Streams and Rivers

Texas' many different streams and rivers support diverse ecosystems influenced by the order of the stream and the part of the stream in which the organisms occur. The healthiest streams and rivers are those with the least altered natural processes.

Chapter 8

Grade Levels/Courses

6th, 7th, 8th, Aquatic Science, Environmental Science

Chapter Objectives

Students will:

1. Generate information about rivers and streams.
2. Use a graphic organizer to help plan an investigation into a local river or stream.
3. Diagram the parts of a stream and explain how biotic and abiotic factors that make up the stream ecosystem function together.
4. Compare and contrast the adaptations of plants and animals living in flowing water to those of other aquatic and terrestrial species.
5. Predict the impact of flooding on the organisms in a stream ecosystem.
6. Describe how technological solutions to problems, such as levees, dams and channelization, can have risks and unintended consequences.
7. Describe possible solutions to potentially harmful environmental changes within a stream ecosystem.
8. Predict the changes in the number and types of organisms in a stream ecosystem based on stream order. Recognize the factors that affect the number and types of organisms a stream ecosystem can support.
9. Diagram and describe the transfer of energy in a stream food web.
10. Diagram the organization within the stream ecosystem including organisms, population, community and ecosystem.
11. Read the chapter and answer the questions.
12. Explain how organisms respond to the external stimuli in these different habitats.
13. Explain how diversity contributes to sustainability of the stream ecosystem.
14. Explain what will happen to the stream food web if pollution occurs.
15. Make a model of the parts of a stream.

16. Use a three dimensional key to identify aquatic macro-invertebrates.
17. Use what they learned in the three dimensional key to key out an organism from the class native aquarium.
18. Examine maps or aerial photographs to find what order their local stream or river is and predict the types of organism to be found based on the stream order.
19. Conduct a field investigation to determine what organisms that live in the nearest stream or river.
20. Assess the health of the stream or river near them based on the aquatic invertebrates found there.
21. Compare adaptations of organisms from different stream habitats.
22. Use safe practices and conservation of resources in the field.
23. Collect data and record information in tables.
24. Draw conclusions based on data.
25. Make connections between testing of water quality and careers.
26. Identify ways human activity can affect aquatic environments.
27. Continue recording weather and chemical and physical characteristics of their stream or river for their long-term study.
28. Demonstrate the use of course apparatuses, equipment, techniques, and procedures.
29. Collect quantitative data from an aquatic environment, including pH, salinity, temperature, mineral content, nitrogen compounds, and turbidity.

Texas Essential Knowledge and Skills in Science

6.1 A, B; 6.2 A, B, C, D, E; 6.3 B; 6.4 A, B; 6.12 E, F; 7.1 A, B; 7.2 A, B, C, D; 7.3 B; 7.4 A, B; 7.5 A, B; 7.7 C; 7.8 A; 7.10 A, B; 7.11 A, B; 7.13 A; 8.1 A, B; 8.2 A, B, C, D, E; 8.3 B; 8.4 A, B; 8.11 A, B, C

Aquatic Science: 1 A, B; 2 B, E, G, H, J; 3 B; 5 A, B, C, D; 7 C; 10 A, B; 11 A, B; 12 A, B, C, D

Environmental Science: 1 A, B; 2 B, E, F, G, H, I, K; 3 B, E; 4 A, B, E, F; 5 A, B, C; 7 A, C, 8 A; 9 A, B, C, E

Materials Needed

<u>Activity 8.1</u>

Science journals

Pencils/pens

White board, chalkboard or chart paper

Markers

KWHL Chart

Activity 8.2

Student Guide

Student journals

Pens/pencils

Activity 8.3

1 ball of yarn

1 set of *Aquatic Organisms* cards from Chapter 5

For each group of 6 students

1 set of stream anatomy cards

Art materials such as:

Construction paper

Scissors

Markers

Colored pens

Chalk

Glue sticks

Student journals

Pens/pencils

Activity 8.4

Laminated copies of two sets of drawings of macro-invertebrates (One set is for the signs and one set for students)

Laminated signs with instructions for each step in the Key

25 wooden stakes approximately 4 feet in length, or music stands, or masking tape

String or painter's tape

A large open area to set up the key/maze

Activity 8.5

Seines and nets including D-frame aquatic dip net and kick seine

Containers for specimen such as:

White trays

Ice cube trays

Hand magnifiers or magnifier boxes

Forceps

Student journals

Pens/pencils

Field guides

Thermometers and weather instruments

Physical Water Quality Indicators check sheet

Bug Picking Water Quality Indicators

High school students should also have secchi disc, stop watch, tennis ball or piece of wood, salinity test, water chemistry test kits

Safety goggles

Gloves

First aid kit

Safety Precautions

Review Field Safety Guidelines.

