



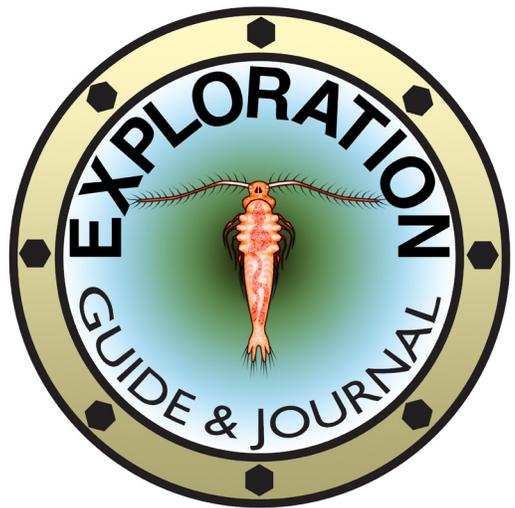
Accompanies Episode 1 of the 13-part video series

Perilous Plankton

Written by Eric R Russell & Bruce J Russell

In this episode...

Cyclops and its intrepid crew of explorers dive into the pond's open water where they get an uncomfortably close view of a filter feeding copepod, barely escaping its powerful feeding currents. They next have a lyrical encounter with *Volvox*, a beautiful colonial alga, and survive a collision with *Daphnia* the water flea, leading to unique views of an animal's internal organs in action and its special adaptations for living in suspension.

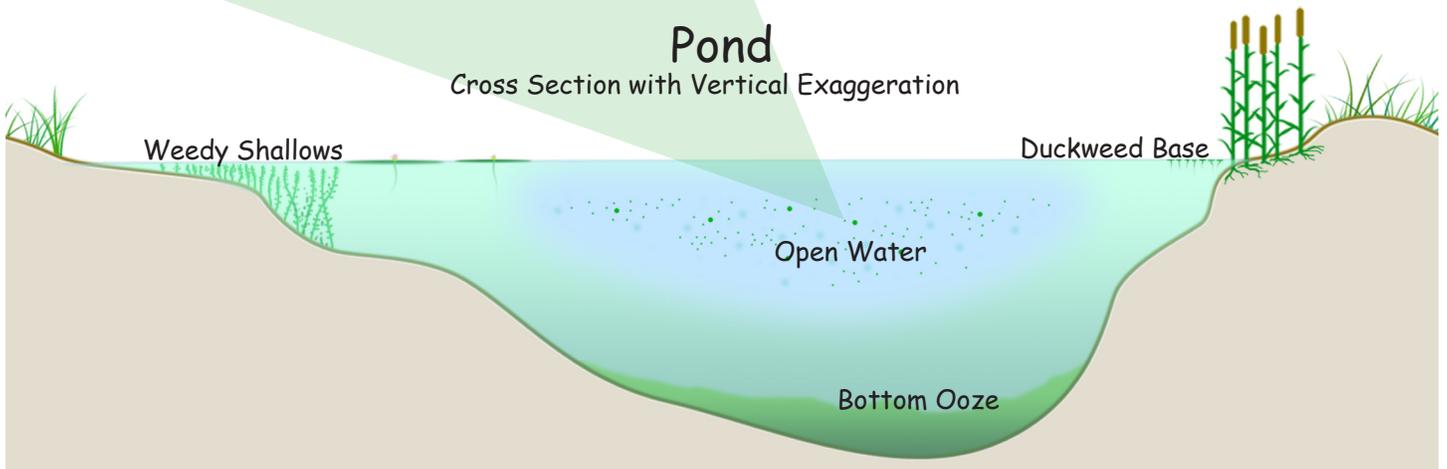


Pond Ecology: Open Water
The Log of Captain Jonathan Adler

Day 1: 06:30 hours... It is the beginning! I can barely contain my excitement! What a great privilege it is to take command of our first comprehensive survey of life in this pond home of ours.

