrum, Scenedesmus, and Volvox

A.

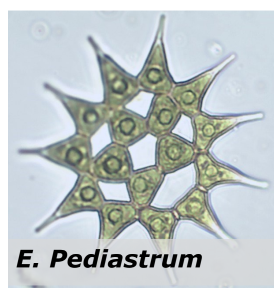


B. Cosmarium

C. Closterium



D. Staurastrum



E. Pediastrum

F. Scenedesmus

G. Volvox colonies

Well-managed ponds usually have slightly green, clear or brown water **(A)**. Note the aerator and the vegetation buffer around the pond.

Desmids, a type of planktonic (free-floating) algae that are distinguished by their beautiful, symmetrical shapes, are very common in well-managed ponds. Among the most common desmids are *Cosmarium* **(B)**, *Closterium* **(C),** and *Staurastrum* **(D)**. Though not considered Desmids, *Pediastrum* **(E)** and *Scenedesmus* **(F)** are also symmetrical types of algae found in healthy ponds.

Volvox **(G)** are green algae that can form spherical colonies of up to 50,000 cells. Each non-reproductive cell in a *Volvox* colony contains two flagella and a light-receptive eyespot.

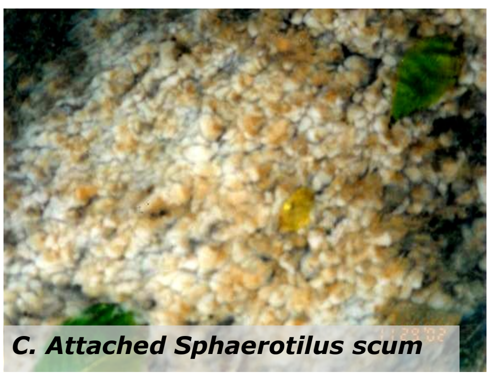
Many diatoms are also common, and can be found on page 17.

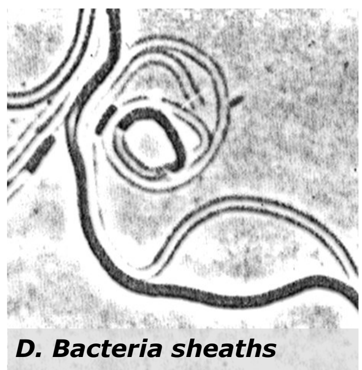
Bacterial Scums

Sphaerotilus and Iron –Oxidizing Bacteria


A. Iron-oxidizing bacteria scum


B. Iron-oxidizing bacteria scum


C. Attached Sphaerotilus scum


D. Bacteria sheaths


E. Bacteria sheaths

Like algae, excessive growth of bacteria can also form scums in streams and ponds. In water with high levels of iron, orange-colored scums of iron-oxidizing bacteria can form **(A, B)**. Ponds and waterbodies that receive acid mine draining may be particularly susceptible to these bacterial blooms. Often, water containing these scums is very low in oxygen.

In streams or waterways receiving high amounts of sewage pollution or other organic matter, a bacteria called *Sphaerotilus* can attach to rocks and other substrates and form long, ropey scums **(C)**. Some people refer to these scums as "sewage fungus". This is not correct since the scums are formed by bacteria, not fungi. *Sphaerotilus* also derives its orange color from iron. *Sphaerotilus* is also common in waterbodies that receive runoff containing airport de-icing fluids. The bacteria break down ethylene glycol and other sugar alcohols found in the fluids. Therefore, it is prudent to not let pets or livestock drink from waterways where *Sphaerotilus* growth is present, even though the bacteria itself is not toxic.

Under the microscope, iron-oxidizing bacteria and *Sphaerotilus* can appear as long rods enclosed in a stiff sheath (**D**, **E**). Iron oxide is accumulated in the sheath, giving the orange color to the scum.

