Macroinvertebrate Mayhem!

Grade Level
Fourth to Sixth

Duration
- Prep time: 15 minutes
- Activity time: 50 minutes

Vocabulary
- Fauna
- Flora
- Habitat
- Hydrology
- Hydric
- Hydrophytic
- Macroinvertebrate
- Metamorphosis
- Peat
- Wetland

Materials
- Macroinvertebrate ID necklaces (42)
- Environmental stressor cards (4)
- Large chart paper/ whiteboard
- Colored markers (3)
- Boundary markers

Learner Objectives

Students will:
- Define macroinvertebrate
- Understand the role of macroinvertebrates as indicators of ecosystem health
- Understand and identify sources of pollution and the effects on a wetland habitat

Getting Ready!

- Read background information
- Set up play area

Summary

Students play a game that simulates changes in a stream when an environmental stressor, such as a pollutant, is introduced. Sensitive organisms are displaced by tolerant ones over time as stream conditions deteriorate. Community structure (biodiversity) is graphed to observe population changes among sensitive, moderate,

Background Information

A habitat is the arrangement of food, water, shelter, and space suitable for the needs of a plant or animal to survive. Different habitats support different communities of flora and fauna. Wetland habitats across North American support a large diversity of animals. A wetland is an area that is covered with water for all or part of the year. It is the transition zone between open water and land. Wetlands are classified by hydrology, hydric (saturated) soils, and hydrophytic (water tolerant) plant communities. Wetlands are generally thought of as coastal or inland. Coastal wetlands include tidal marshes, estuaries, and marine environments. Inland wetlands include a variety of marshes, swamps, and fens. Inland marshes include freshwater marshes, wet meadows, wet prairies, prairie potholes, playas, and vernal pools. Swamps include forested bogs, shrub swamps, and mangrove swamps. Fens are peat-forming wetlands that receive nutrients and water from upslope sources through drainage rather than precipitation. Wetland classification depends on the source of water, the presence or absence of peat, and dominant large vegetation. For example, the word “marsh” describes a wetland with non-woody vegetation that grows taller than the water (e.g. cattails). On the other hand, a swamp is dominated by trees. Fens are dominated by grasses, sedges, and wildflowers.

Wetlands are home to a large diversity marcoinvertebrates! Macroinvertebrates are organisms that lack a backbone and are visible without the aid of magnification. These animals live in water on rocks, logs, sediment, debris, and aquatic plants during some stage of their life cycle. Macroinvertebrates include crustaceans such as crayfish, mollusks such as clams and snails, aquatic worms and the immature forms of aquatic

insects such as stoneflies and mayflies.

Macroinvertebrates are an important part of wetland, riparian, and lake ecosystems as they are a key part of the food web (both as food sources and decomposers), and act as indicators of the health of their aquatic habitats. There are several reasons why scientists use macroinvertebrates as indicators of water quality. Certain species are sensitive to different changes in the environment and they cannot easily escape these changes. Many species spend a year or more in their aquatic habitat and are susceptible to environmental changes throughout the year. Finally, they can be easily and inexpensively collected.

Some macroinvertebrates are more sensitive to pollution than others; picture the expressions "canary in the coal mine" and "cockroaches are able to survive a nuclear bomb." The same principle holds true for macroinvertebrates. In the presence of pollution, sensitive organisms, such as stoneflies, mayflies, and caddisflies, will die. Moderate and tolerant organisms can survive in polluted habitats, thereby taking the place of the absent sensitive organisms.

Organism Background

- **Stoneflies** are found in fast-flowing, oxygen rich water. They lack obvious gills and are predators of other macroinvertebrates or eat plant material they find in the stream. All stonefly species are sensitive to pollution.
- **Mayflies** are found among rocks in flowing water, on aquatic plants, or in burrows in calm water (including lakes). Their abdominal gills allow them to survive in moderately low dissolved oxygen environments. Most eat plant material they collect or scrape algae off rocks. Most mayfly species are sensitive to pollution.
- **Caddisflies** build either cases for protection or nets to catch food from flowing water. They are slow movers and absorb oxygen through their soft bodies. Very few are free-moving predators. Most caddisfly species are sensitive to pollution.
- **Dragonflies** are all predators and have a hinged lower jaw that allows them to jut out to catch prey. They are only found in slow-moving parts of streams or in lakes or ponds. Their gills are on their abdomen, which they use to propel themselves forward to ambush prey or to absorb oxygen in low-quality environments. All dragonfly species are moderately tolerant to pollution.
- **Midges** are very small, tolerant stream insects, usually found in high numbers when conditions are poor (excessive sedimentation, low dissolved oxygen, low flow, etc). Some are bright red because they use hemoglobin to absorb the last bit of oxygen from the water.

- **Rat-tailed maggots** are so tolerant they can live in pools of sewage sludge – their tail is actually a snorkel that allows them to breathe air, no matter how poor the dissolved oxygen levels get!

Discuss!

