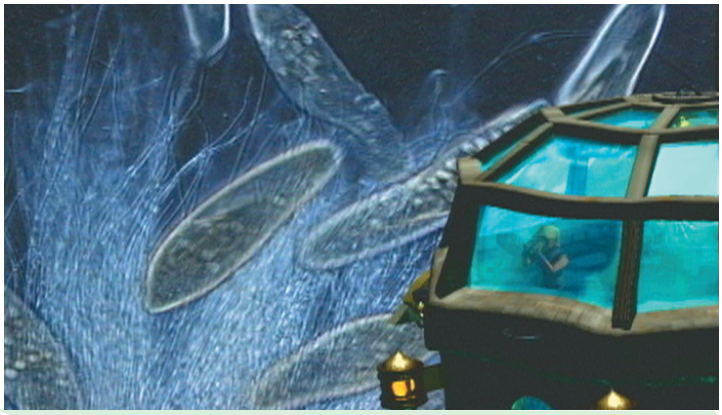
Accompanies Episode 6 of the 13-part video series

Voyage to the Bottom of the Food Chain

Written by Eric R Russell & Bruce J Russell

In this episode...

While exploring the dark pond bottom, the *Cyclops* crew continues to observe a variety of bacteria. They discover that these bacteria are the food of choice for large single celled protists, in this case... a group of paramecia. Food chains can begin with **decomposers**, like bacteria, or **producers**, like photosynthetic plant and algae cells. Then they encounter a second group feeding on green algae cells, and use the opportunity to study *Paramecium's* feeding and digestion up close... until they learn what in fact feeds on *Paramecium*.



EXPLORATION GUIDE & JOURNAL

Pond Ecology: Bottom Ooze

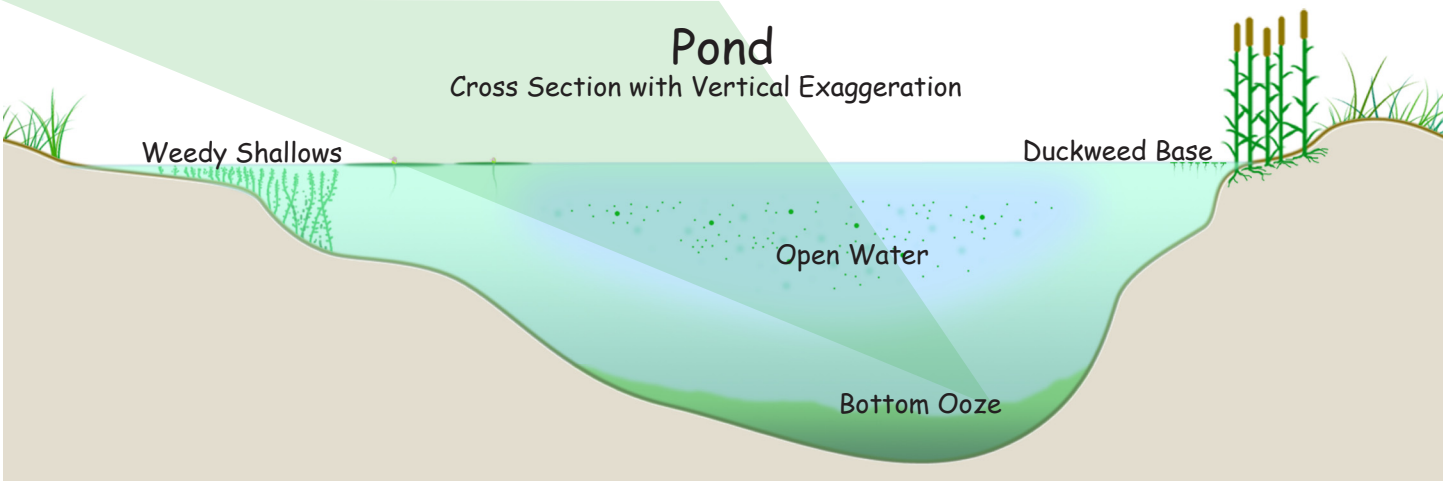
The Log of Captain Jonathan Adler

Day 12: 08:00 hours... Outside, the pond bottom drifts eerily past our windows. Surrounding the Cyclops is a murky world of darkness made up of rotting pond plants and microorganisms. This is the graveyard of the pond – where all pond organisms fall to rest when life ends. And yet, this is where life begins again! All thanks to bacteria.