Protozoan Scums

A. Protozoan scum

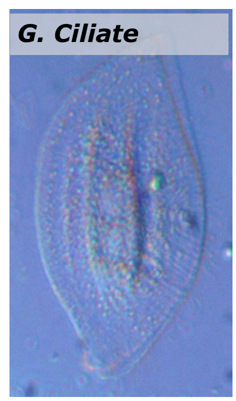
B. Protozoan scum

C. Protozoan scum

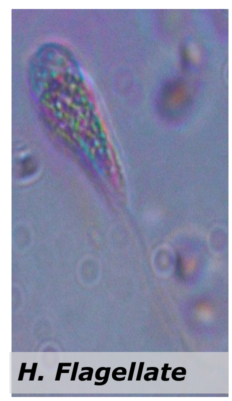
D. Protozoan scum

E. Shelled amoebozoan

F. Amoebozoan without shell



G. Ciliate



H. Flagellate

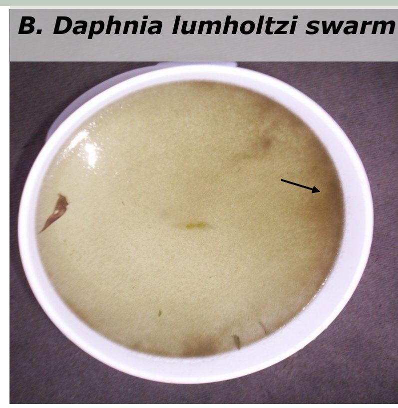
Whitish-grey scums appear often in still waters, and may be caused by small, single-celled animals called protozoans. Protozoan scums may form a shiny, almost oily film on the surface of the water (**A**, **B**, **C**). Sometimes they will also appear as a "foam" (**D**).

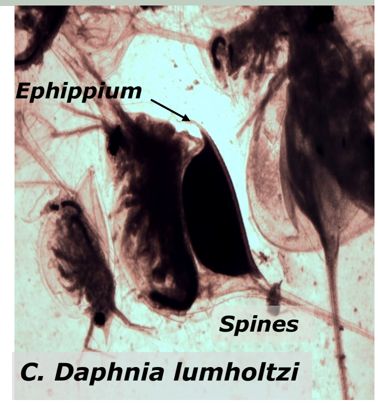
Common protozoans include amoebozoans with or without shells (**E**, **F**), ciliates (**G**) and flagellates (**H**). These organisms feed on bacteria that have concentrated in certain areas of the pond by the wind blowing over the surface of the water.

Generally, there are no safety issues with water that contains protozoan scums. However, some species of amoebozoans can cause disease if ingested through the mouth or up the nose. Some amoebozoans and ciliates are also indicators of sewage or other organic pollution.

Zooplankton Scums


A. Daphnia lumholtzi swarm


B. Daphnia lumholtzi swarm



C. Daphnia lumholtzi

Zooplankton are microscopic animals that swim or float freely in the water. They include a wide variety of organisms, including *Daphnia*. *Daphnia* are a small crustaceans in the order Cladocera that are commonly found in ponds. *Daphnia* and other cladocerans, can "swarm" producing scums that are usually brown.

On October 9, 2009, *Daphnia lumholtzi* was found as a swarming brown scum in Lake Cumberland. *Daphnia lumholtzi* is native to Africa where it is the major species of zooplankton in Lake Victoria. The literature states that it may have been introduced into the United States of America with shipments of Nile perch in the 1980s. It has now spread to at least 56 reservoirs in mid-western and southern states. It can clog fish gills.

In the microscopic view of *Daphnia lumholtzi* (**C**), note the saddle-shaped ephippium (shell that encloses the egg) on the back of the middle specimen. *Daphnia* with ephippia were more concentrated in the scum than they were in other water samples from the lake. There were also small males in the scum, seen in the left specimen (**C**). This suggests swarming is an adaptation for sexual reproduction in this species, since ephippial (resting) eggs are formed only by sexual reproduction.