1. Get students to define macroinvertebrate and think of examples. *A macroinvertebrate is an animal with out a backbone that you can see without magnification. Examples of macroinvertebrates include insects, spiders, slugs, crabs, worms, etc*.
2. Go over the examples of macroinvertebrates used in this activity (stonefly, mayfly, caddishfly, dragonfly, midge, and rat-tailed maggot) and discuss the important role that they each play in the food chain.
    a. If time allows, explain the different lifecycle of insects: complete and incomplete metamorphosis. Caddisflies and butterflies undergo a complete metamorphosis. These insects begin as eggs, then hatch into a grub-like larvae which then pupate before becoming adults that do not resemble their larval form.
    b. Stoneflies, mayflies, and dragonflies undergo an incomplete metamorphosis. These insects begin as eggs, which then hatch into a nymph. Nymphs resemble adult forms and slowly grow wing pads until they are ready to molt a final time into adults.
3. Tell students that macroinvertebrates act as indicators for the health of their aquatic environments and habitats. Some macroinvertebrates are more sensitive to changes in pH, nitrogen, and other environmental stressors than others.
4. Discuss ways that a stream can become polluted and how this can alter stream conditions. *Examples include pollutions causing toxic conditions, algae blooms, sedimentation/low visibility, and low dissolved oxygen*.
5. Ask students if you would expect to see more or less species diversity in a healthy habitat compared to a polluted habitat?
6. Introduce the activity to the group! Students will become aquatic macroinvertebrates and try to survive several pollution events.

Investigate!

1. Select one or more students to be environmental stressors depending on the size of the group or the magnitude. These students will be the taggers.
2. Distribute 1 macroinvertebrate card to each remaining student.
    a. If their card has 2 sides, have them use the side with the more sensitive organism first (colored green or yellow).
3. Review each of the organisms and their tolerances. Sensitive organisms have limitations to their movements across the play area that reflects their individual adaptations:
    a. Stoneflies must perform 1 pushup every 5 steps across the field (10 steps for

younger students). They lack obvious gills and become oxygen-starved in polluted water; pushups move more water across their bodies for better oxygen absorption.
   b. Mayflies must flap their arms and spin in circles as they cross. They too need more oxygen when water is polluted, which is absorbed by their fluttering gills.
   c. Caddisflies, with their case, are limited to hopping across the field with their legs together.
   d. It's difficult for them to escape pollution events!
4. Have Sensitive organisms practice their movements.
5. Both moderate and tolerant organisms behave normally in polluted conditions, so they can run across the field.
6. When a sensitive or moderate organism is first tagged by pollution, the student flips over their ID card to show that the less tolerant macroinvertebrate was replaced by a more tolerant one.
   a. NOTE: Their card will not change during the rest of the activity, nor will any students' card who started out as a tolerant organism.
7. Before the beginning of each round, record the number of students in each tolerance group.
   a. See sample chart in teacher tips.
8. Ask students to predict what will happen before each round.
   a. During each round of play, environmental stressors will try to affect the macroinvertebrates by tagging them as they move from one side of the play area to the other ("crossing the stream").
9. Define the play boundaries and begin!
10. After three rounds, reconvene to discuss the results.
11. With student assistance, graph the starting organism numbers and the changes in numbers after each round.
12. As each round is completed, there will be an increasing number of tolerant organisms as they replace Sensitive and Moderate organisms. Remember to graph the number of students in each tolerance group before starting the next round.
   a. Environmental stressor students can change places with macroinvertebrates at the end of each round, selecting different types of pollution if desired.

Wrap Up & Review!

Generalize what happened to the distribution of organisms over time, particularly the rise of tolerant organisms as they take the place of sensitive macroinvertebrates. Ask for reasons for the changes.

- Review why some organisms are more tolerant of poor environmental conditions than others.
- Have students compare the stream environment at the beginning of the game to the environment at the end.
- How can the assorted pollution sources be remedied or prevented? Why is it important

to do so?

Teacher Tips

Consider the following ratio for sensitive, moderate, and tolerant macroinvertebrate necklaces:

- 30 Sensitive (green): 10 each of stoneflies, mayflies, and caddisflies
- 8 Moderate (yellow): dragonflies
- 4 Tolerant (orange): 2 each of midges and rat-tailed maggots
- The back side of each Sensitive or Moderate card has an orange Tolerant organism

Sample Chart:

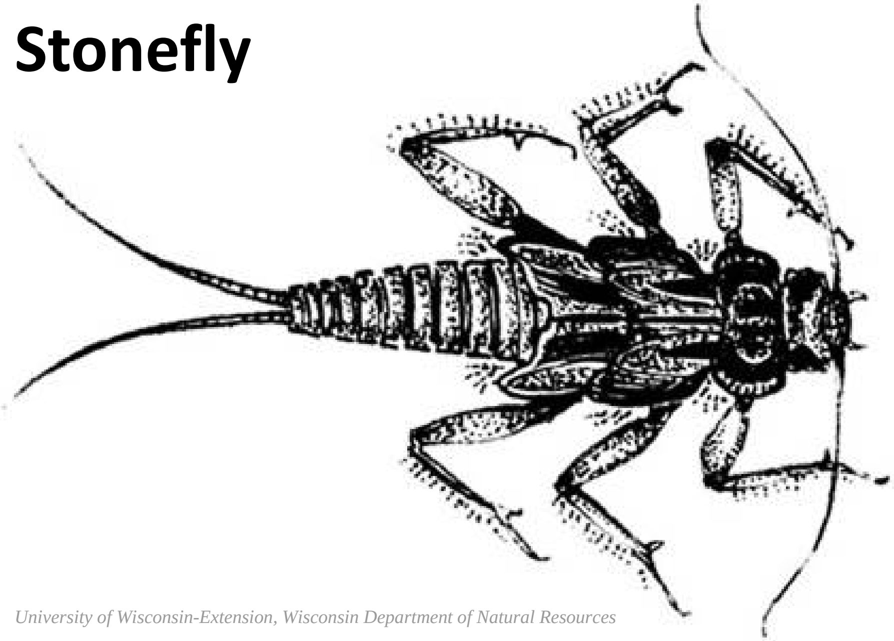
Organism	Tolerance	Number of Organisms			
		Start	Round 1	Round 2	Round 3
Stonefly Larva	Sensitive	6	5	2	0
Mayfly Larva	Sensitive	6	3	1	0
Caddisfly Larva	Sensitive	6	4	3	1
Dragonfly Nymph	Moderate	4	3	2	1
Midge Larva	Tolerant	2	6	9	14
Rat-tailed Maggot	Tolerant	2	5	9	14
TOTALS		**26**	**26**	**26**	**26**

Resources:

Project Wet

http://www.ncsu.edu/sciencejunction/depot/experiments/water/lessons/macro/

Stonefly



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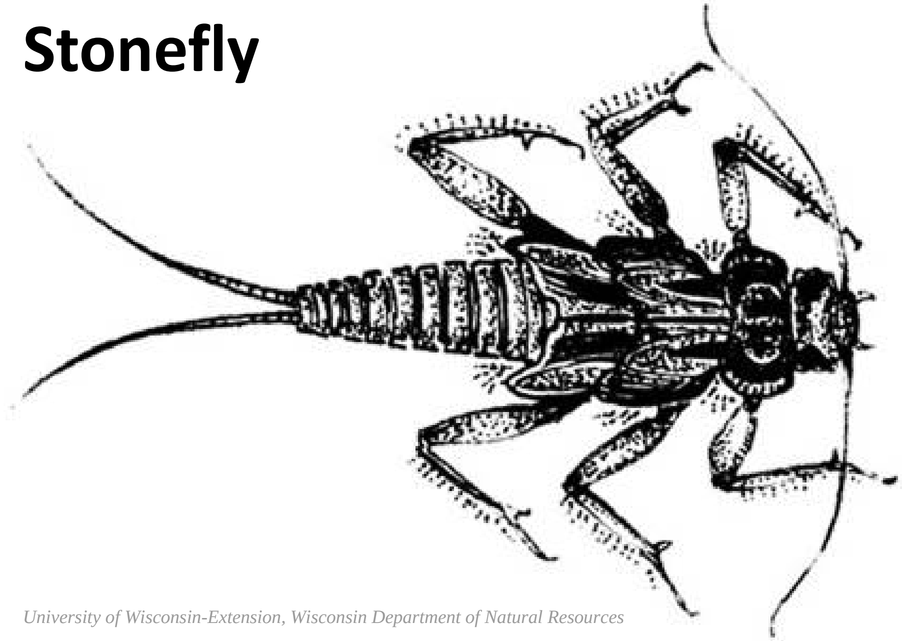
Stonefly



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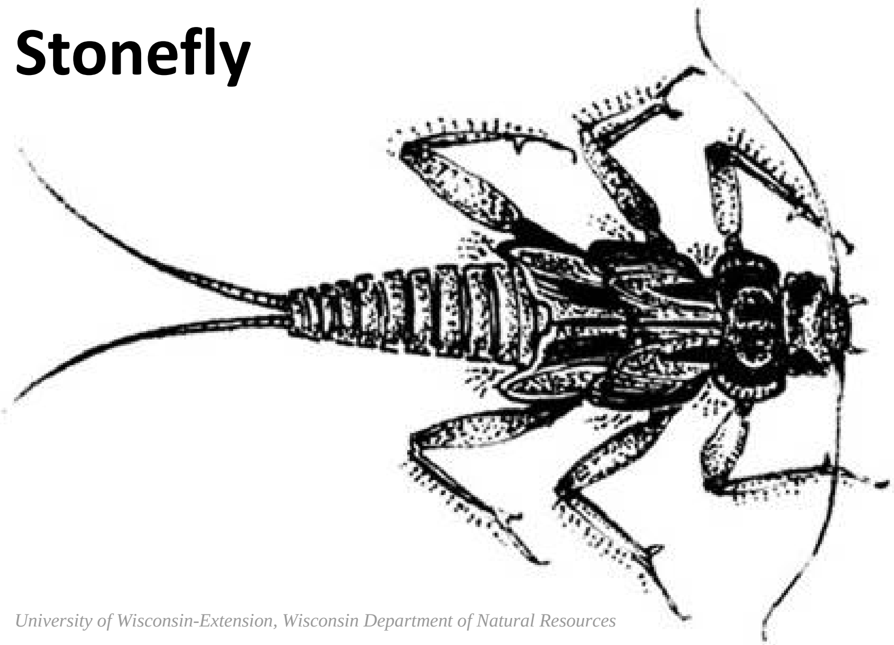
Stonefly



