



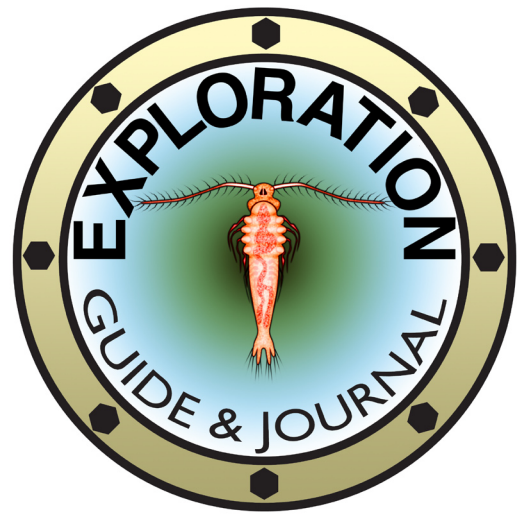
Accompanies Episode 7 of the 13-part video series

— Quick Current Critters —

Written by Eric R Russell & Bruce J Russell

In this episode...

En route to Duckweed Base, the *Cyclops* and crew are Sucked into the pond outlet, where they are washed out of the pond and tumble into a rapidly flowing stream. In the rapids they discover a world of aquatic insects living under the algae coated rocks. Careful observation reveals that insects are marvelously adapted for living on water-swept rocks. They use hooks, stream-lined shapes, suckers and safety lines—adaptations that allow these aquatic insects to exploit this hazardous habitat free from large predators and other organisms that might compete for food.



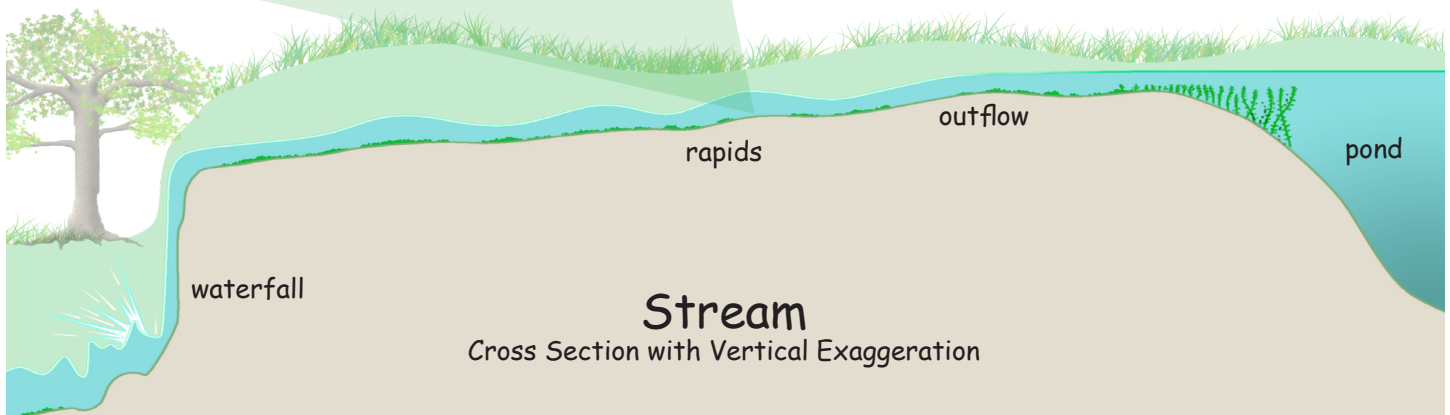
Stream Ecology: The Rapids The Log of Captain Jonathan Adler

Day 13: 09:45 hours... It must have rained last night. We awoke this morning to cooler water.

This is a very exciting day for us! Gyro reports that we are on schedule to arrive home at Duckweed Base before noon. All aboard are excited with the prospect of several days of rest and relaxation before continuing on with our biological survey mission. The crew has performed quite well on this first voyage. My report to the Micro Exploration Institute will praise these courageous explorers, and I will be recommending promotions for everyone.

10:15 hours... Gyro reports a concern. He is feeling a bit of a cross current against the wheel. To my distress the current increases with each passing minute. I can only guess that the rain in the night has flooded the pond, and that we have encountered an uncharted outflow current. Barron reports from the engine room that we don't have enough power to escape the current.

A moment later my fears are confirmed. We are being swept out of the pond, powerless and out of control!



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.