The long tail spines often get tangled (bottom right of **C**), contributing to the clumping of individuals, so the scum does not separate. It was this "crossing" of tail spines that inspired the Northern Kentucky University students who collected the organisms to name the brown scum "holy crap".

Know Your Watershed

The first and most crucial step in effectively managing your pond is knowing what surrounds and drains into your pond. This not only includes what surrounds the pond on your property or in your neighborhood, but in the watershed. A watershed is an area of land that drains into a particular body of water when it rains or snows. Land use practices in the watershed will affect water quality in the pond.

Rainwater or snowmelt that runs over the land is called stormwater runoff. Stormwater runoff can carry fertilizers from agricultural operations, residential neighborhoods or urban development into streams, ponds and other waterways. It can also create unstable banks that cause sediment to run into your pond. Stormwater runoff can come into ponds directly from the surrounding area, or it can be washed in through storm sewer pipes, which is often the case in residential or urban neighborhoods.

In addition to understanding how excess nutrients could get into your pond from the surrounding watershed, it is important to test conditions in your pond to establish a "baseline" of conditions in which you can subsequently monitor changes. Key parameters to monitor in the pond are outlined in Table 2 on page 25. Following this table are **Best Management Practices (BMPs)** for controlling nutrient runoff and managing algal growth in your pond.

YMCA Camp Ernst, Northern Kentucky

Table 2. Water Quality Parameters

Dissolved Oxygen	Dissolved oxygen levels fluctuate daily and are lowest before dawn, due to the respiration of aquatic organisms, and highest at dusk, due to photosynthesis of algae and aquatic plants. Oxygen levels can drop significantly during the summer months as temperatures rise and oxygen gas leaves the water. Decomposition of dead animals, as well as dead algae and aquatic plants, can also cause drops in oxygen. Life in a pond can become stressed when oxygen levels dip below 6 mg/L.
pH	pH is a measure of the concentration of hydrogen ions in a substance and indicates whether it is acidic, basic or neutral. pH is usually highest in the late afternoon because plants and aquatic algae remove carbonic acid from the water during photosynthesis, raising pH levels. Healthy ponds in this region have pH levels around 7.5, although most aquatic organisms can tolerate pH levels between 6 and 8.5.
Nitrate Nitrogen and Ammonia	Nitrate nitrogen is a nutrient that can fuel algal or aquatic plant growth in ponds in excessive amounts. While nitrogen is present in all living things and naturally cycles through a pond system, nitrate levels in excess of 3 mg/L can indicate nutrient pollution from stormwater runoff or other sources. Ammonia is also a form of nitrogen and can come from animal waste. Ammonia is very toxic to aquatic life; levels as low as 0.1 mg/L can be harmful.
Phosphates	Phosphorous is a nutrient in ponds that can fuel algal growth in very small amounts. It can be found in two forms: inorganic (free) phosphate, which is readily taken up by algae and aquatic plants, and phosphate that is bound to sediment and other particulate matter, which is not readily available. Over time, this phosphate can become free phosphate. Phosphate levels in excess of 0.1 mg/L can cause excess algal or aquatic plant growth in a pond.
Alkalinity	Alkalinity refers to the "buffering capacity" of water to neutralize acids. The ability of water to withstand changes in pH is good for aquatic life. Alkalinity in pond water comes from dissolved minerals in the water that contain carbonates and bicarbonates. Limestone, which contains calcium carbonate, is a source of alkalinity in many ponds in this region. Alkalinity levels of 20 mg/L or more are best for protecting fish and other aquatic animals.

Native Vegetative Buffers

One of the simplest ways to improve water quality in the pond is to refrain from mowing to the edge. Turf cannot sufficiently stabilize the bank, and eroding banks add sediment and nutrients to the water. Furthermore, shallow edges created by eroding banks can encourage excess algal growth. A monoculture of turf grass can also attract geese and other nuisance wildlife that favor flat, open areas that are free of predators. One goose can produce over one pound of droppings per day that contain pathogens, like *Escheria coli (E. coli)* bacteria, as well as nutrients that can enter the pond. A vegetative buffer of native plants will filter water entering the pond, stabilize banks, and provide excellent habitat for beneficial wildlife. Many birds and pollinating insects will be attracted to this habitat and, in turn, provide food to fish and other aquatic inhabitants.