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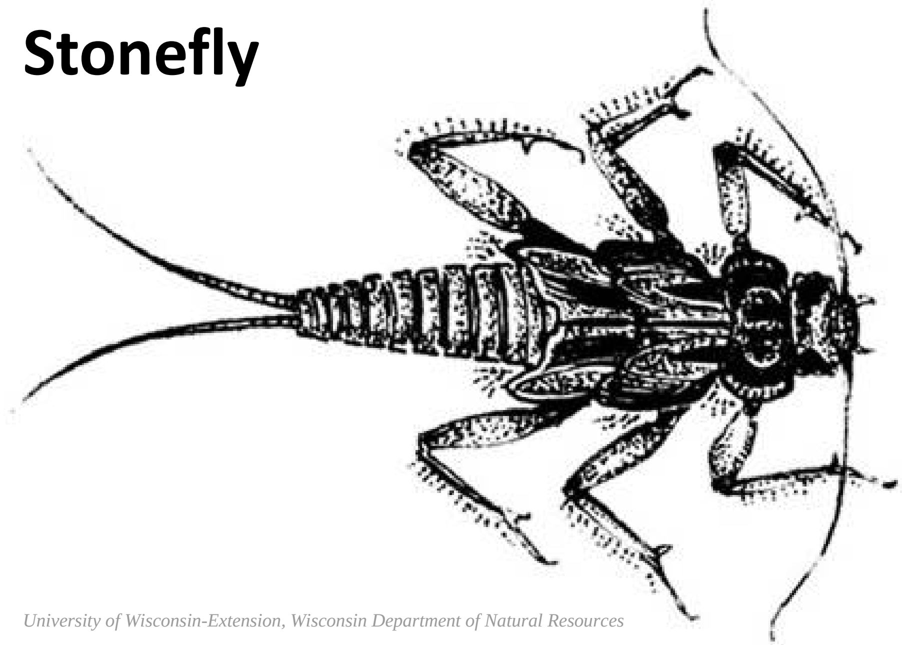
Stonefly



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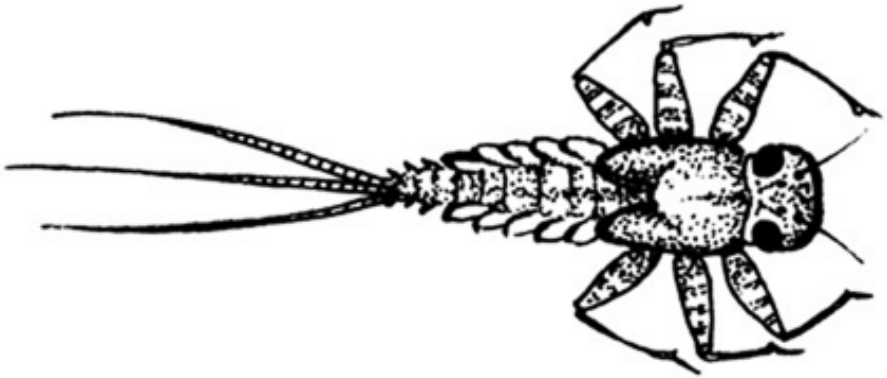
Mayfly



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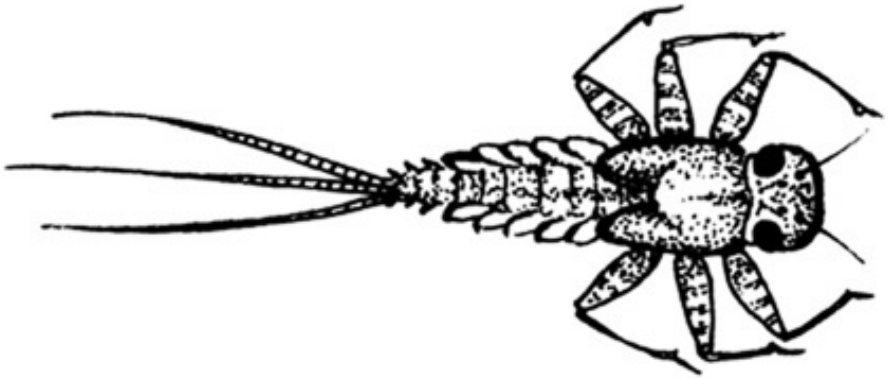
Mayfly