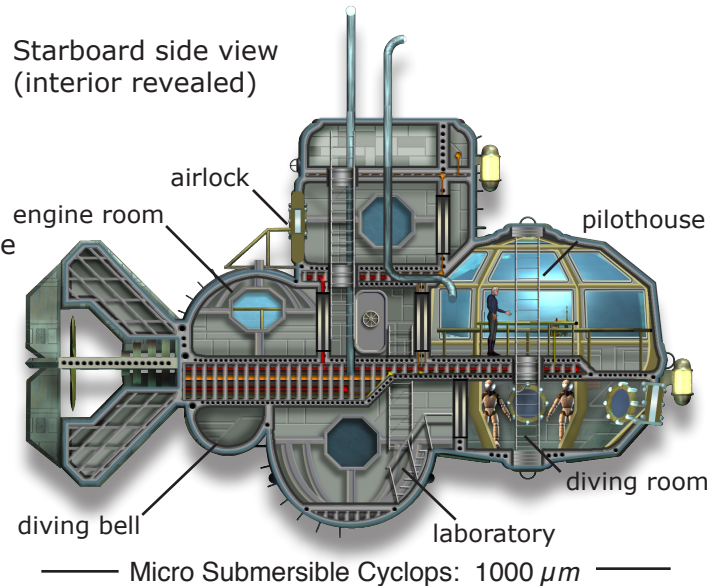
- Captain
- Ship's Naturalist
- Helmsman/Navigator
- Engine Master

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

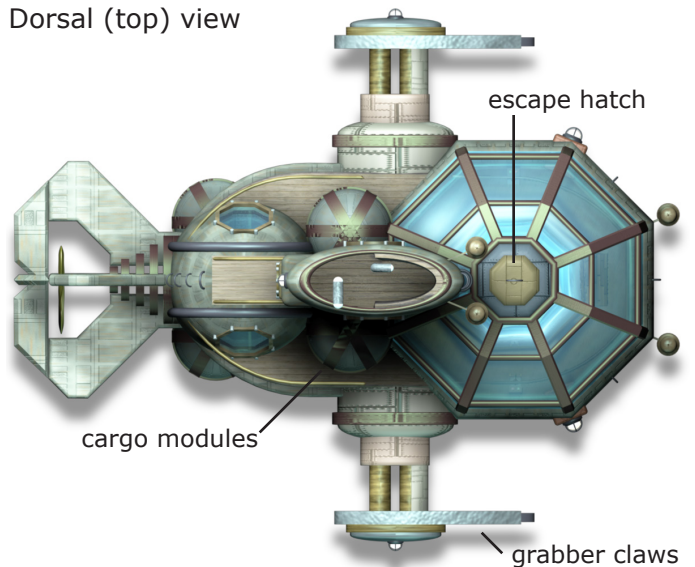
The glass enclosed pilothouse is a unique feature that allows for optimal observation of the surrounding aquatic environment.

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



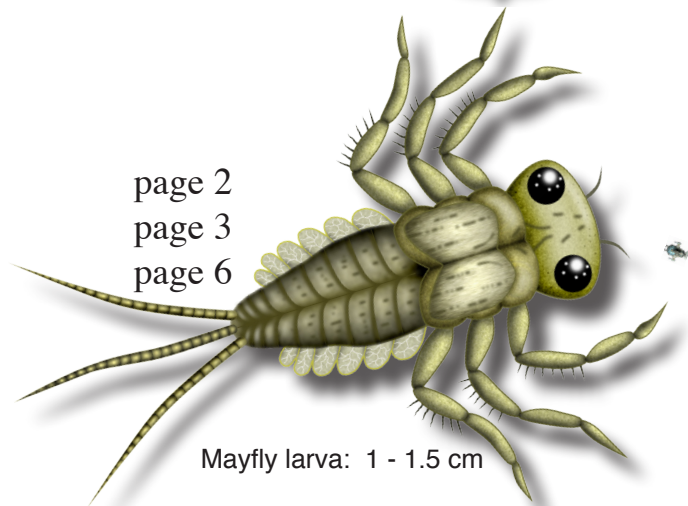
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- The Cyclops Exploration Vehicle
- About the Organisms
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About the Organisms

Mayfly Larvae: The larval stage of mayflies are adapted for life under rocks and for dealing with rapid stream current.

