

MACROINVERTEBRATE MANIA

A Teacher's Guide to Aquatic Wild & Project Wet Adaptations



August, 2023

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Preface

Known by many names – Trout, Salmonids, or Steelhead in the Classroom. All of these are part of the Classroom Aquarium Education Program (CAEP)!

CAEP is offered statewide, with the help and support of local community partners that include local fly-fishing clubs, educational, and environmental organizations. These groups are the backbone of the program, they play a crucial role in helping educators develop stewards of California's aquatic habitats. Each year, teachers and their students set up an aquarium to hatch, raise, and release fish under a California Department of Fish and Wildlife (CDFW) permit. Macroinvertebrate Mania was created by CDFW staff and is designed for teachers participating in CAEP.

These classroom activities are Aquatic Wild and Project Wet adaptations that complement the 2023-2024 CAEP Invertebrate Calendar. This calendar features 12 species of aquatic invertebrates that can be found in clean, healthy streams across California. Each species has a dedicated StoryMaps website that includes supplemental information, photos, and videos.

CAEP Teachers: The Bay Delta Region Interpretive Staff appreciates the extraordinary steps you take to educate your students and we are grateful for your work. We hope this project will support you and your students.

For more information, updates, ideas, and inspiration, visit us at:

Website: www.classroomaquarium.org

Facebook: www.facebook.com/TroutInTheClassroomSF

Blog: <http://classroomaquarium.wordpress.com>

Email: R3CAEP@wildlife.ca.gov

Activity 1: Are you Me?

Background

Summary

Students learn about macroinvertebrates that live in California's streams and investigate how aquatic insects grow.

Materials

- [Macroinvertebrate Mania Slides](#)
- Print copies of [Activity 1: Are You Me?](#): This 4-pg document features 10 aquatic insects in immature and adult life stages for students to make pairs

Teaching/Learning Sequence

The health of California's streams is important for our enjoyment and for the plants and animals that live in and around them. When a stream is healthy, it means that the flowing water is cold and not polluted with things like trash or harmful chemicals. It's important for us to keep streams clean and unpolluted because they provide recreational opportunities like fishing and swimming, potable water, irrigation for crops, and a habitat for many living creatures, such as benthic macroinvertebrates.

Benthic macroinvertebrates are organisms that lack an internal skeleton and are large enough to be seen without the aid of a microscope. Some examples of macroinvertebrates include aquatic insects such as dragonflies and stoneflies, mollusks like gilled snails, and freshwater crustaceans like crayfish. These small creatures are a key part of their ecosystem, and they depend on healthy waterways to survive and thrive. A lot of macroinvertebrates will spend most of their lives in the water before they change into their adult form.

Macroinvertebrates will go through two different types of growth forms, complete or incomplete metamorphosis. Animals that undergo complete metamorphosis have four distinct life stages: egg, larva (or nymph), pupa, and adult. Incomplete metamorphosis occurs in three stages: egg, nymph, and adult. During complete metamorphosis, the young insects and adults look very different. The juvenile and adult stages have a more cohesive appearance during incomplete metamorphosis, so the nymphs look like miniature versions of the adult.

This activity highlights ten aquatic insects that are featured in the 2023-2024 Invertebrate Calendar. These macroinvertebrates are sensitive to water pollution, so their presence indicates a healthy stream ecosystem. A healthy environment, with an abundance of macroinvertebrates, will provide an ample food source for trout and salmon. Which, in turn, allows us to engage in the enjoyable activity of fishing and increases our chances of successful and rewarding angling experiences.

Goal

Students will:

- Define the term macroinvertebrate
- Identify several macroinvertebrates that live in California's streams
- Recognize several macroinvertebrates at young stages and match them with corresponding adult stages

Engage

Start the activity by showing a picture of a notable US President when they were a child or perhaps a picture of yourself as a kid, if you feel comfortable sharing. Ask students if they recognize who is featured in the picture.

- Ask: *"Have you ever noticed that in pictures taken when they were younger, your family members do not look the same as how they look now?"*

Explain: Just like humans, some animals can look different when they grow. The difference in early and adult stages is especially apparent for animals like insects (such as butterflies, dragonflies, and beetles). Today we're going to learn about insects that live in or near the water during different life stages. These critters are called aquatic macroinvertebrates.

Play YouTube video [Explore What Trout Eat in the Wild \(CAEP\)](#)

Explore

1. Split the class into two groups and designate one group to be the macroinvertebrate "adults" and the other to play as the "nymphs"
2. Give each student a printed aquatic insect card and be sure to hand out the corresponding match to someone in the other group.
3. Instruct students to look for their match by pairing appropriate adult and nymph forms.
4. When all students are done, check if their choices are correct.

Explain

Ask students to use Jamboard to review all ten aquatic insects and connect the nymphs and adults. [Activity 1: Are You Me? \(Student\)](#). Answer key includes a labeled slide for each aquatic macroinvertebrate with enlarged illustrations.

[Activity 1: Answer Key \(Teacher\)](#).

