Accompanies Episode 2 of the 13-part video series

Photosynthetic Fauna

Written by Eric R Russell & Bruce J Russell

In this episode...

The *Cyclops* crew observes a kind of *Paramecium* that hosts green algae cells within its body. They wonder how this relationship helps each organism. Later, a single algae cell is rescued and its green secrets revealed through experiments. The ship's naturalist discovers that in the presence of light, the green cell generates oxygen, along with several kinds of food molecules. This process is called **photosynthesis**.

Pond Ecology: Open Water & Weedy Shallows

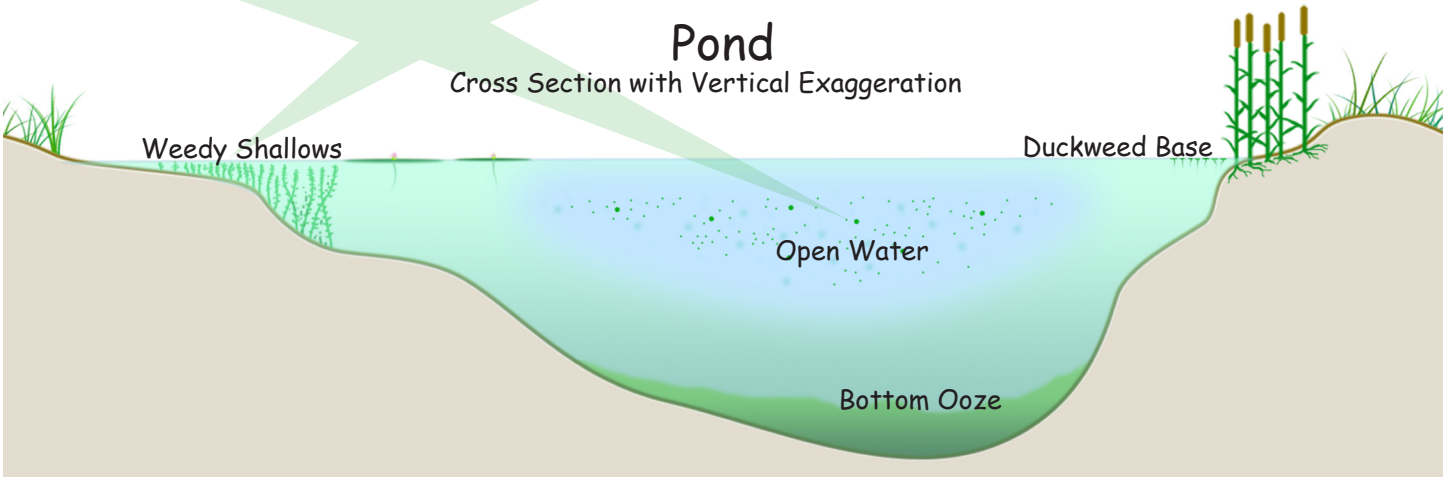
The Log of Captain Jonathan Adler

Day 3: 08:40 hours... Cruising at slow speed near the surface, the Cyclops encounters a large single-celled organism common throughout the pond – a paramecium.

This particular species of paramecium is different than the others we have seen – it is green! A closer inspection reveals that the green coloring comes from smaller green bodies inside. And these smaller green bodies are organisms themselves – algae cells!

The green cells inside do not appear to be the paramecium's lunch. We wonder what function they serve, or if their home inside the paramecium is simply a safe place to live, out of harm's way.

We have seen similar small green cells living independently throughout the sunny regions of the open water, thriving wherever sunlight is constant.