I must say the *Cyclops* is a most amazing ship - the perfect instrument for exploring the hidden worlds of the vast pond universe. It will take many months, and our voyage will undoubtedly hold many surprises - as well as perils. But the ship is tough and I am confident that the *Cyclops* and her crew can endure whatever adventures the pond inhabitants throw our way.

08:00 hours... With a cheerful ringing of the ship's bell we depart Duckweed Base and set a steady course for the open water. Our helmsman, *Gyro*, informs me that it will take several hours to reach our first survey site. Hopefully we are too small to be of any interest to the large vertebrates (fish and frogs) that inhabit the shallows near Duckweed Base.



MS Cyclops

Vehicle Dimensions

LENGTH	1 mm
BEAM	.65 mm

Vehicle Mission

Maximum speed	10 centimeters per minute
Maximum depth	2.5 meters
Mission duration	60 days

The microsubmersible *Cyclops* is designed for extended exploration of freshwater ponds, streams, and wetlands. The vehicle carries a standard crew of four.

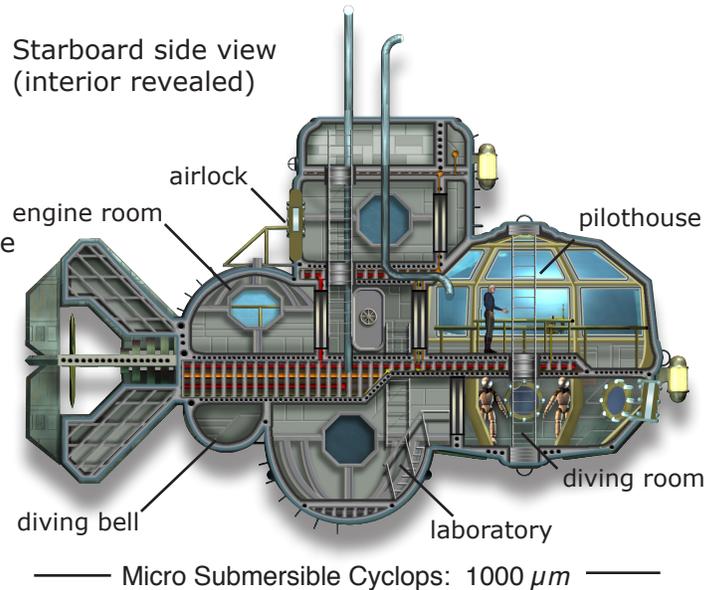
- Captain
- Ship's Naturalist
- Helmsman/Navigator
- Engine Master

There are two onboard auxiliary craft for specialized exploration: a *diving bell*, and a *terrestrial crawler/rover* (disassembled).

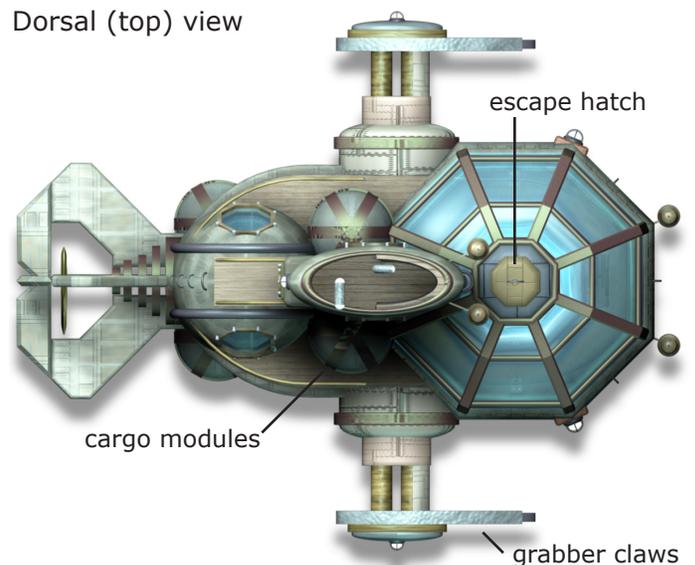
The glass enclosed pilothouse is a unique feature that allows for optimal observation of the surrounding aquatic environment.