Evaluate

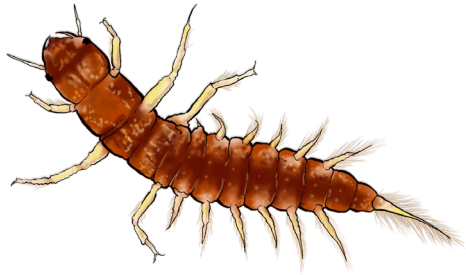
Instruct students visit the StoryMaps websites linked below and choose one aquatic animal to present on. Tell students to draw a picture of the nymph and adult life stages and ask them to circle any physical changes that are different between the two stages. Direct students to write down their thoughts on how these changes may make it easier for the animal to live in its habitat. Consider incorporating the included coloring pages and content listed in A Deeper Dive.

[A World of Invertebrates](#) (2023-2024 Invertebrate Calendar homepage)

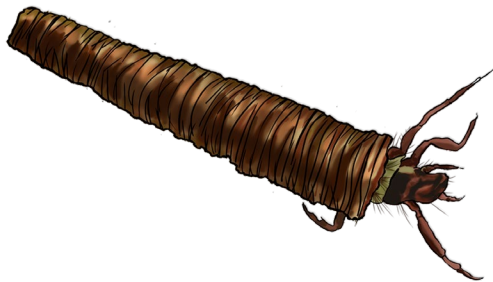
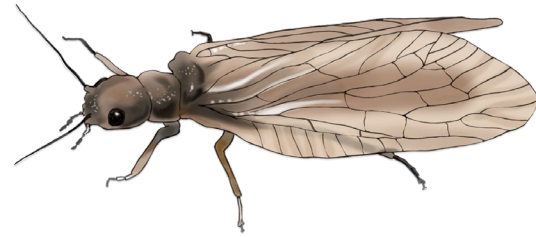
1. [Alderfly](#)
2. [Caddisfly](#)
3. [Damselfly](#)
4. [Dobsonfly](#)
5. [Dragonfly](#)
6. [Fishfly](#)
7. [Mayfly](#)
8. [Riffle Beetle](#)
9. [Stonefly](#)
10. [Water Penny](#)

Activity 1: Aquatic Insect Cards

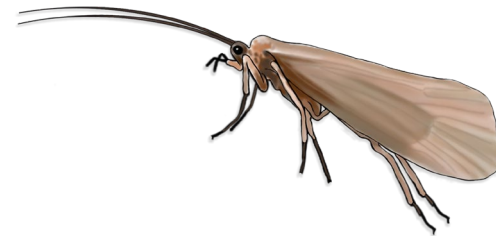
Alderfly Nymph



Adult Alderfly

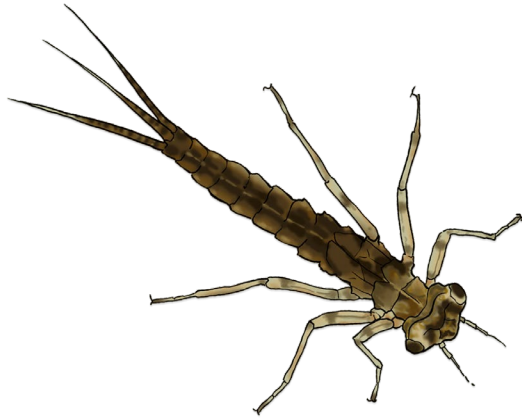


Cased Caddisfly Nymph

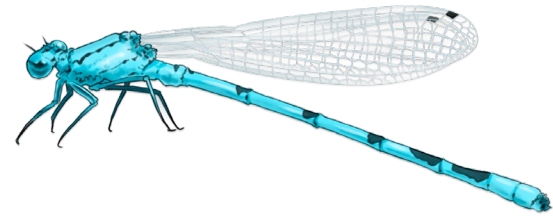


Adult Caddisfly

Damselfly Larva



Adult Damselfly

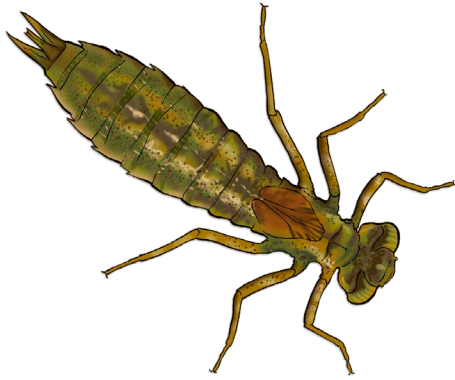


Dobsonfly Nymph

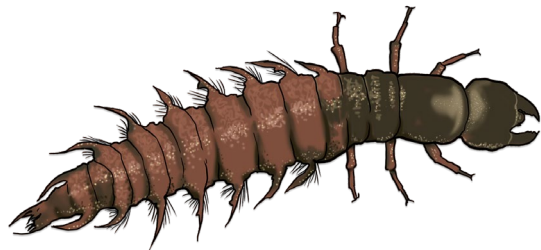
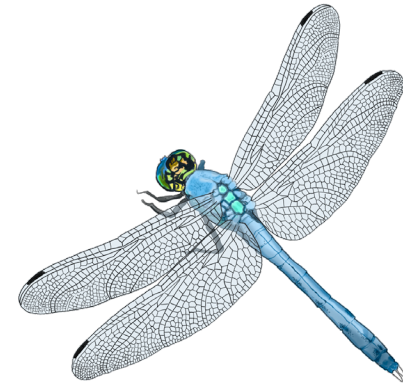