They are everywhere! Some are short rods – others long ones. Or spring-shaped spirals. Or chains of small round beads. Or hair-like strands. We cannot count or classify the many species that thrive here on the pond bottom, breaking down dead organisms and absorbing the important chemicals needed for life. This is the beginning of a **food chain**.

Through the darkness we see larger shapes. Predators? Scavengers? I turn up the lamps...

Paramecium has arrived. Many large single celled organisms are feasting on the bottom-dwelling bacteria, gorging themselves as fast as they can – and there are plenty of bacteria to go around!



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

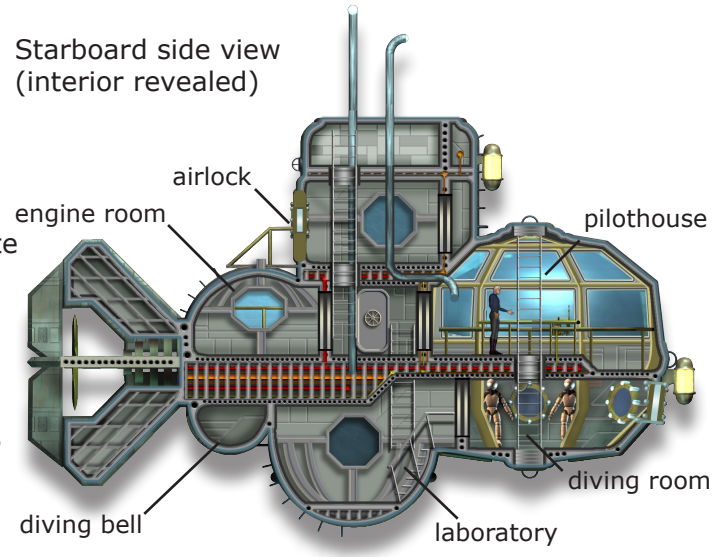
There are two onboard auxilary craft for specialized exploration: a *diving bell*, and a terrestrial *crawler/rover* (disassembled).

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.

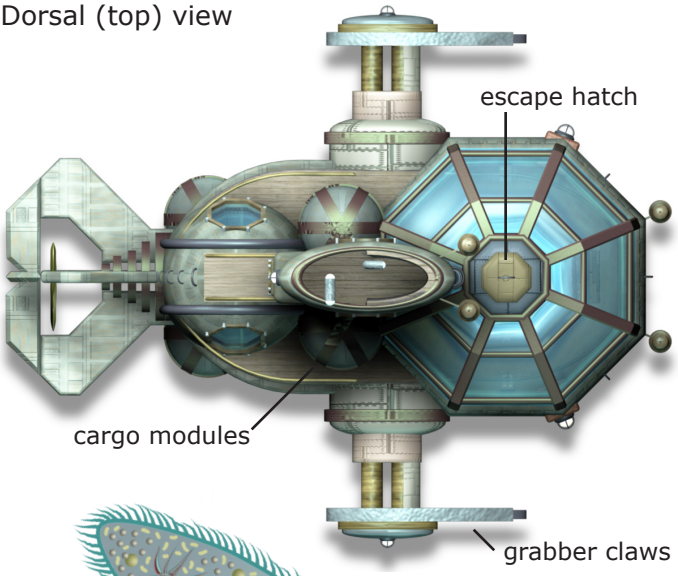
What if you were a scientist onboard the *Cyclops*? Imagine what the pond environment looks like to these micro sized explorers, only 50 microns (*µm)* tall. What unique problems might they encounter because of their size? How would they acquire repair materials, such as glass? Where would they find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