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

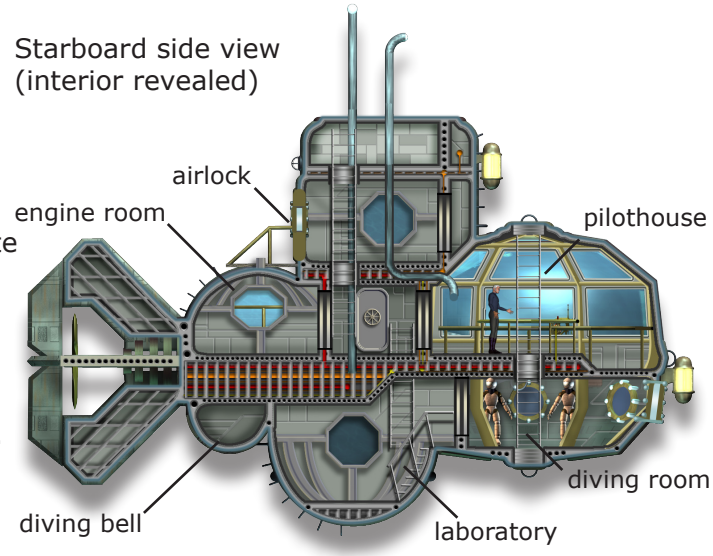
There are two onboard auxilary craft for specialized exploration: a *diving bell*, and a terrestrial *crawler/rover* (disassembled).

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.

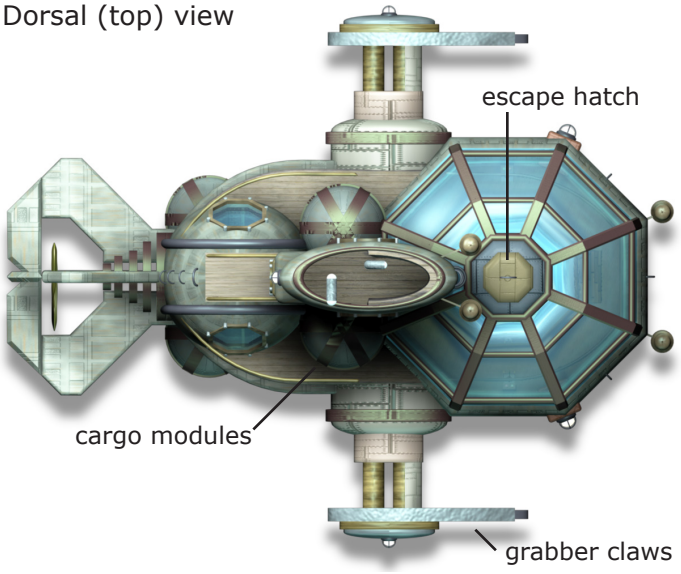
What if you were a scientist onboard the *Cyclops*? Imagine what the pond environment looks like to these micro sized explorers, only 50 microns (*µm)* tall. What unique problems might they encounter because of their size? How would they acquire repair materials, such as glass? Where would they find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

Starboard side view
(interior revealed)

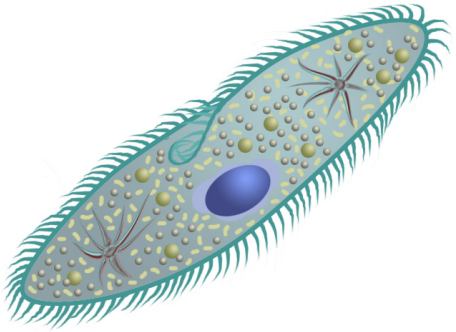


Micro Submersible Cyclops: 1000 *µm*

Dorsal (top) view



Contents of this guide...

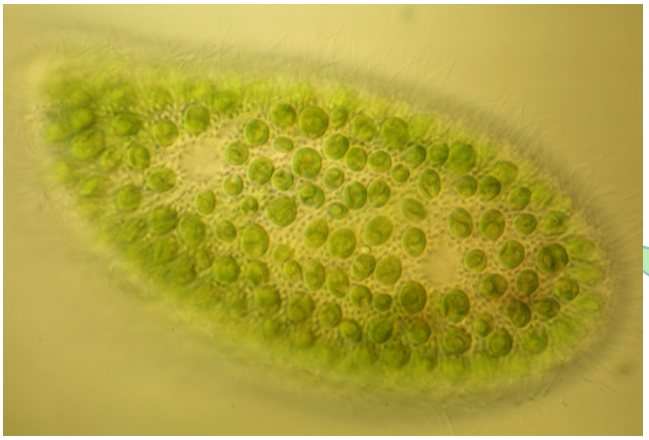


Paramecium caudatum: 750 *µm*

About the Organisms

Paramecium bursaria

Paramecium bursaria, the green paramecium, is filled with symbiotic algae cells.