Adult Dobsonfly

Dragonfly Larva



Adult Dragonfly

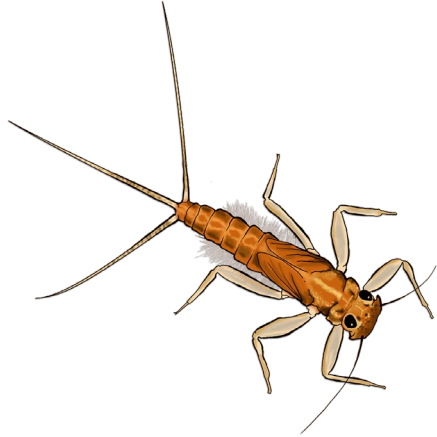


Fishfly Nymph

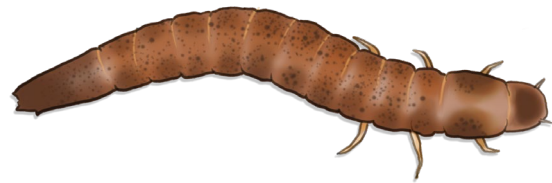
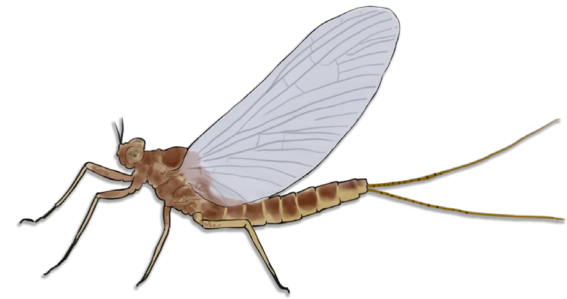


Adult Fishfly

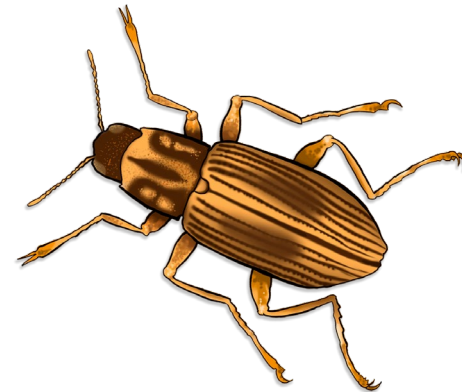
Mayfly Nymph



Adult Mayfly

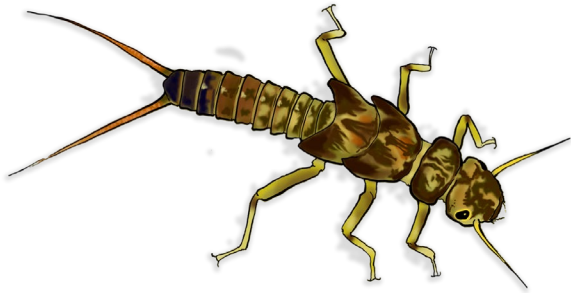


Riffle Beetle Larva

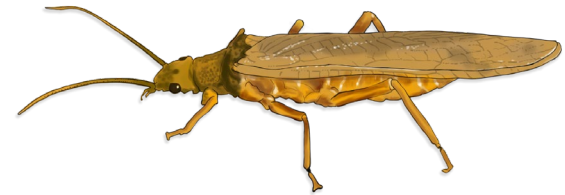


Adult Riffle Beetle

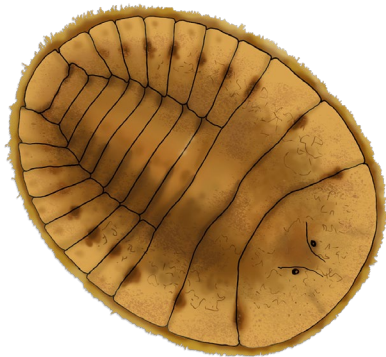
Stonefly Larva



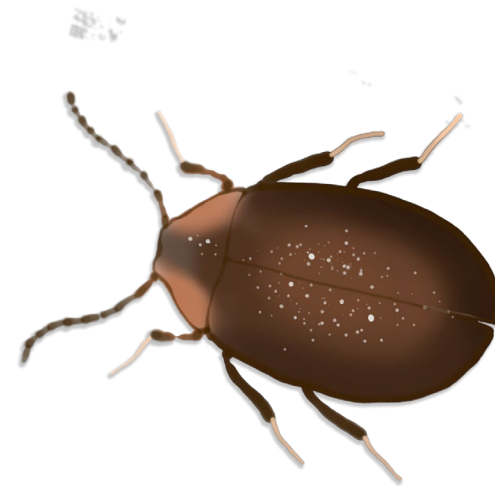
Adult Stonefly



Water Penny Nymph



Adult Water Penny



Activity 2: Water Quality? Ask the Bugs!

Background

Summary

Students learn about the health of a stream and sample aquatic macroinvertebrates represented by ordinary objects while conducting a simulated stream bioassessment.