Manipulator grabbers (claws) facilitate rapid making-fast and retrieving samples for study.

What if you were a scientist onboard the *Cyclops*? Imagine what the pond environment looks like to these micro sized explorers, only 50 microns (μm) tall. What unique problems might they encounter because of their size? How would they acquire repair materials, such as glass? Where would they find food, fuel, or oxygen?



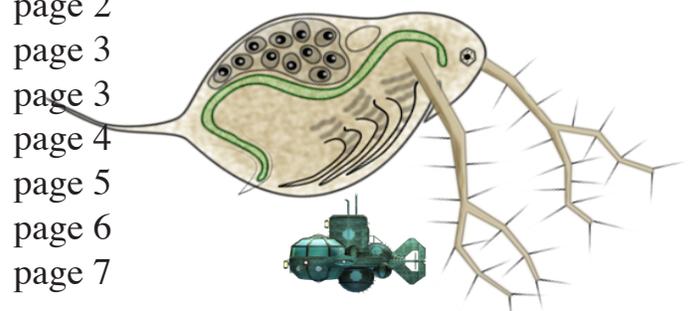
Dorsal (top) view



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Daphnia, the water flea: 4-6 mm

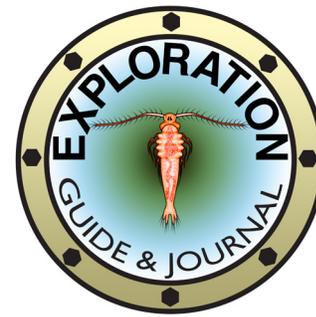
About the Organisms

What is plankton?

Plankton is the name given to all of the freely drifting organisms found in the open water habitat of lakes, ponds, wetlands, and oceans.

Biologists often refer to planktonic animals as “zooplankton” and to plant-like organisms as “phytoplankton.”

Phytoplankton is eaten by zooplankton, and zooplankton becomes food for small fish... and on up the food chain.



Copepods

Copepods are crustaceans, relatives of crabs and shrimp. They have a hard shell-like cover on their bodies and jointed appendages.

The largest copepods live in the ocean and are about 1 cm (centimeter) long. Most copepods in ponds are 4 mm (millimeters) long or less.

Copepods feed on tiny green cells (algae) that are also present in the pond (phytoplankton).

Copepods that live in the open water hold their antennae out to slow their rate of sinking, holding them where they can find the most food.

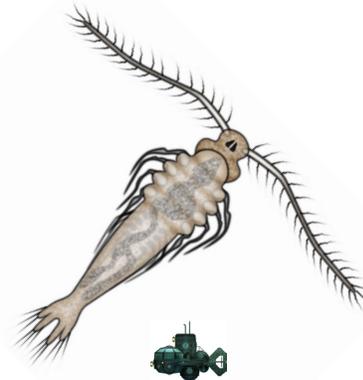
Their fan-like mouth parts create the currents that bring in food.

Copepods swim on their backs using five pairs of swimming legs.

The Log of Captain Jonathan Adler

Day 2: 07:30 hours... We have arrived at the region of the pond designated as the “open water.” I have ordered the ship made ready for an exploratory dive to a depth of 150 centimeters.

17:55 hours... We are abruptly pulled off course by a sudden change in the water current. We soon see the source of the strange powerful current - it is the feeding vortex of a monstrous copepod!