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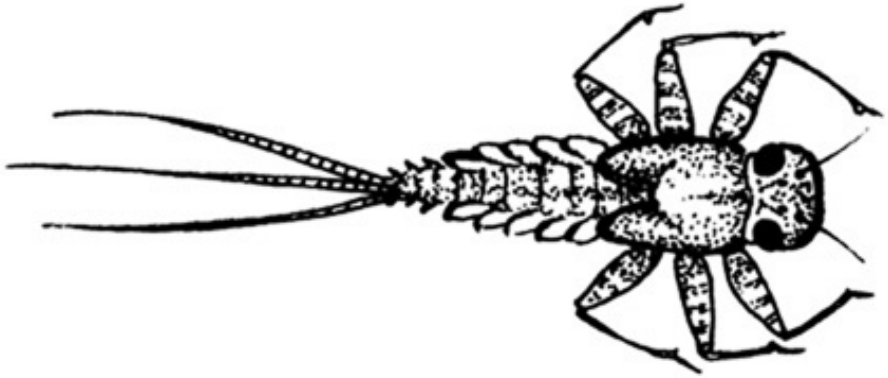
Mayfly



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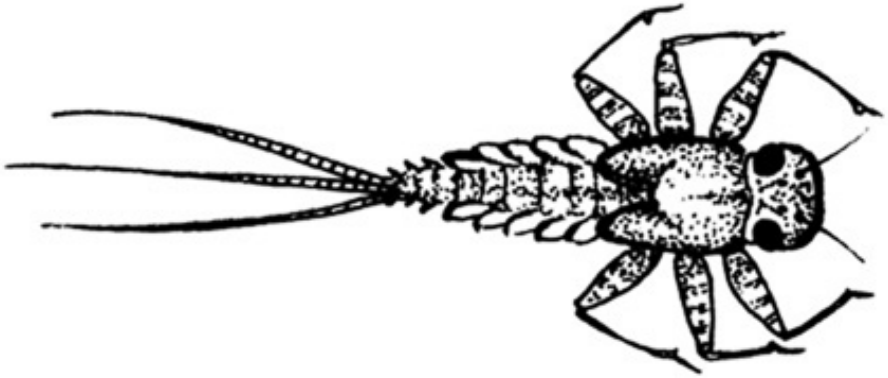
Mayfly



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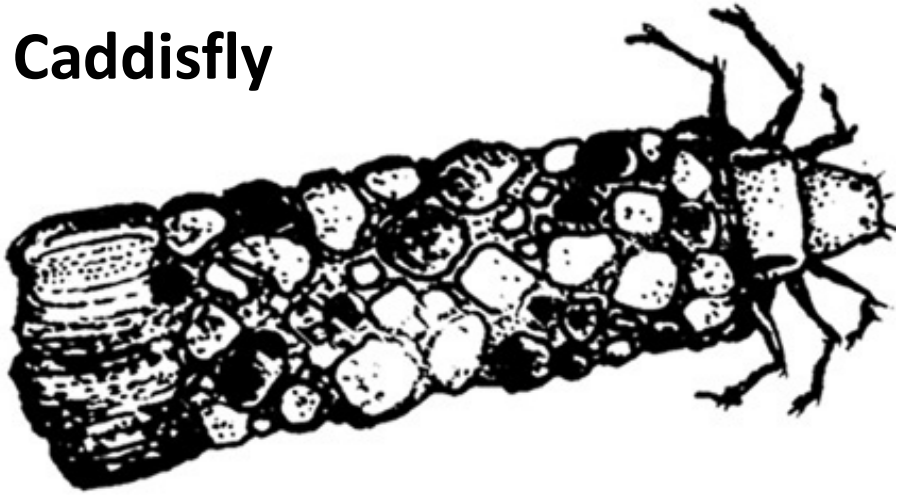
Caddisfly



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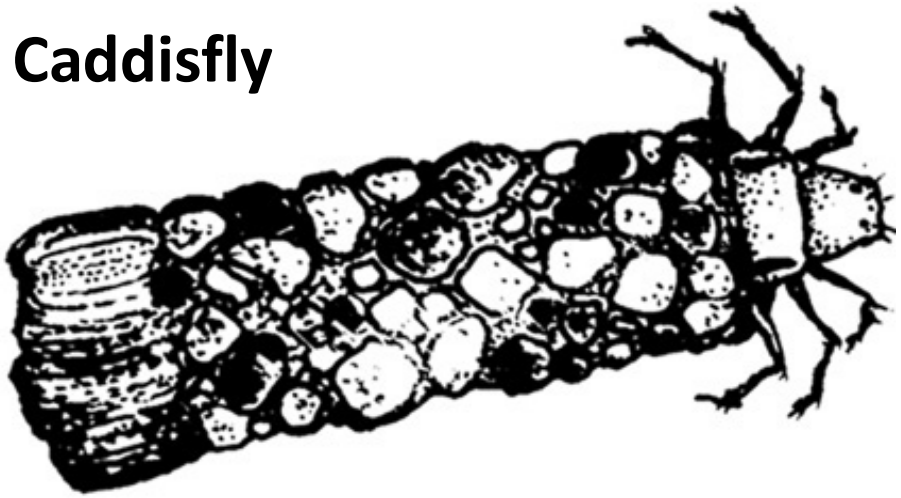
Caddisfly