Materials

- Print copies of [Activity 2: Water Quality? Ask the Bugs!](#): This 5-pg document includes the Stream Bioassessment Report and a table of the 11 macroinvertebrates that this activity focuses on.
- Materials for bioassessment: 3 tubs or trays that will represent streams, 11 types of different small items (10-20 each, see suggestions in Explore), 3 egg cartons for sorting macroinvertebrates, scooping tools e.g., aquarium nets or large spoons.
 - Optional: use of water in each tray and adding color to make it harder for students to produce a biased sample.

Teaching/Learning Sequence

The California Department of Fish and Wildlife promotes the use of ecological indicators to measure the health of aquatic environments. Experts at CDFW's Aquatic Bioassessment Lab use surveys known as stream bioassessments to understand the health of freshwater habitats. During a stream bioassessment scientists use special tools to collect and identify species found in or near the water. A bioassessment of aquatic macroinvertebrates is a relatively simple and inexpensive method that helps scientists monitor the health of streams. People who focus on the study of insects are called entomologists, and people who specialize in the abundance of water insects are known as aquatic invertebrate taxonomists. Entomologists and aquatic invertebrate taxonomists are like detectives of the water world, they can determine the water quality based on the presence of certain creatures.

During this activity, students will simulate a stream bioassessment to collect and identify some macroinvertebrates featured in the 2023 CAEP Invertebrate Calendar. Students will learn that some macroinvertebrates are very vulnerable to water pollution, while others can tolerate polluted waterways. The presence of critters that are sensitive to water pollution, may indicate a healthy stream ecosystem. After carefully documenting their findings and noting the diversity

and abundance of macroinvertebrates, your students will determine the water quality of three streams — just like a professional would!

Goal

Students will:

- Analyze the relationship between macroinvertebrate populations and stream water quality

Engage

Play YouTube video [Using Insects to Detect the Health of a Stream \(CAEP\)](#)

Explore

1. Inform your class that they will be simulating a stream bioassessment using ordinary objects to represent macroinvertebrates.
2. Set up three collection stations and place objects according to the chart below. You can use orbeez balls, marbles, or office supplies. Please note that the original activity calls for 50-100 items of each different item type and plan accordingly, depending on your class size.

Macroinvertebrate	Represented by	Number of Items per Stream Sample			Total Items
		Stream #1	Stream #2	Stream #3	
Stoneflies	Red beads	13	7	0	20
Riffle beetles	Green beads	13	7	0	20
Mayflies	Blue beads	7	3	0	10
Caddisflies	Black beads	6	4	0	10
Dobsonflies	White beads	6	4	0	10
Damselflies	Yellow beads	4	4	2	10
Dragonflies	Orange beads	4	4	2	10
Midges	Small paper clips	0	4	6	10
Leeches	Large paper clips	0	3	7	10
Water scorpions	Thin rubber bands	0	3	7	10
Tubifex worms	Thick rubber bands	0	3	7	10

3. Divide students into three groups.
4. Instruct students to simulate three rapid bioassessments. Using their aquarium net or spoons, students will have 20 seconds to gather macroinvertebrates from their stream.

Each group should sample all three streams, sort like items, count, and record their findings on the Stream Bioassessment Report.

Explain

Expand on the findings of the Stream Bioassessment Report. Have students compare their results with other groups and identify similarities and differences. Discuss which stream had the highest level of water quality and consider what factors may have impacted the water quality. Ask students if their samples accurately reflect the population of invertebrates in their stream and how they know. Brainstorm how a real stream bioassessment could be modified to increase its accuracy.

Evaluate

Instruct students visit the StoryMaps websites linked below and choose one aquatic animals to present on. Direct students to write a report highlighting any interesting facts related to pollution tolerance, life cycle, or habitat. Consider incorporating the included coloring pages and content listed in A Deeper Dive.

[A World of Invertebrates](#) (2023-2024 Invertebrate Calendar homepage)

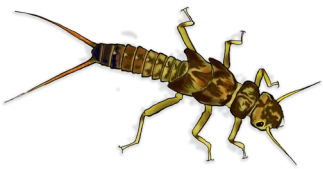

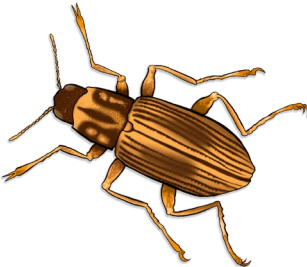

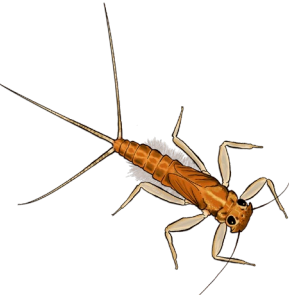

1. [Alderfly](#)
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3. [Damselfly](#)
4. [Dobsonfly](#)
5. [Dragonfly](#)
6. [Fishfly](#)
7. [Mayfly](#)
8. [Riffle Beetle](#)
9. [Stonefly](#)
10. [Water Penny](#)
11. [Gilled Snail](#)
12. [Crayfish](#)

Activity 2: Stream Bioassessment Report

Group Instructions

1. Simulate a rapid bioassessment as instructed by your teacher.
2. Put a check next to the macroinvertebrate group if you found any macroinvertebrates of that kind.
3. Calculate the group scores using the multipliers provided.
4. Total all of the group scores for your Total Score.
5. Use the Water Quality Assessment Chart to compare your Total Score and record the relative water quality rating for your stream sample.
6. Write a short Water Quality Assessment Report.