Scale comparison to Gyro

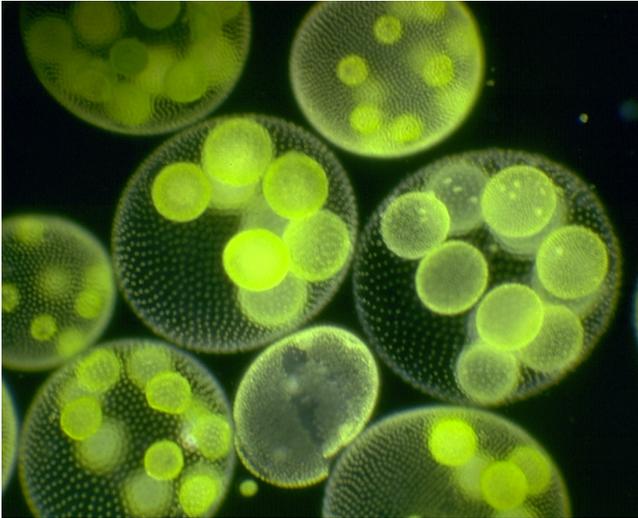
Trapped in the vortex we now have a terrifyingly close-up view of the copepod's fan-like mouth parts. These fans create a current in the surrounding water that draws in smaller organisms such as algae cells, and in this case the Cyclops!

We are now in danger of being crushed by the copepod's mouth. How will we escape this filter-feeding monster?

A thought: When an object too large to devour becomes trapped in the animal's feeding vortex, the beast must possess a simple way of rejecting it, like a reflex of some kind. That will be our only hope for escape.

Gyro, my crackerjack helmsman, suggests that perhaps a large air bubble would interrupt the copepod's feeding behavior for a moment... just long enough for us to make a quick getaway.

Volvox

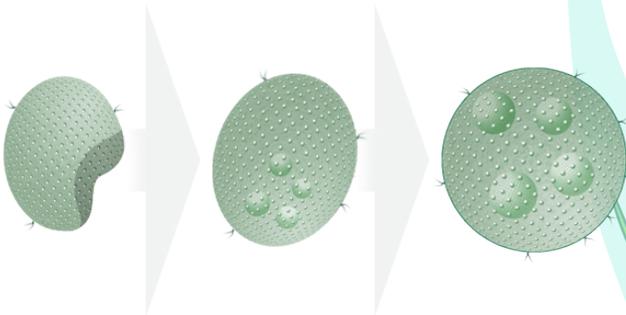


Great blooms of *Volvox* occur when nutrients wash into a pond during spring run-off.

The individual cells making up a *Volvox* colony carry out photosynthesis.

The spherical colonies measure about 500 micrometers in diameter – half a millimeter – and some *Volvox* get much larger, reaching 2 to 3 millimeters across.

Volvox reproduces asexually by producing daughter colonies.

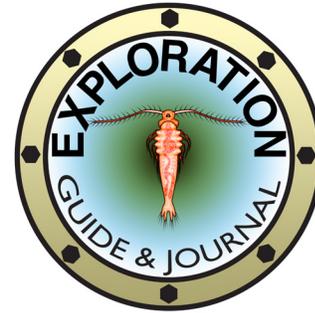


The daughters begin as reproductive cells that divide to form a hollow ball of cells with a small pore on one side. Part way through development the daughter colony turns itself inside out through the pore.

When daughters break out they leave their parent an empty hulk.

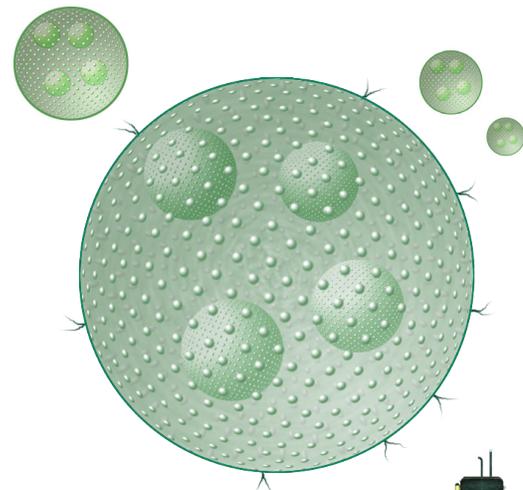
Before its pond dries or freezes, *Volvox* produces eggs and sperm.