Look for:

- flattened bodies and appendages
- mouth parts adapted for scraping algae from the rocks
- rows of leaf-like gills along their abdomens

A mayfly's circulatory fluid is pumped through branching vessels in each gill. The gills can be fanned to improve extracting oxygen from water. This also helps flush carbon dioxide.



larval mayfly

The adult mayflies are short-lived, some only live for a day. They mate and lay their eggs in the stream. Mayfly larvae are preferred snacks for hungry trout.



adult mayfly

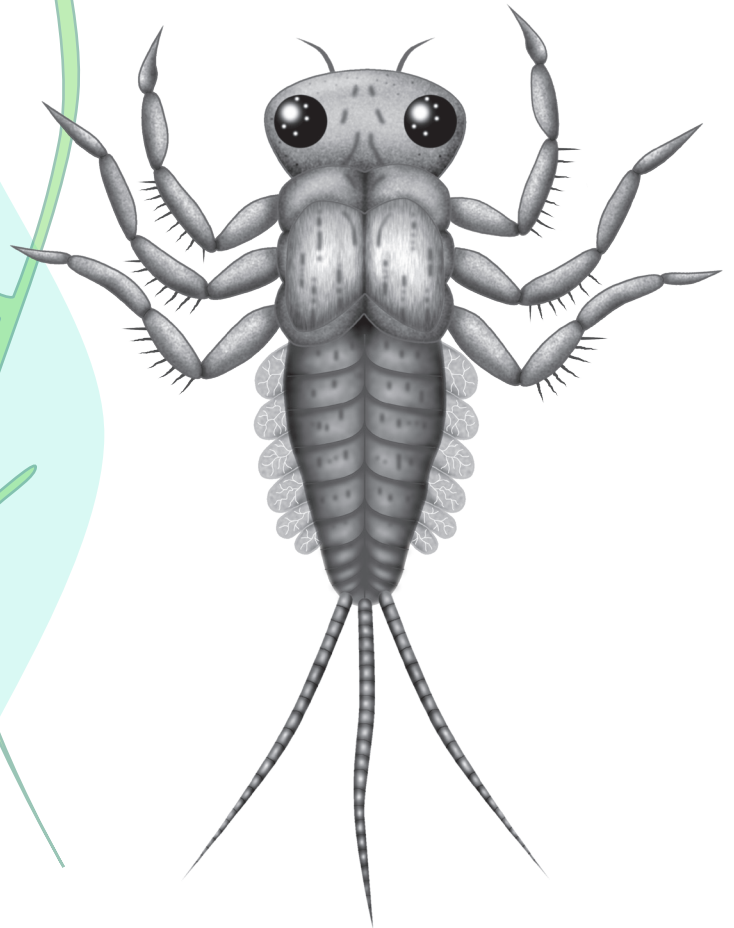


The Log of Captain Jonathan Adler

10:20 hours... we are caught in the rapids!

Enormous stream rocks streak past the windows as the current whisks the Cyclops downstream. Our friends at Duckweed Base will worry when we are overdue. I am hoping that they send out a scout to find us. In the hopes that they do, I order the crew to shoot a signal flare. Maybe somebody will see it!

When we gain control of the ship again we are stunned by the presence of many animals crawling around the stream rocks. They all have hard shell-like coverings, bodies in three sections, and six legs - they are insects! Because they are living in water, we must be seeing the larval stage of an adult insect that normally lives above water, in the air or on the land.



About the Organisms

Caddisfly larvae: They look like moving sticks, or little tubes made of sand grains. Caddisfly larvae cement these protective homes together as they grow. Like mayflies, they harvest algae attached to the rocks.



Stonefly larvae: Stoneflies are usually found living underneath stream rocks where they prey on mayflies, capturing them with their sharp mandibles. They are one of the largest stream insects and a favorite food of trout. If conditions become stagnant, stonefly larvae will begin doing “push-ups.” This behavior helps circulate water over the tufts of gill filaments located at the base of each leg. The adult stonefly looks much like the larva, but with leathery wings.



The Log of Captain Jonathan Adler

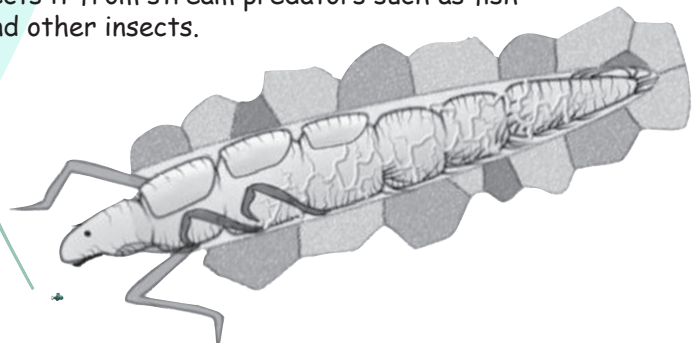
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One type of insect, mayfly larvae, have flattened bodies for living on the rocks without being whisked downstream by the powerful current. Their streamlined bodies and hooked feet allow mayflies to crawl over stream-swept rocks, scouring the surfaces for food. But what are they eating? A close look at the surface of a sunlit rock reveals the answer. Diatoms - just like the ones we found living in the pond! These photosynthetic algae cells cover the rocks, and provide food for the mayflies.