Starboard side view
(interior revealed)

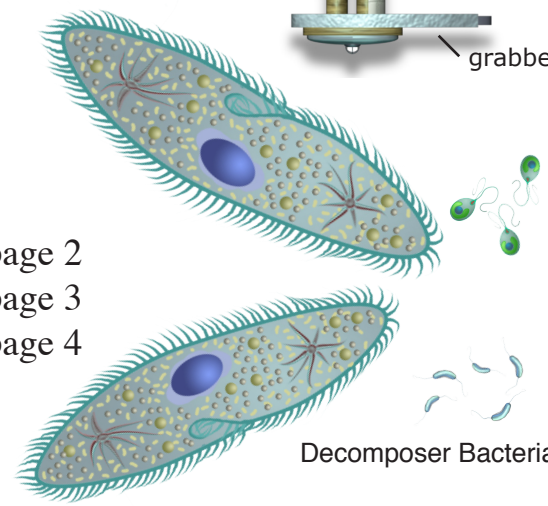


Micro Submersible Cyclops: 1000 *µm*

Dorsal (top) view



Contents of this guide...



Decomposer Bacteria: 45 *µm*

Paramecium: 500 *µm*

About Food Chains

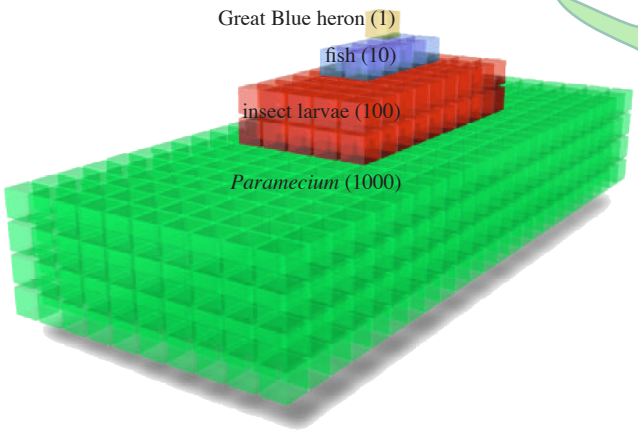
In ponds, algae cells are food for all sorts of small animals and protists. The algae cells make their own food by *converting sunlight and carbon dioxide into starch for energy.* This is how a **food chain** begins with **photosynthesis**.

A **food chain** can also begin with **decomposition**. Dead organisms and waste material fall to the pond bottom where they are digested by bacteria. Bacteria are eaten by protozoans. The protozoans are eaten by small water animals and so on.

In this episode the crew observes *both* beginnings of a food chain. First, they see *Paramecium* devouring bacteria. Later they witness an attack by *Paramecium* and other ciliated protists on a swarm of small green cells. The abundant green cells create an unusual feeding opportunity for *Paramecium*, which usually subsists on a bacteria diet. The paramecia, in turn, become food for small pond animals such as baby fish, mosquito larvae, water worms, and colonies of filterfeeding animals known as bryozoans – the colony seen at the end of the episode.

Advanced Food Chains Facts: At each step in a food chain, only part of the energy contained in the organism being eaten is stored in the cells and tissues of the eater. A rough rule is that only about 10% of the energy moves from one food chain step to the next. In this food chain a heron eats fish, fish eats mosquito larva, mosquito larva eats *Paramecium*, *Paramecium* eats single cell green alga and bacteria.