The fertilized eggs (zygotes) develop a thick outer wall that protects the eggs from freezing and drying.



The Log of Captain Jonathan Adler

Day 3: 10:30 hours... Diving to a depth of 300cm we find ourselves drifting amongst a large population of beautiful green spheres. Each sphere contains a number of small spheres that appear identical to the parent.



Scale comparison to Cyclops

12:20 hours... After an exploratory dive, Lyra, our aquatic naturalist, has observed that the spheres are made up of smaller green cells, and that each of these has a pair of whipping flagella. We can deduce that this is how the large round colony spins and moves about. But how do the small single cells coordinate their efforts?

A closer look reveals that the cells are actually connected by lines! Perhaps these lines carry chemical signals between each cell in the colony that tell them how to direct their flailing flagella.

We observe these delightful orbs for some time. They are quite hypnotic to watch. A sudden surprise draws our attention! One of the large spheres splits open, and the smaller daughter colonies inside escape. This must be how **Volvox**, as this organism is called, gives birth to new colonies.

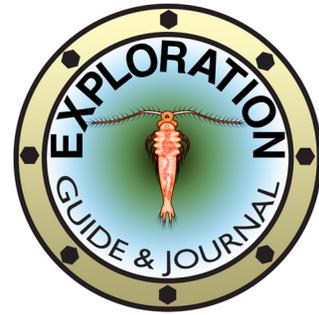
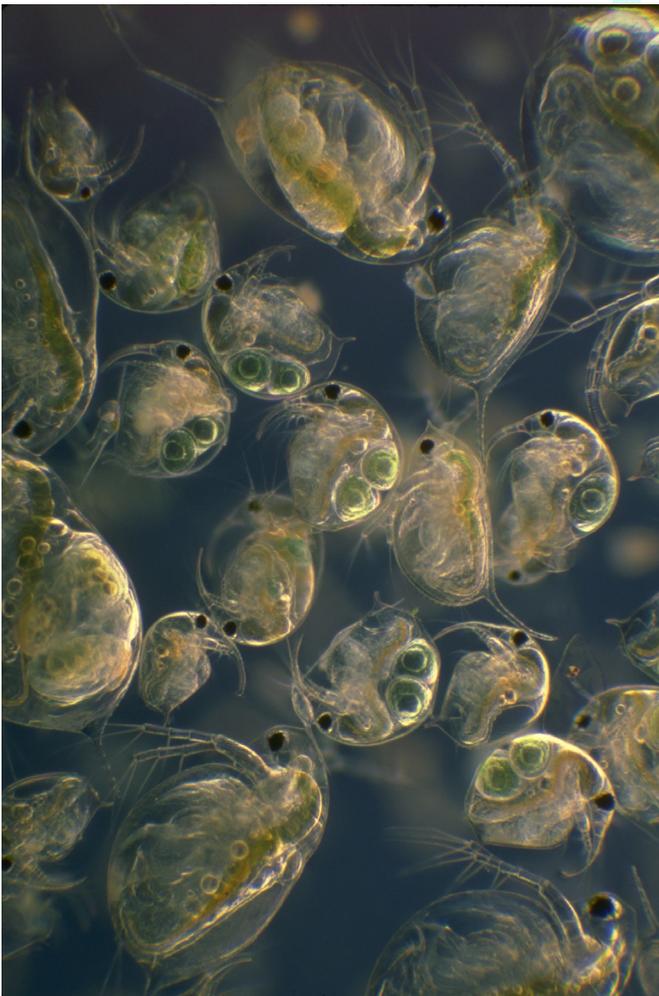
Daphnia

The Water Flea

Under a microscope *Daphnia's* clear body shows many features common to all advanced animals:

- an eye controlled by muscles with nerve connections to the animal's brain
- a heart that pushes clear circulatory fluid around the body
- special organs for oxygen uptake (pads on the rapidly moving swimming legs)
- jaws for grinding microorganisms captured on currents, produced by the swimming legs
- an intestine where the ground-up food particles are digested
- a protective outer shell
- a brood pouch for incubating young that hatch from large yolk-filled eggs

Like copepods, cladocerans become food for the larger predators of the pond.