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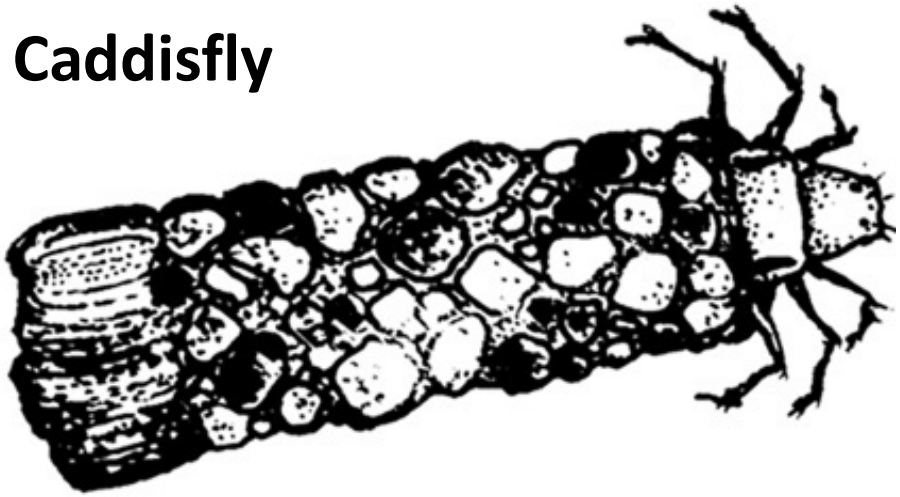
Caddisfly



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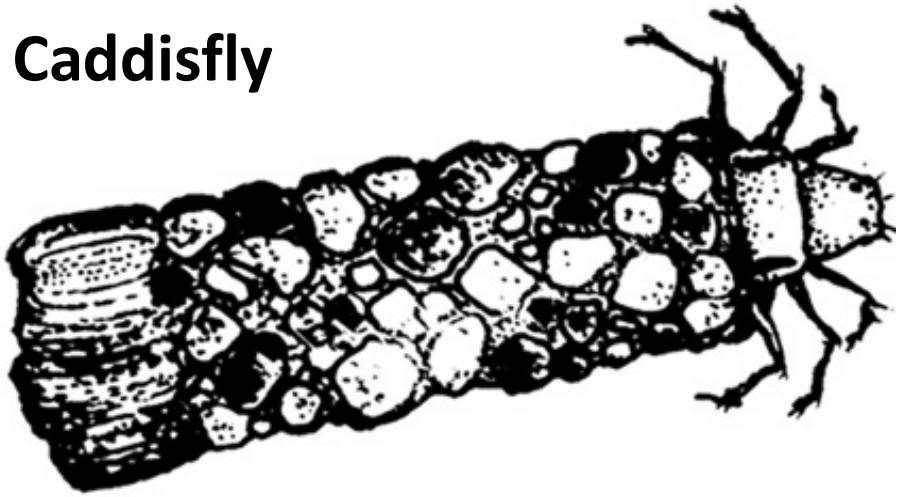
Caddisfly



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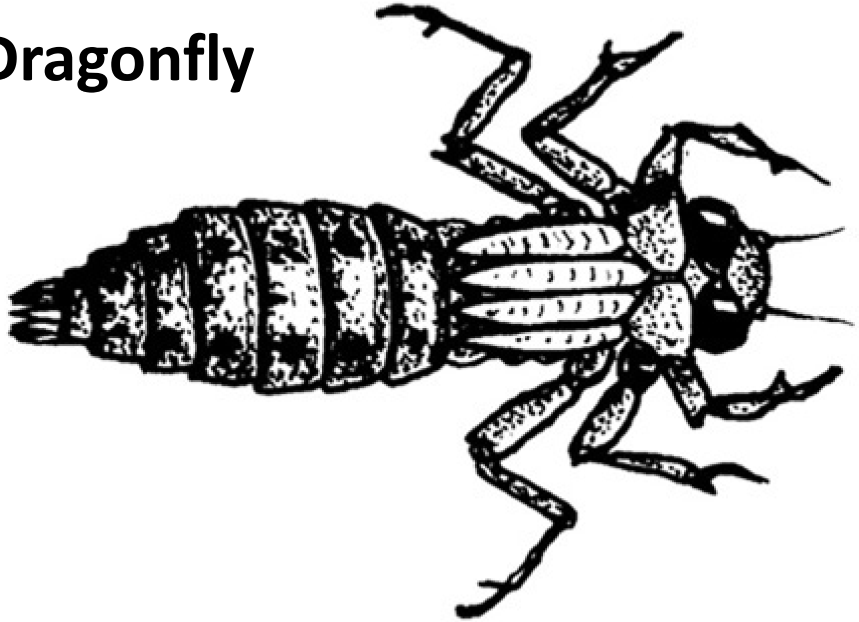
Dragonfly