Stream #:			
Date:			
Recorded by:			
Group 1 Very Sensitive	Group 2 Sensitive	Group 3 Tolerant	Group 4 Very Tolerant
<ul style="list-style-type: none"> ● Stoneflies ● Riffle Beetles ● Mayflies ● Caddisflies 	<ul style="list-style-type: none"> ● Dobsonflies ● Damselflies ● Dragonflies 	<ul style="list-style-type: none"> ● Midges ● Leeches 	<ul style="list-style-type: none"> ● Water Scorpions ● Tubifex Worms
# of checks =	# of checks =	# of checks =	# of checks =
<u>X 4</u> Group Score =	<u>X 3</u> Group Score =	<u>X 2</u> Group Score =	<u>X 1</u> Group Score =
Total Score =		Water Quality Assessment Chart ≥ 23 Potentially Excellent Water Quality 17-22 Potentially Good Water Quality 11-16 Potentially Fair Water Quality ≤ 10 Potentially Poor Water Quality	
Water Quality Assessment Report:			

Macroinvertebrate	Looks like...	Represented by...
 <p data-bbox="453 483 585 516">Stoneflies</p>		
 <p data-bbox="432 889 611 922">Riffle Beetles</p>		
 <p data-bbox="464 1256 583 1289">Mayflies</p>		

Macroinvertebrate

Looks like...

Represented by...



Caddisflies









Dobsonflies



Damselflies

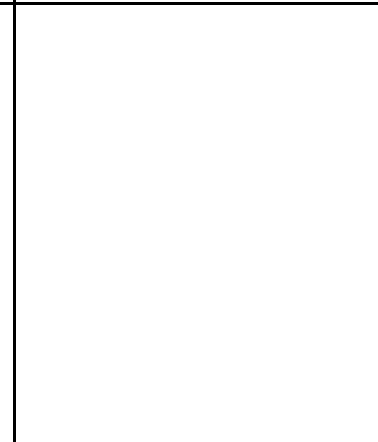
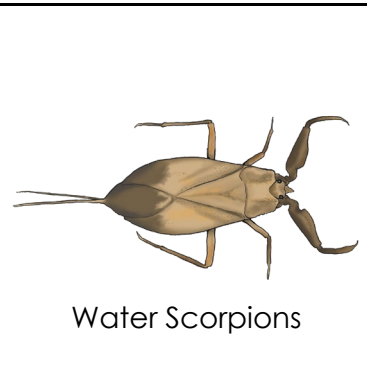


Macroinvertebrate	Looks like...	Represented by...
 <p data-bbox="441 560 609 600">Dragonflies</p>		
 <p data-bbox="462 852 577 893">Midges</p>		
 <p data-bbox="451 1209 598 1250">Leeches</p>		

Macroinvertebrate

Looks like...

Represented by...



A Deeper Dive

Additional resources you can explore with students:

- [Macroinvertebrate Jeopardy](#)

CDFW YouTube Videos:

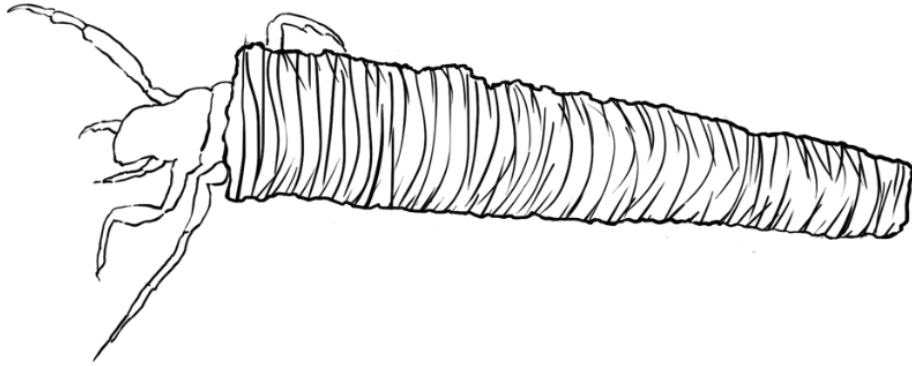
- [Using Insects to Detect the Health of a Stream \(CAEP\)](#)
- [Explore What Trout Eat in the Wild \(CAEP\)](#)
- [Small Critters Within Rivers](#)
- [Importance of Urban Streams](#)
- [Climate Change: Threats to Aquatic Ecosystems](#)
- [Invasive Quagga and Zebra mussels](#)

Unaffiliated YouTube Videos (please preview for age-appropriate content):