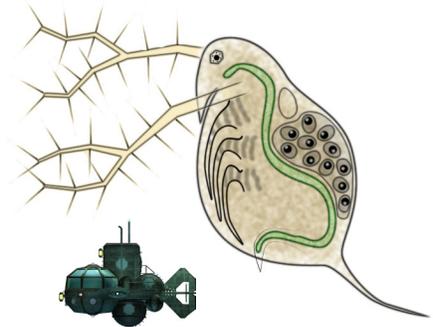


The Log of Captain Jonathan Adler

Day 3: 14:30 hours... Collision! Emerging from the dark we strike a large object. The crash doors close automatically, so that we cannot see what hit us. Luckily, the ship suffers no serious damage

When the crash doors are unshuttered, we finally see the object that collided with Cyclops... it is a *Daphnia*, also known as the water flea.

Confident that the animal is stunned for a time, Lyra and I will leave the Cyclops in diving suits to get a closer look at the beast.



Scale comparison to Cyclops

The first impression is as if looking at a complex animal with the benefit of x-ray vision. We easily see through the *Daphnia's* clear shell, and can survey all of its internal organs.

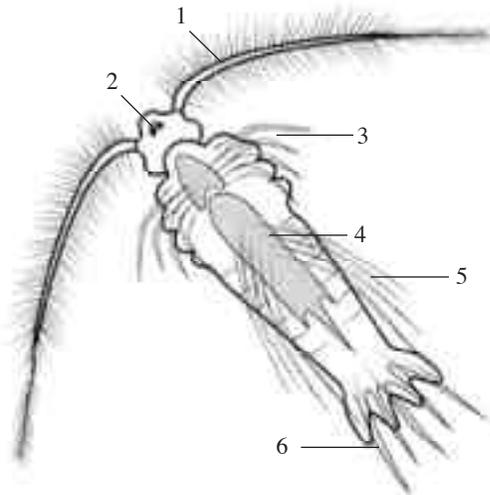
Its digestive system appears full of the single celled algae that make up its usual diet.

Its eye is a cluster of light receptors connected to its brain by nerves, and controlled by a network of muscles, very much like a human eye.

Its heart beats quickly, pumping a clear fluid through the animal's body, presumably delivering oxygen to muscles and organs.

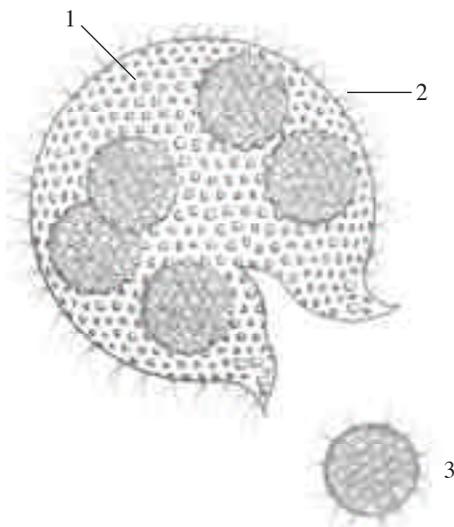
And in the back cavity, a cluster of developing eggs is plainly visible!

