POND SCUM

What Lurks In The Water Below?

Paul J. Harmon

Spirulina

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By Paul J. Harmon

It's summer again, the sun is bright and high in the sky … most days, and all those tiny green things in our ponds and streams are "lovin' it!" Algae are growing at a phenomenal rate, enough to let us see them green or blue-green or golden-brown in the water or on the bottom. If the balance between photosynthetic production by the algae isn't matched by the voracious eating of the zooplankton which eat algae, you may see an algal bloom explode in your backyard ponds!

What about those microscopic producers? What are they? What do they look like close-up? And what role do they play in our lives?

Well, let's start basic. Plants can capture the energy in sunlight, produce its own food and store it in molecules of sugar. Some of the key producers of sugars and oxygen are photosynthetic "algae." Traditionally known as "algae" and thought of as aquatic and photosynthetic, they include the "blue-greens" that sometimes form the bluish-green "hair" on rocks in streams; "greens", the bright green producers of healthy ponds; "reds" that live mostly in salt water (some in the Orient are edible); "golden-browns," including the beautiful diatoms; and "browns," including the giant kelps of the oceans. Algae feed the majority of life on Earth in the form of phytoplankton, kelp forests, and microscopic layers of life covering the surface of rocks in our mountain streams!

Now and then, when the pond in my backyard is bright green with algae, I scoop up a cup of the green water, call my kids, get out the microscope, and disappear into a microscopic world of amazing creatures! Looking through a compound microscope, my son shouts, "Awesome!" at the diversity of the occupants of a drop of water on a slide. The natural world of producers (photosynthetic organisms), consumers (those that eat to get energy), and decomposers (those that help decay organisms to get energy) is incredibly diverse in color, size, reproductive method, growth rate, movement, shape, texture, and method of getting energy!

Humans organize that mass of information about that diversity into groups of similar characteristics. Carolus Linnaeus (a.k.a. Charles Linney) developed the first classification scheme that used Latin binomials in 1753, and divided all of nature into three "kingdoms": Plants, Animals, and Minerals (non-living). In recent decades, amazing discoveries in biology have highlighted problems with Linnaeus' system. For example, the "green alga" *Chlamydomonas* is green and photosynthetic -- like a plant, but it moves -- like an animal. So


Spirogyra

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which is it, plant or animal? The answer now is … neither!

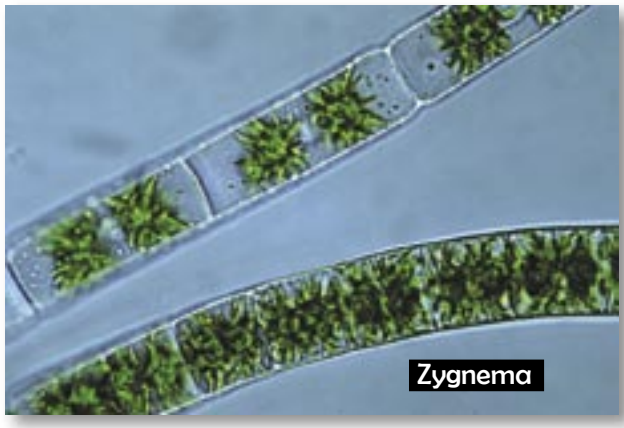
By the late 1970s, taxonomists had come to recognize at least five Kingdoms, and saw that living organisms could be divided into two fundamentally different groups, the *prokaryotes* and the *eukaryotes*. The eukaryotes included the four kingdoms of *Protists, Fungi, Plants*, and *Animals*. Eukaryotes are often made up of many cells. The prokaryotes are unicellular species.

•PROKARYOTES

Biologists were shocked in the late 1970s when Dr. Carl Woese at the University of Illinois discovered a new group of organisms. While studying the DNA sequences of various prokaryote species, he found a distinctly different group which superficially looked like bacteria. He found that the new group, which he eventually called Archaea, are biochemically and genetically as different from the other bacteria as they are from plants, animals, fungi, and protists!

Archaea

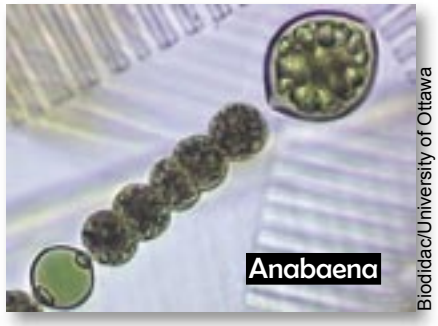
Archaea often live in high temperature environments, including the hot pools of high alkaline and high acidity water in Yellowstone National Park, as well as near the heat vents at the bottom of the oceans where they endure temperatures above 100 degrees Celsius! Many of the Archaea generate methane as they breathe. In time researchers discovered Archaea in the digestive tracts of cows and termites. They live in marine life, mud on the bottom of marshes with no oxygen, in petroleum deposits underground, and extremely saline waters.