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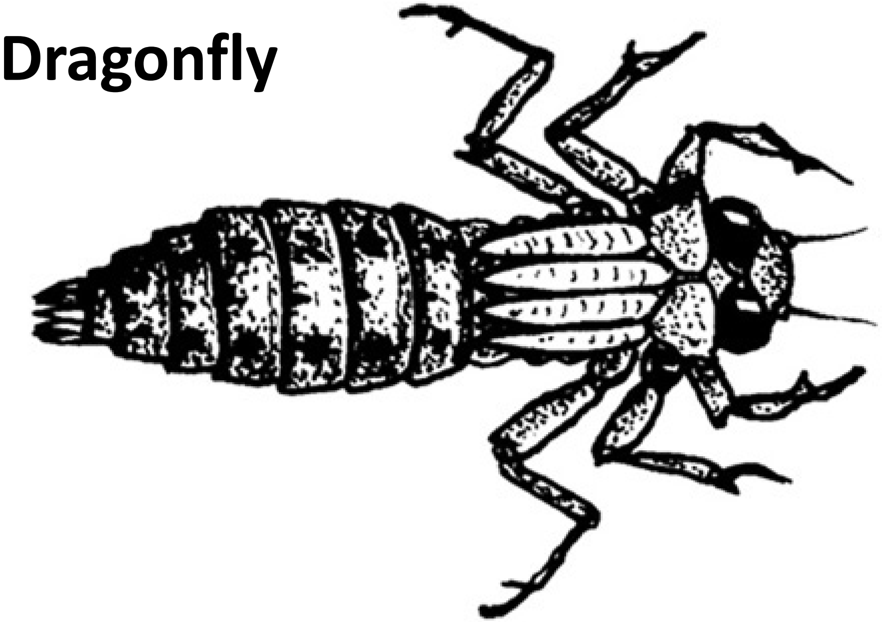
Dragonfly



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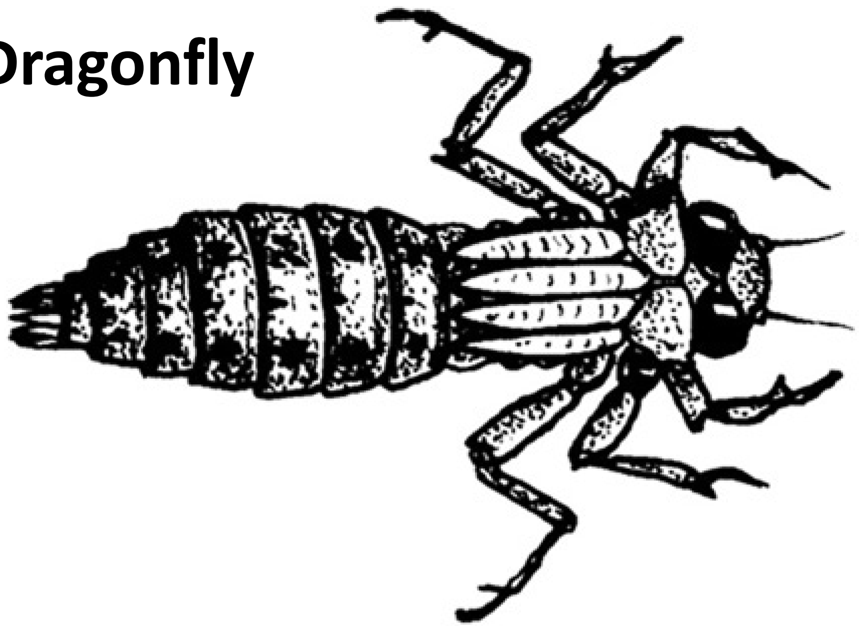
Dragonfly



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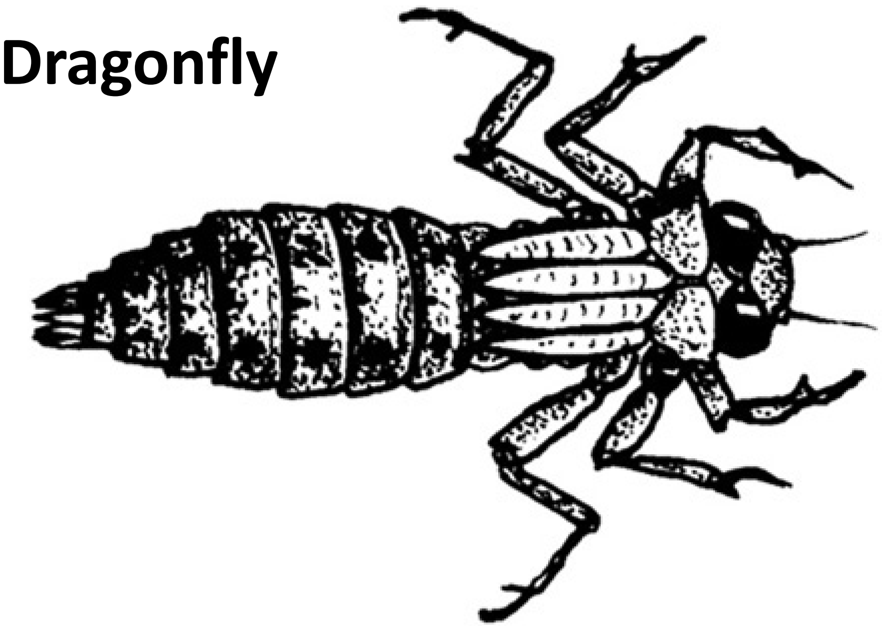
Dragonfly