Key to Organisms



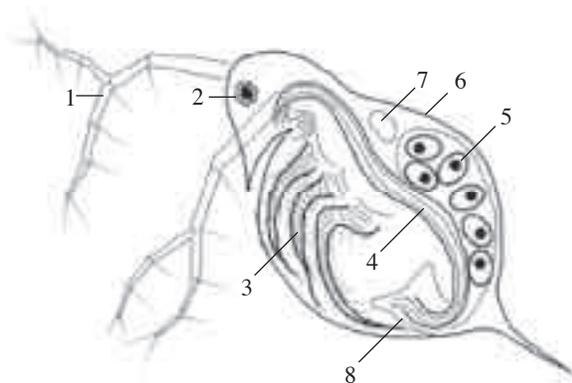
Copepod

1. antennae, for suspension
2. eyespot
3. feeding appendages
4. intestine
5. swimming legs
6. caudalsetae



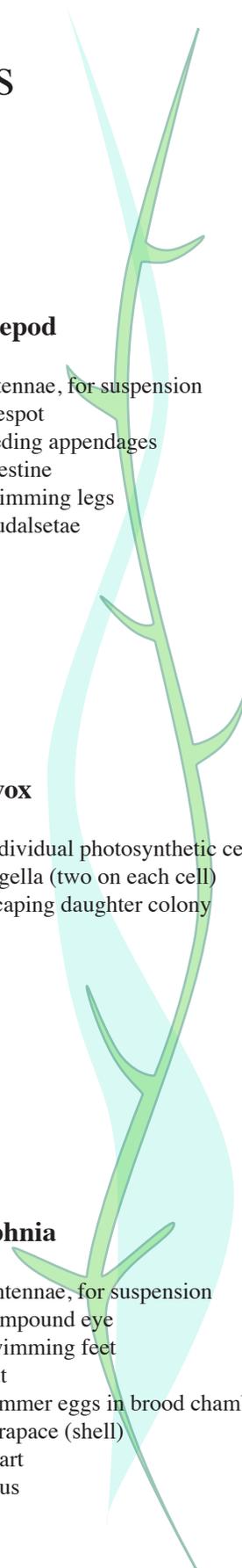
Volvox

1. individual photosynthetic cells
2. flagella (two on each cell)
3. escaping daughter colony



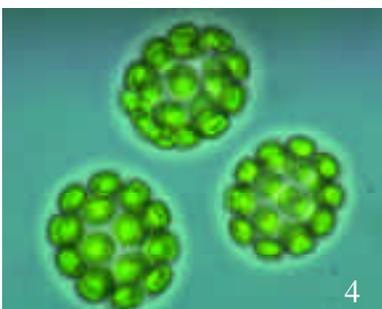
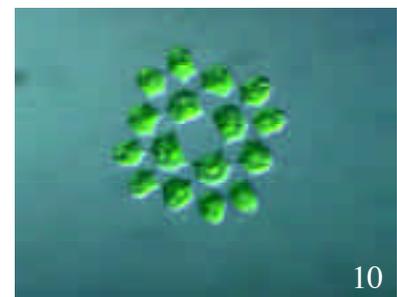
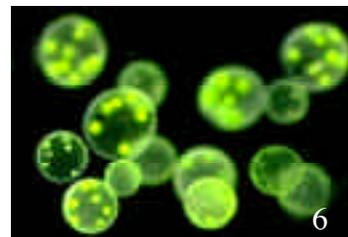
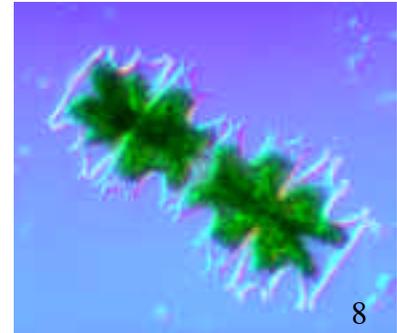
Daphnia

1. antennae, for suspension
2. compound eye
3. swimming feet
4. gut
5. summer eggs in brood chamber
6. carapace (shell)
7. heart
8. anus



Plankton Gallery

These organisms were collected from a small pond using a plankton net. As a biologist interested in classification, organize this set of organisms into what you would consider to be groups of relatives.



For identification key visit
www.microscopicmonsters.com