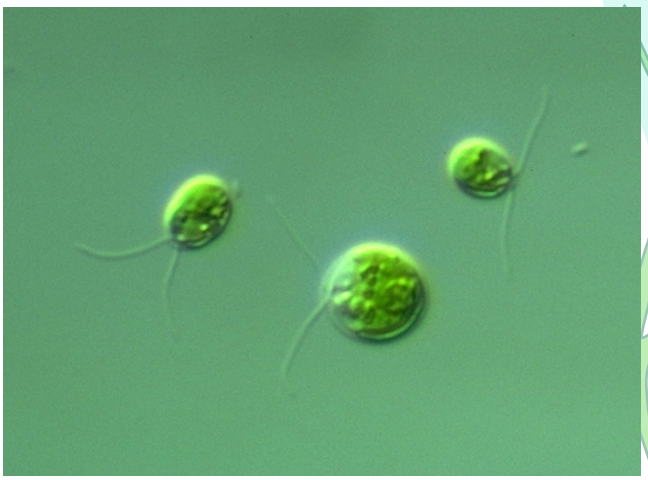
The algae make food molecules by photosynthesis and share some of these food products with their large host.

The paramecium provides its small green guests with the raw materials needed for photosynthesis, and a relatively safe environment in which to live.

The relationship between the green algae cells and the paramecium is called a symbiotic relationship.

Chlamydomonas

Chlamydomonas is a small single-celled algae.



Like many algal protists *Chlamydomonas* is a flagellate, using its pair of whip-like strands to propel itself through the water.

It travels to levels in the pond where sunlight is strong enough for photosynthesis, but not so strong that it cooks the cell.

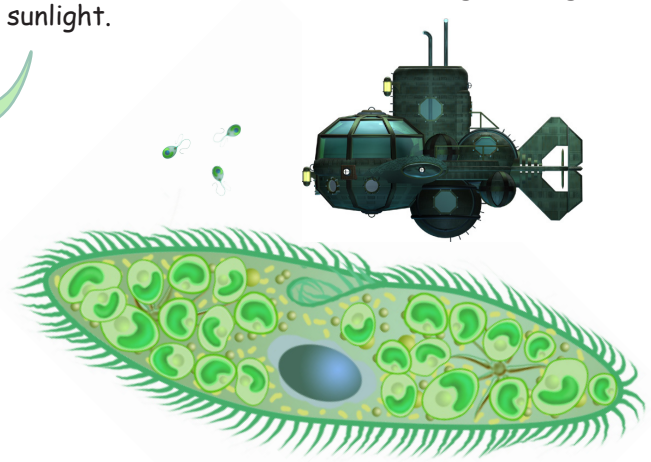
EXPLORATION GUIDE & JOURNAL

The Log of Captain Jonathan Adler

Day 3: 10:30 hours... A surprise! When we pass over the green paramecium, the Cyclops blocks the light from hitting it – and to our astonishment, the organism immediately moves back into the sunlight!

Could the paramecium be moving back into the light for the benefit of its little green guests?

We have observed that green microorganisms gather in sunny patches of the pond. Further observation is needed to learn the connection between green organisms and sunlight.



Scale comparison to Cyclops

12:15 hours... Gyro sounds the bubbles above" alert.

Air bubbles are a particular nuisance to the Cyclops. The reason is we could easily become trapped by surface tension between air and water, and be unable to escape. We must avoid these algae-generated oxygen bubble rafts at all costs.

To avoid rising into the bubble raft we must add weight to the ship. As time runs out I order the oxygen tanks flooded with water – and thankfully the Cyclops stops rising. However, now our oxygen supply is dangerously low. To make matters worse, Gyro reports something is impairing the ship's steering system. What now?