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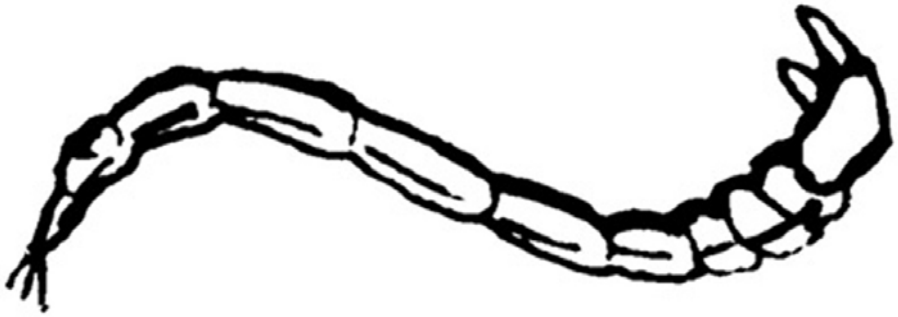
Midge



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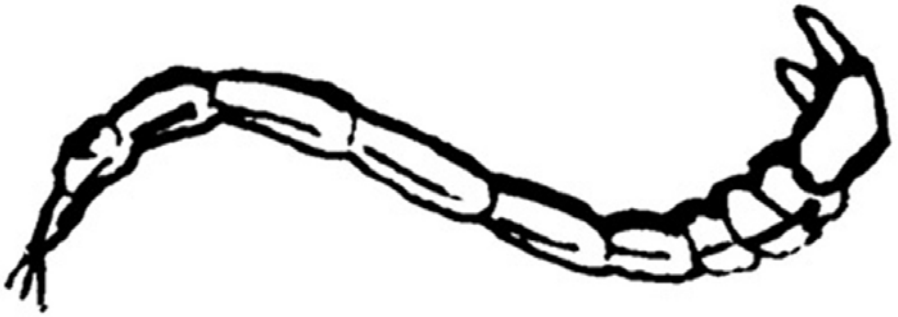
Midge



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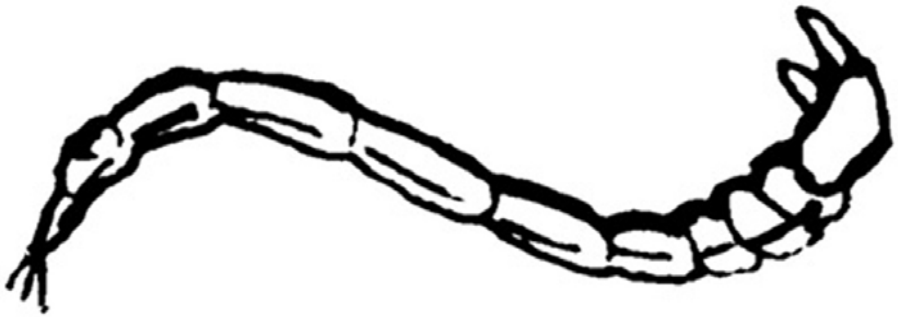
Midge



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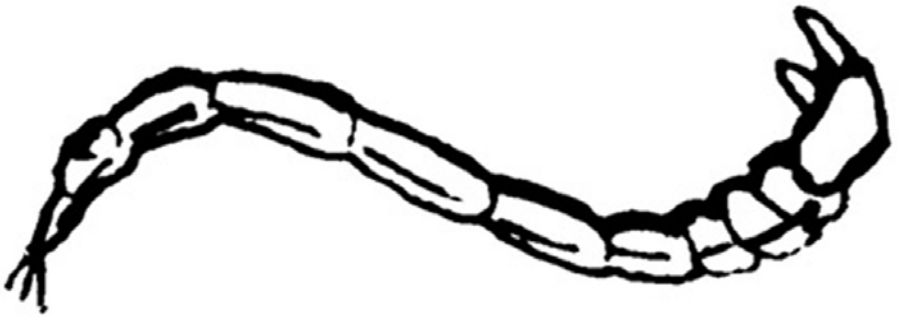
Midge



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Rat-tailed Maggot

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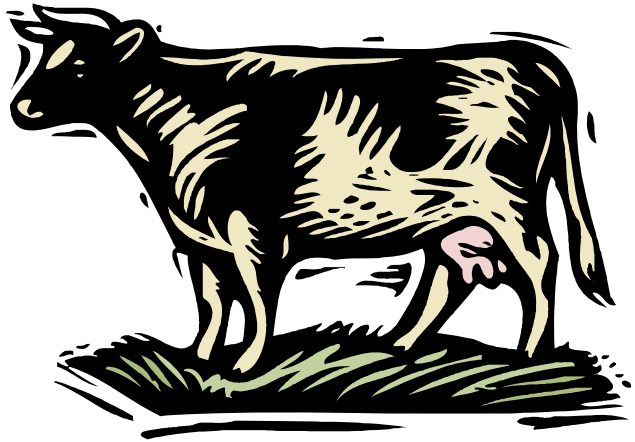
Fertilizer



Pesticide

Erosion

High Water Temperature