Energy Pyramid of a Food Chain



EXPLORATION GUIDE & JOURNAL

The Log of Captain Jonathan Adler

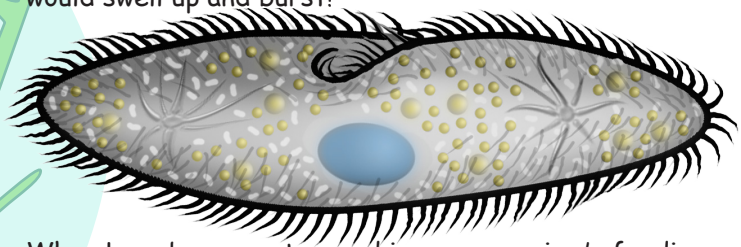
10:40 hours... Because the paramecia are holding relatively still to feed on the bacteria, we have an excellent opportunity to observe the large protists up close. Their internal **organelles** are quite easy to see.

- A bluish central nucleus
- A pulsing star-shaped water pump at each end
- A groove-like mouth that turns into digestive sacs filled with captured bacteria.
- An outer surface covered with a thick coat of waving cilia.

We learn that a paramecium uses its cilia in several ways: to move about its environment both forward and backward, to create a feeding current of water that draws in food, to hold itself in a "feeding station" where it can easily suck in large amounts of food organisms.

Lyra observes that when a paramecium eats, some parts of bacteria and green algae cells are not digestible. They must be expelled by the paramecium.

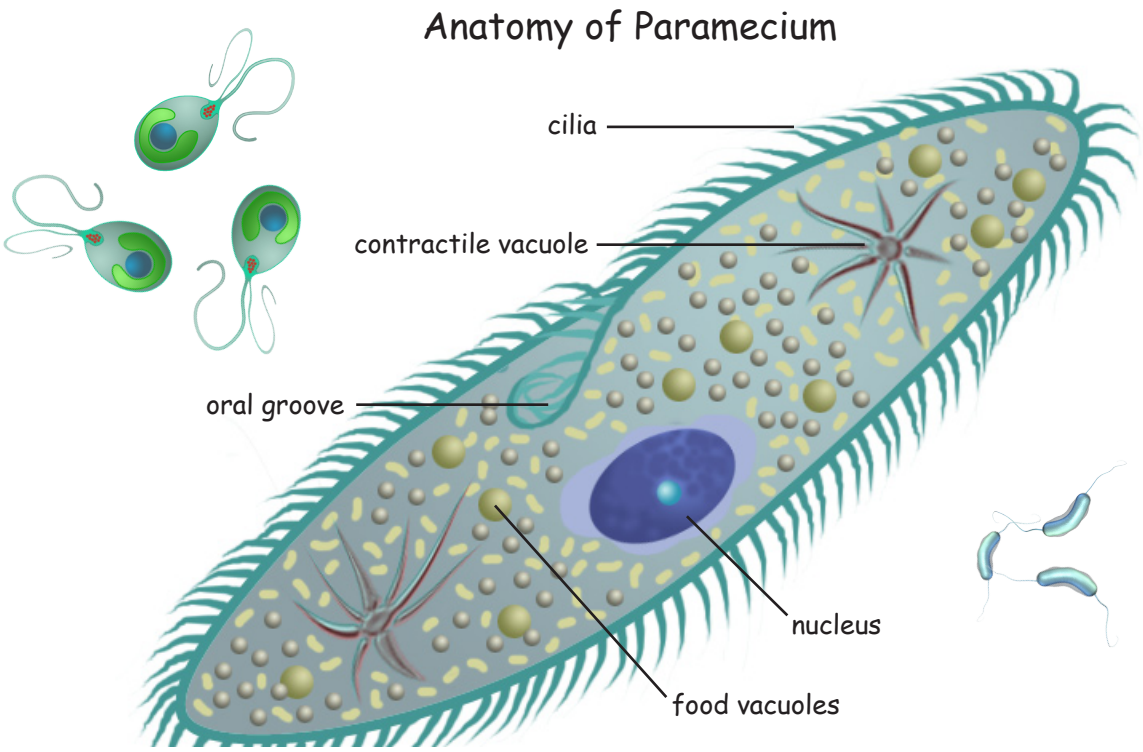
Water enters the paramecium constantly, but we observe that the cell has an way to pump water back into the environment – two pumps, one located at each end of the paramecium. If it were not for these pumps, the cell would swell up and burst!