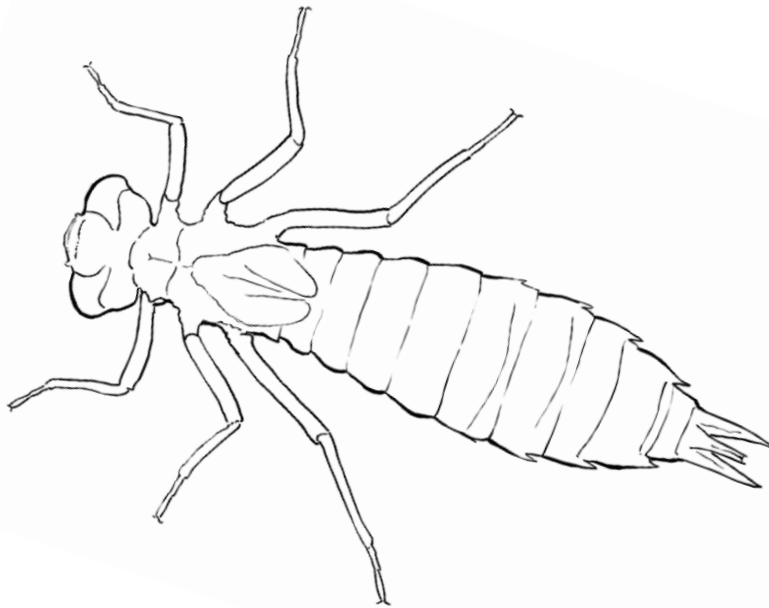
- [A Baby Dragonfly's Mouth Will Give You Nightmares | Deep Look](#)
- [Nature's Scuba Divers: How Beetles Breathe Underwater | Deep Look](#)
- [Sticky. Stretchy. Waterproof. The Amazing Underwater Tape of the Caddisfly | Deep Look](#)
- [These Rare Damselflies Find Love With a Twist in Fog City | Deep Look](#)
- [Dragonfly facts: neither dragons nor flies | Animal Fact Files](#)
- [Dobsonfly facts: also known as hellgrammites! | Animal Fact Files](#)
- [Stonefly Facts: a CLEAN WATER insect | Animal Fact Files](#)
- [Crawfish Facts: aka CRAYFISH facts | Animal Fact Files](#)
- [2 Minute Macro Video - Snailed It! Lunged Snails Vs. Gilled Snails](#)
- [Mayfly's incredibly short and action-packed lifecycle - BBC](#)