Lyra puts on her diving suit and leaves the ship to see if she can discover the problem with the rudder, and is surprised by what she finds!

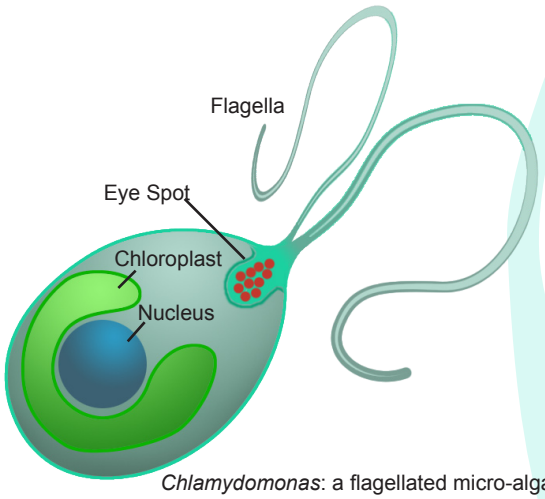
Where Energy Comes From

Life takes energy. In the world of humans, we get energy from the food we eat. If we eat a bowl of rice, the rice came from rice plants that grew in a field with sunlight, water, and nutrients from the soil. If we eat a piece of fish, that fish ate smaller fish, which ate tiny aquatic insects, which ate microscopic algae such as *Chlamydomonas*.

Plant cells and algae cells have one thing in common: they are green. The green coloring comes from small bodies inside the cells called **chloroplasts**. *Chlamydomonas* has a single chloroplast shaped like a horseshoe.

When sunlight hits a chloroplast in a plant or in an organism like *Chlamydomonas*, energy from the light causes a **chemical reaction** that makes high-energy **food molecules**... and produces **oxygen** as a waste product. This chemical process uses **photons** of sunlight to **synthesize** food energy molecules.

We call the process **photosynthesis**.



Chlamydomonas: a flagellated micro-alga

Photosynthesis

- a function of plant and algae cells
- occurs in the chloroplast of the cell
- requires sunlight, water, carbon dioxide
- converts light energy, water, and carbon dioxide into simple starch (basic food molecules)
- produces oxygen as a waste product

EXPLORATION GUIDE & JOURNAL

The Log of Captain Jonathan Adler

14:30 hours... To our delight, Lyra discovers a single greenish cell caught in the ship's rudder assembly. When she attempts to free the organism it takes her on a merry jaunt as she grasps the tether with all her strength.

Not wanting to lose my prize naturalist, I set about a quick plan to lure the green cell close enough for capture. I suddenly remember our recent encounter with the large green paramecium, and how it would move out of our shadow to bask in the sunlight. Perhaps this energetic green organism has a similar habit.

I turn to the ship's controls and power up the external lamps. Sure enough, as I had hoped, the organism changes its mad course and heads toward the light.

15:15 hours... Lyra is now safely aboard the Cyclops again and our new mascot – the green algae cell – is being observed in a glass enclosure.

It has the usual characteristics of a single cell: a roundish clear body filled with cytoplasm. This one has two flagella, which it uses like propellers for moving about. Each flagellum joins the body where we observe a cluster of red granules. We suspect this red "eye spot" is sensitive to the presence of light, and steers the cell by sending chemical signals to the flagella.

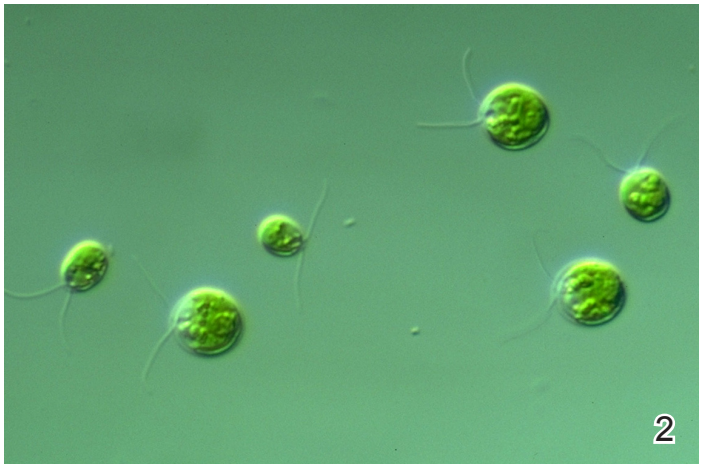
Also inside the cell is a nucleus, a number of whitish starch bodies, and a curved green structure. This is the organism's chloroplast. When light is shined upon it, the oxygen levels in the tank begin to rise and more starch bodies are produced. We believe we are watching the process of photosynthesis as it occurs.