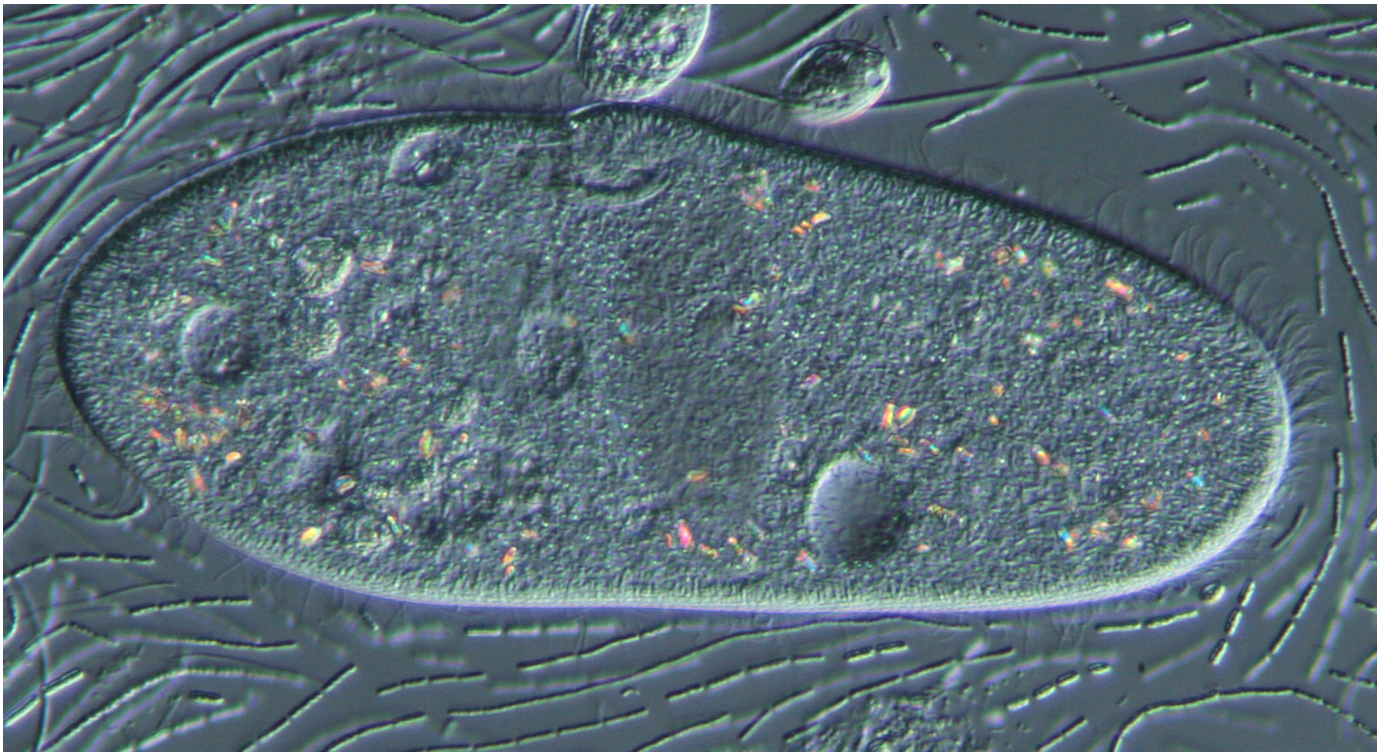


When Lyra becomes trapped in a paramecium's feeding current we must act quickly to distract the cell. We know that paramecia are attracted to bacteria by the carbon dioxide that bacteria give off. Quickly, Barron releases the contents of the Cyclops' carbon dioxide holding tanks, which lures the paramecium away, allowing Lyra to escape – once again.

As we continue our voyage, we look back to see a large colony animal feeding on the paramecia we were observing only moments ago. It seems that in the food chain of the micro world, there is always a bigger monster!

Key to Organism





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