Student Coloring Book

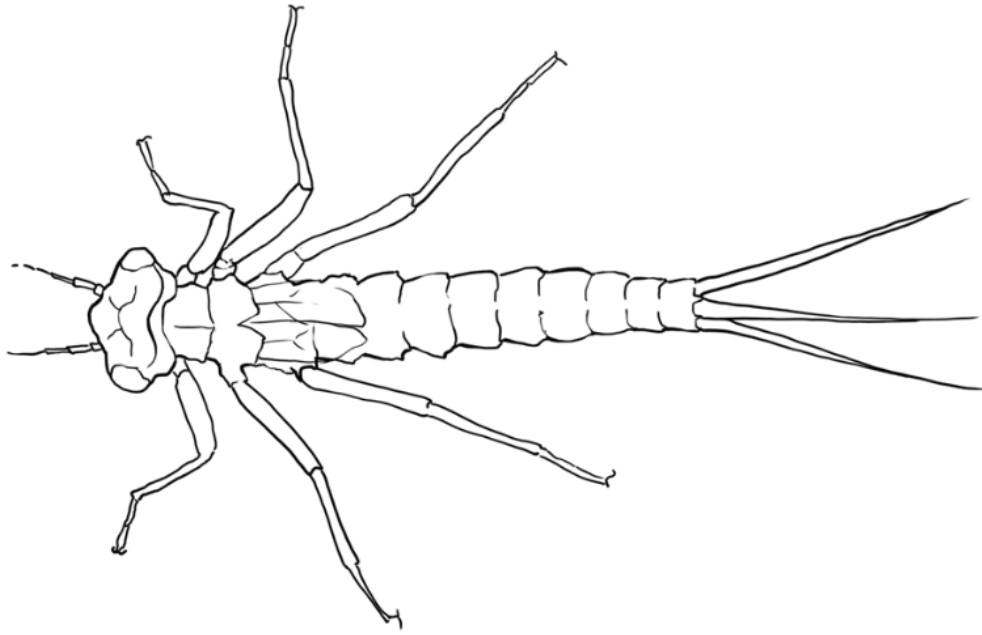
Caddisfly



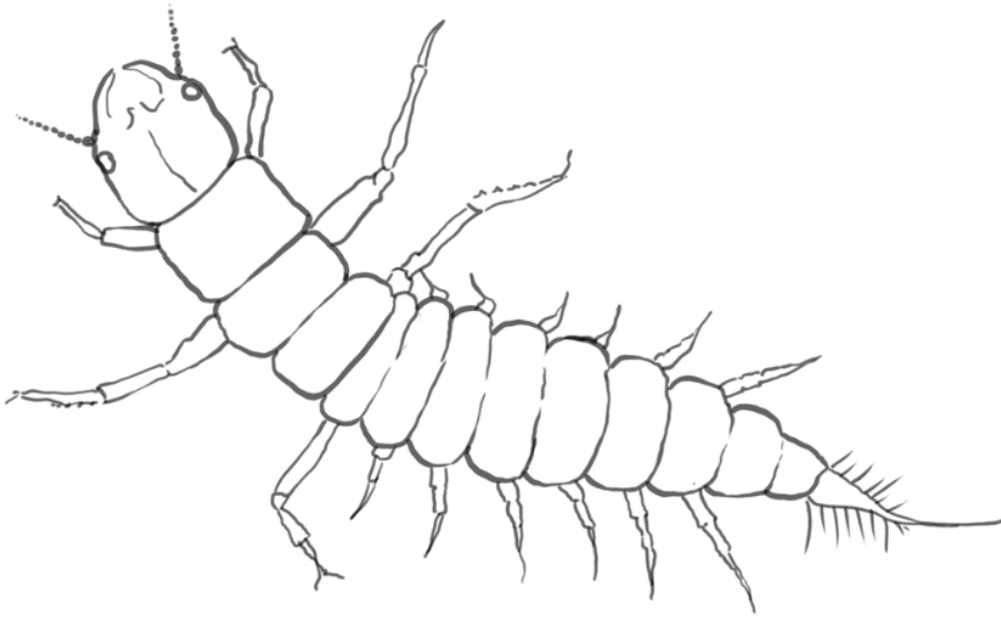
Dragonfly



Damselfly



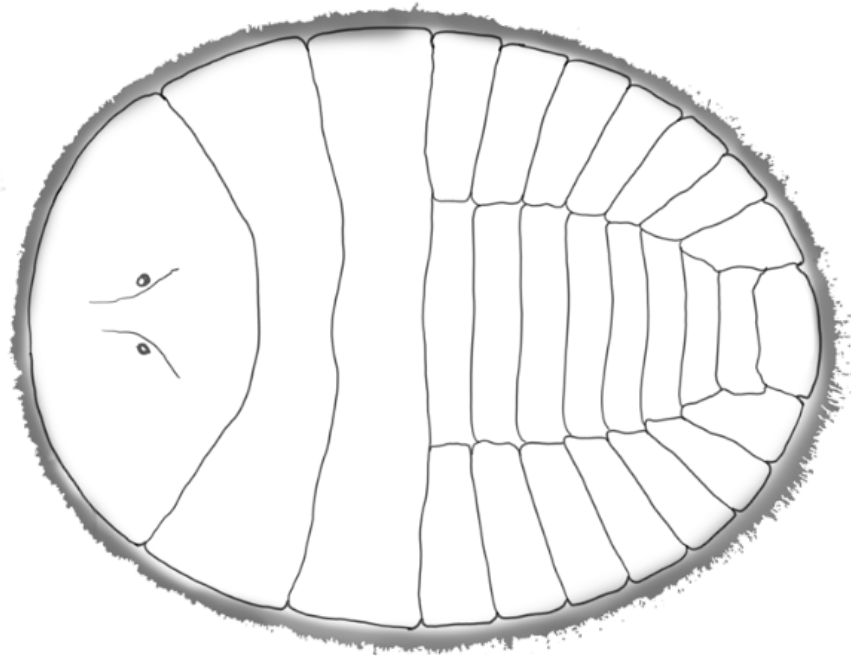
Alderfly



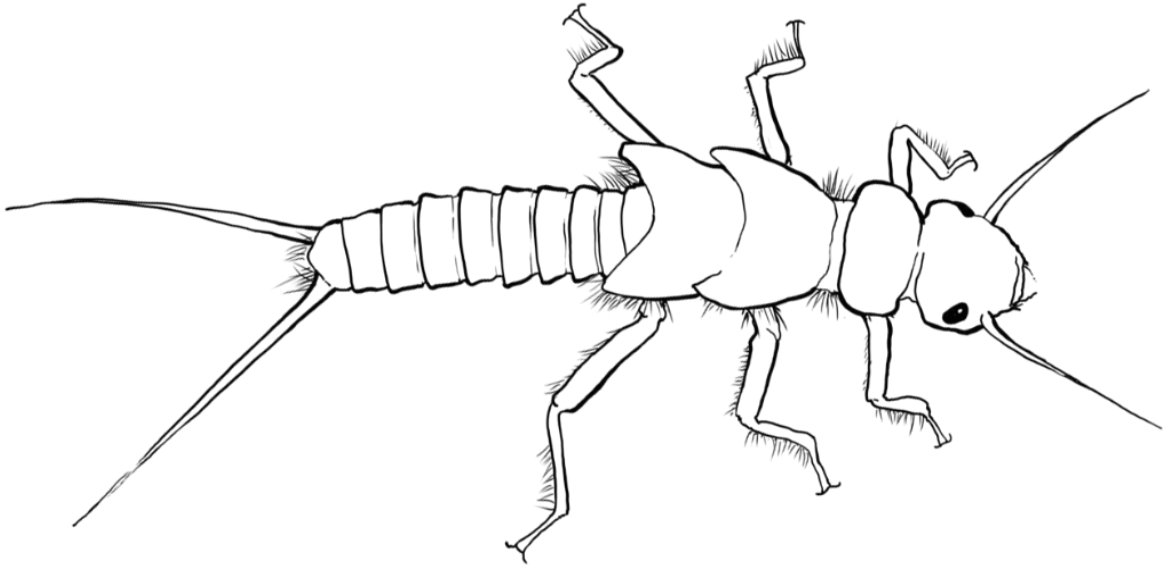
Fishfly