Zygnema

University of Maryland

Bacteria

With these changes in taxonomy, species once thought to be "blue green algae" are now known as Cyanobacteria–bacteria that often produce a bluish pigment. Some species are red to pink. Since they are aquatic and are photosynthetic, we commonly refer to them as algae; yet they are prokaryotes, like the bacteria. Cyanobacteria are quite small, usually unicellular, and often grow in colonies large enough to see. You are probably aware of them as strands of blue-green "hair" growing on the rocks of ponds or streams that have an unhealthy amount of nitrogenous waste from sewage or fertilizers in them. They can tolerate high nitrogen levels that green algae often cannot, and thus become indicators of dangerously polluted water.


Anabaena

Biodidac/University of Ottawa

Cyanobacteria are important providers of nitrogen fertilizer in rice and bean cultivation. They are thought to have historically generated most of the oxygen in our atmosphere during the Archaean and Proterozoic geological eras. In fact, the tiny organelles in plant cells, called plastids, whose chlorophyll enables the plant cells to generate their own food from sunlight energy, are actually cynobacterium living within the plant's cells.

Anabaena is one of the common species that lives with various species of fungi to create what were once thought to be 'species' of lichens. We now know that lichens are communities of mostly cyanobacteria and fungi that form when conditions get too dry and sunny for the species to live separately! Change the species of cyanobacterium but leave the same species of fungus, and "*poof,*" you have another 'species' of lichens growing


Green Algae

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before your eyes!

Spirulina, another cyanobacterium, has long been a food source high in protein and cultivated in ponds in tropical countries. It was eaten by the Aztecs, is in a number of Oriental dishes, and can be bought at health food stores as a dried powder or tablet as a nutritional supplement.


Univ. of N. Alabama

Micrasterias

The first time I saw *Spirulina*, I freaked out! Staring into a compound microscope, I saw hundreds of species of microbes, and suddenly there came across the field of view a blue-green, noodle-like creature that spiraled its way across the circle of light, and disappeared into the darkness on the other side! As I scrambled to gently move my slide to chase this "alga," it reversed itself and spiraled back again, exiting to the left!


Stephen Durr

Volvox

●EUKARYOTES

What about "green algae" in freshwater ponds? In unpolluted ponds, you can find both filamentous green algae and those with only one or two cells. One of the more interesting species is a colonial species called *Volvox* that looks like bright green spheres of numerous individuals cells, all surrounding two, three, four or more smaller spheres of identical cells -- like a ball of balls composed of hundreds of bright green moving cells! Volvox cells have whip-like flagella with which they move.

Desmids

Desmids, of which more than 40 genera and more than 10,000 species are known in the world, are mostly single-celled green alga, primarily found in freshwater habitats. They live as phytoplankton (floating producers at the bottom of the food chains), on the bottom of lakes and streams or clinging to submerged portions of plants. Many species grow in long colonies of long filaments. None of them have flagella. Some of the most beautiful desmids have cell walls composed of two compartments connected by a narrow isthmus, straddled by a single green plastid. One of the *Micrasterias* is shown here, squarish, with two 'hemi-cells'. *Staurastrum*, another desmid, looks like a "Star Wars" Star Fighter of two three-armed stars connected in the middle.


Staurastrum

Biodidac/University of Ottawa

One of the most beautiful and easiest green algaes to identify is the filamentous *Spirogyra*. This species gets its name because its chloroplasts are ribbon-like and wound inside the elongate cells like a spiral. *Spirogyra* can be found in both clean fresh water bodies, as well as somewhat polluted ones, but when found in greater numbers indicate the water is polluted.

Diatoms

Billions of diatoms settled to the bottom of ancient lakes or oceans, accumulating to form mineral layers called diatomaceous earth or *diatomite*. The white chalky material is mined for use in cleansers, filtering agents, abrasives and paints. Diatoms include *Navicula*, *Pinnularia*, (spindle-shaped golden browns), plus the protist and dinoflagellate *Ceratium* (looks like a rocket ship!). Diatoms are likely the most important contributors to the plankton of the seas, with an estimated 40,000 to 100,000 species. They are a primary source of food for many aquatic and marine animals. Because they contain chlorophyll, they are also a major source of oxygen for our planet, and are credited with fixing 20-25 percent of all carbon on earth as well.

It's clear that the microscopic life of the Prokaryotes –Archaeans and Bacteria–and the microscopic Eukaryotes are critically important components of life on Earth. Millions of years ago they supplied enough oxygen to launch new life. Today, thousands of species continue feeding life in our oceans and freshwater, providing oxygen, and both causing disease and producing antibiotics.

The next time you head to your backyard garden pond, favorite fishing hole, the beach, or walk past the sulphur springs of Yellowstone National Park, think about the amazing diversity of unseen species that form the foundation of life on our planet!

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For An Even Closer Look

To learn more about that diversity of microscopic life, you may wish to visit these websites:

- www.ucmp.berkeley.edu
- www.psaalgae.org
- www.microscopy-uk.org.uk/index.html
- www.microscopy-uk.org.uk/pond/algae.html

Also for a fun kid's activity, check out *"A Virtual Pond Dip"* at http://www.microscopy-uk.org.uk/ponddip/index.html