The following plants are recommended for native buffers in Northern Kentucky, Southwest Ohio and Southeast Indiana: **pickerelweed** *(Pontederia cordata),* **blueflag iris** *(Iris versicolor),* **sweetflag (***Acorous calamus),* **cardinal flower** *(Lobelia cardinalis)***, native sedges and rushes, arrowhead or duck Potato** *(Sagittaria latifolia)***, swamp milkweed** *(Asclepias incarnata),* **water arum** *(Calla Palustris),* **lizard's tail** *(Saururus cernuus), and* **swamp rose mallow** *(Hibiscus palustris).*

Harvesting Algae

An easy and effective best management practice for managing established algal blooms is to physically remove algal mats from the pond through raking or netting. This removes not only the algae, but excess nutrients that would eventually be cycled back into the lake when the bloom dies off. Harvested algae can be taken away from the pond and allowed to decompose. Algae can also be composted and can make an excellent soil amendment for gardens.

Bottom-Up Aeration

Adding a pond aeration system can help address current algal blooms and prevent future algal blooms. Adding oxygen to the water from the bottom up will help avoid stratification, which occurs when the lake separates into three layers based on temperature. Stratified ponds can "turnover" in the spring or fall, bringing poorly oxygenated water up from the bottom, causing fish kills. Bottom-up aeration provides oxygen for microorganisms to more efficiently break down pond muck and nutrients, so they do not cause future blooms. The appropriate bubblers in the right season can make more oxygen available to fish and other pond organisms and avoid unpleasant fish kills. These systems are especially helpful in residential or urban ponds, where storm sewer pipes often discharge runoff directly into the water.

Management of Agricultural Ponds

State and Federal Cost-Share programs may be available to assist eligible landowners engaged in agriculture, forestry, and wildlife. Cost-Share programs are available through local soil and water conservation districts and cover select Best Management Practices (BMPs) to increase water quality and decrease soil erosion. Using these programs will protect natural resources with a reduced cost to the landowner. Contacts for the Boone, Campbell and Kenton County Conservation Districts can be found on page 30.

Below is a list of common practices that are used to manage healthy ponds:

Exclusion fences- as seen in the picture below, this practice can remove livestock from ponds or other sensitive areas to reduce excess nutrients and sediment from entering the water source.

Watering facilities- once livestock access is restricted to the pond, watering facilities can be used as a clean alternative water source, as seen in the picture below. These could be fed by the pond, or city water.

Vegetative buffer strips- this practice (mentioned previously on page 26) is used in areas between pollutant sources and waterbodies to filter out excess nutrients before reaching the surface water.

Nutrient Management Plan- this practice involves developing a plan to more effectively use nutrients to avoid over-application to crops and to minimize the risk of polluting nearby sources of water.

Exclusion fence

Watering facility

References and Resources

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Resources

Algae Identification Lab Guide by Agriculture and Agri-Food Canada Agri-Environment Services Branch:
http://publications.gc.ca/collections/collection_2011/agr/A125-8-1-2011-eng.pdf

A Field Guide to Common Aquatic Plants of Pennsylvania by Bryan Swistock and Susan Boser:
http://pubs.cas.psu.edu/FreePubs/pdfs/agrs110.pdf

Managing Aquatic Vegetation by Ohio Department of Natural Resources:
http://www.dnr.state.oh.us/wildlife/Home/fishing/pond/aquatic_veg/tabid/6216/Default.aspx

Although these guides come from different areas of the United States of America and Canada, the information in these guides is relevant for the Kentucky, Ohio and Indiana.

Acknowledgements and Contacts

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