Lyra suggests that a small zoo of these organisms might serve us by producing all the oxygen we could ever need! It appears that a happy accident has provided us with a solution to our oxygen problem.

As we continue our mission I am in awe. We have observed that every green cell in this life-rich world is a living factory, producing oxygen and the molecules for life. It is here in the micro world, I humbly realize, that the foundations of the living world begin!

Gallery of Organisms in this Adventure

The crew of the Cyclops encountered two photosynthetic organisms in this adventure. A freshwater pond, wetland, or lake contain many different species of single-celled producers – the word we use for organisms that make their own food from photosynthesis. Here are a few.



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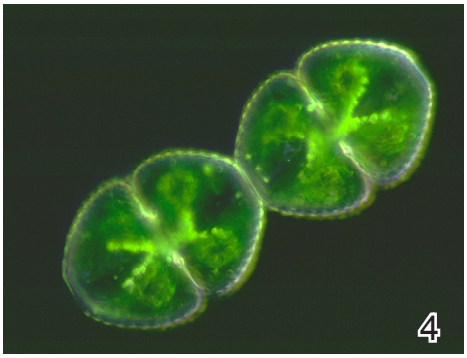

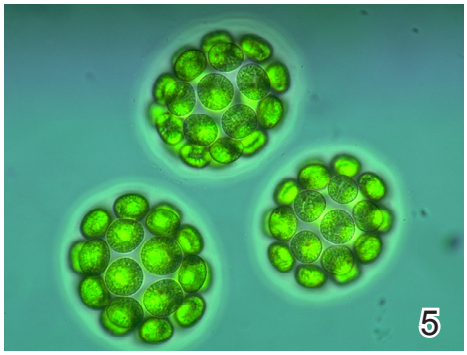

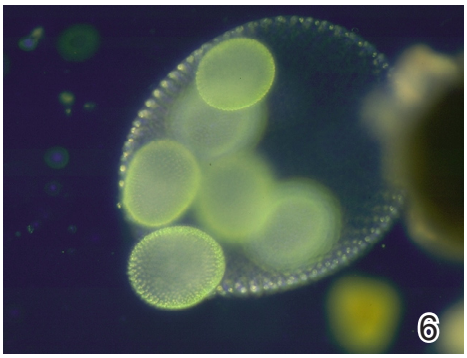

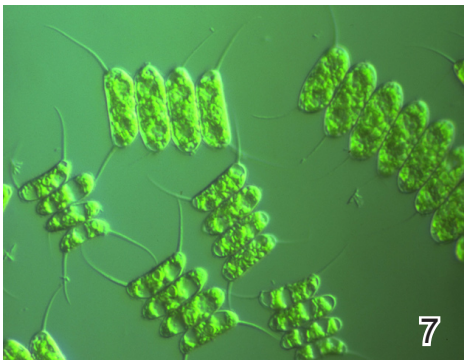

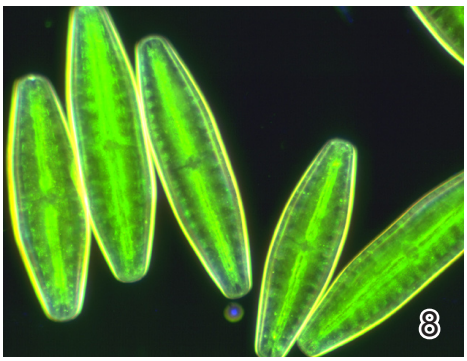

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