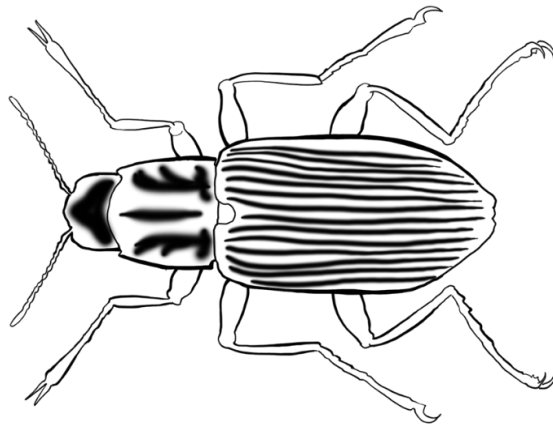
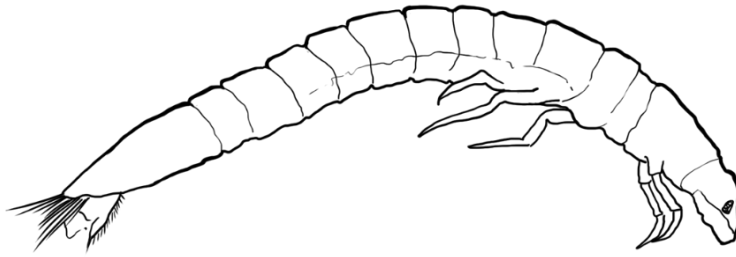
Water Penny



Stonefly



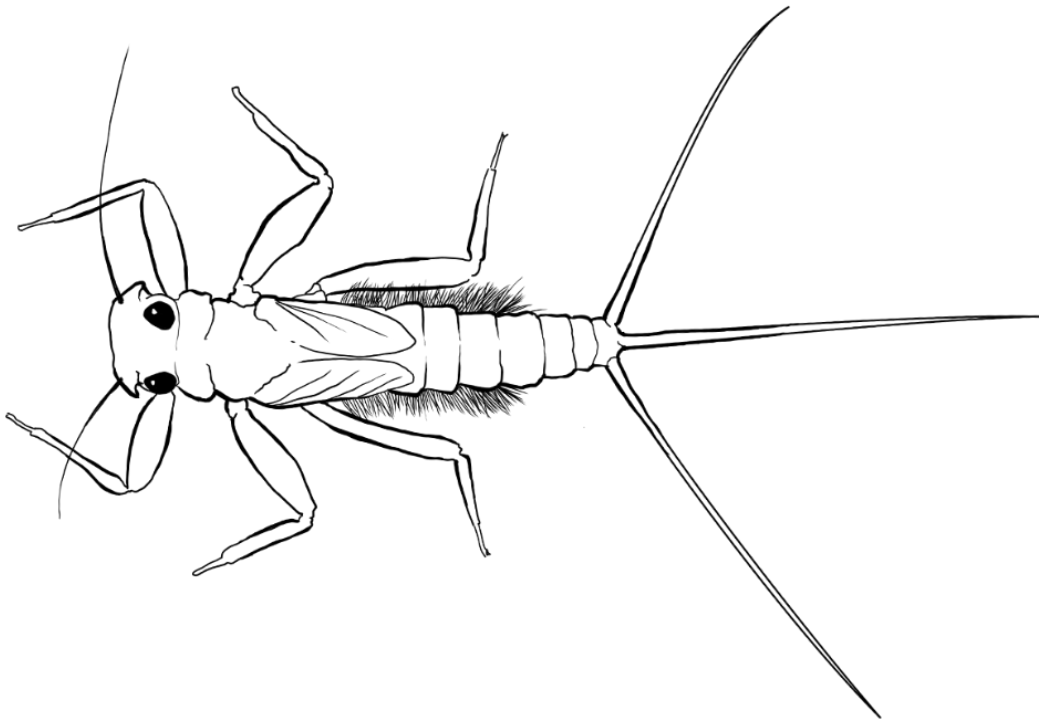
Riffle Beetle



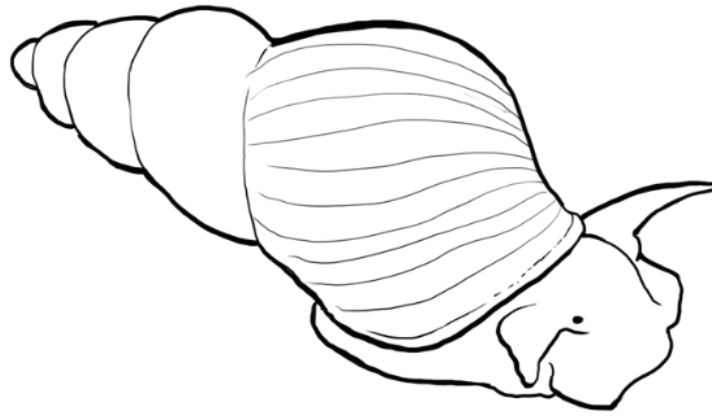
Dobsonfly



Mayfly



Gilled Snail



Crayfish