12:35 hours... further downstream we see a jumble of sand grains moving about! A closer peek shows that this pile of sand grains is a house for another type of stream insect. A caddisfly larva. Some caddisflies build houses from sand grains, others from small sticks. The insect's head and legs emerge from a tube-like house that protects it from stream predators such as fish and other insects.



Water tigers: These are the larval stages of diving beetles. The one shown is *Dytiscus*, the giant water beetle. *Dytiscus* larva are surface breathers, periodically poking their tails through the surface to take in air.

The water tiger feeding method is fascinating (and a little horrifying) to observe. They attack fish and tadpoles, spearing their prey with rapier-like mandibles. The mandibles are hollow and there is no mouth. After injecting digestive enzymes into the prey, *Dytiscus* reverses its pump and sucks up the partially digested content.



The Log of Captain Jonathan Adler

13:20 hours... swept into a slow moving pool, we see a savage monster of the stream insect world.

This very large insect larva goes by the well-earned name of water tiger! It is a fierce predator, as we soon observe.

The water tiger attacks a tadpole. Its long, needle-sharp fangs pierce the poor pollywog, which quickly becomes still.

We believe that the water tiger injects some kind of toxin into the tadpole, paralyzing it, and turning the internal organs into soup.

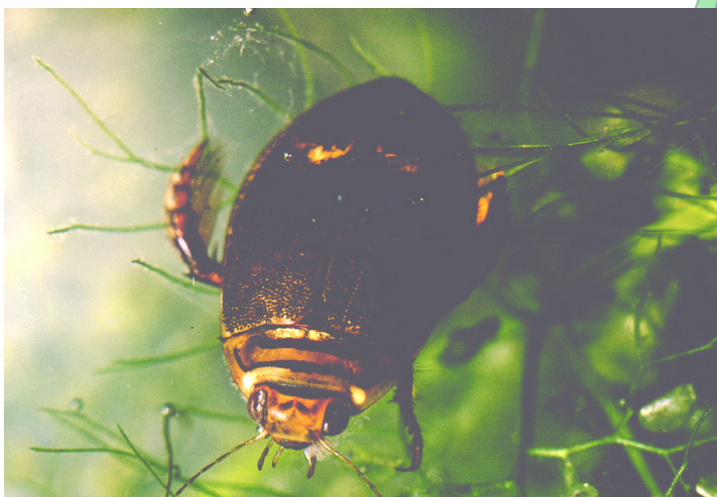
After a minute a ghastly feast begins. Through its fangs the water tiger begins sucking in the tadpole's liquified insides. What a surprise, to find an insect that preys upon more complex animals. Tadpoles and small fish are no match for the fearsome water tiger!

Although we are most likely too small to grab its attention, we steer clear of the feasting water tiger and continue our white water journey down the stream.



larval Dytiscus

Care should be taken when handling water tigers as the mandibles of a large specimen are capable of piercing the soft parts of hands and fingers.



adult Dytiscus

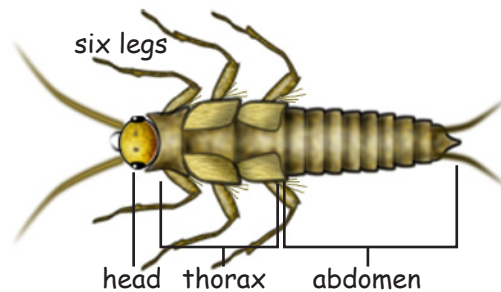


Key to Organisms

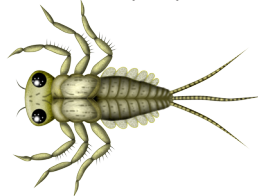
The Insect Body Plan

All insects have bodies in three sections: **head**, **thorax**, and **abdomen**. The **head** contains eyes, brain, mouth, and antennae. The **thorax** is where legs and wings attach. The **abdomen** has reproductive organs and the intestine. Insect larvae and the adults they become have the same body plan. Wings do not fully develop until the insect emerges from a pupa and begins life above the water.

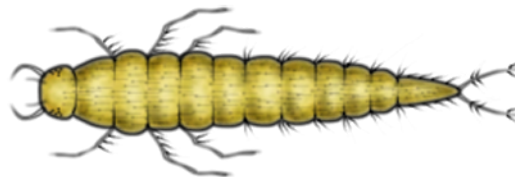
Stonefly



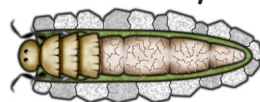
Mayfly



Water tiger



Caddisfly





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The Bacterium that Came to Dinner
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