Vocabulary

- Abdomen
- Channels
- Diverse
- Ecosystem
- Floodplain
- Gills
- Headwaters
- Key
- Larva
- Nymph
- Pool
- Primary consumers
- Producers
- Proleg
- Riffles
- Riparian corridors
- River
- Run
- Secondary consumers
- Segmented legs
- Stream

- Stream banks
- Stream ecologist
- Stream order
- Streambed
- Tertiary consumers
- Thorax
- Wing covers

Enrichments

Project WET

- After Math
- Macro-invertebrate Mayhem

Project WILD Aquatic

- Blue Ribbon Niche
- Riparian Retreat
- To Dam or Not to Dam
- Water Canaries

Videos

Texas, The State of Flowing Water from Texas Parks and Wildlife Department

Texas, The state of Water: Finding a Balance, ”Forests of the River Bottom”

Extension

- Stream Table (*River Cutters* from GEMS)

Service Learning

- Litter pickup

Lesson 8.1: What Do I Know?
What Do I Want to Find Out?

Essential Concept

Rivers and streams are varied in Texas.

Objectives

1. Students will generate information about rivers and streams.
2. Students will use a graphic organizer to help them plan an investigation into a local river or stream.

TEKS

6.2 A, B, C; 7.2 A, B, C; 8.2 A, B, C

Aquatic Science: 2 B, E, J; 3 B;

Environmental Science: 2 B, E, K; 3 B

Estimated Time

1 Class period

Materials

Science journals

Pencils/pens

White board, chalkboard or chart paper

Markers

KWHL Chart

Special Instructions

Set up a KWHL Chart for the class to plan an investigation to a river or stream. The KWHL Chart lists what students **Know**, what they **Want** to find out, **How** they can find out, and what they **Learned.** The **How** of the chart is where students plan what they will do in order to answer the questions they decide to investigate in the **Want to find out** section. What they **Learned** is where they will draw conclusions. (See chart at the end of this lesson.)

Procedure

1. What Do I Know about Rivers and Streams?

Ask students to use their science journals to free-write for five minutes everything they know about rivers and streams.

Use the white board, chalkboard, or chart paper to lead a class discussion by asking each student to contribute something they have written in their science journals to the board without repeating an item. Have students add to their notebooks any information on the board that they hadn't already included.

2. What Do I Want to Find Out?

Start with the information above as the **K** in the KWHL Chart. Walk students through the KWHL chart as a class to plan a field study to investigate rivers or streams. Develop questions to investigate based on what the class **wants to find out. How** will you find the answers to your questions? Plan investigative procedures, data needed, equipment required, etc. When you return from your field trip, add conclusions to the KWHL chart based on what you **learned** during your investigation.

Or, for more advanced students you may have each small group work through the KWHL chart and generate one or two questions they would like to investigate and plan how they can answer their questions. Another possibility would be to have groups generate several questions and then have the class choose some of the questions to investigate and plan their procedures as a class.

Students may come up with a wide variety of ideas about what they want to investigate. Include something about what lives in different places in rivers and streams. You may wish to add to your KWHL chart right before your field trip to incorporate some things that students will learn during the lessons in this chapter.

3. Looking Ahead

Explain to the class that this chapter will help them understand what a stream ecosystem is and how it functions.

Vocabulary

- Diverse
- Ecosystems
- River
- Stream

Student Page

PLANNING AN INVESTIGATION

What I **KNOW**	What I **WANT** to Find Out	**HOW** I Can Find Out	What I **LEARNED**

Lesson 8.2: Reading and Research

Essential Concept

There is a hierarchy of stream formation from headwaters to streams, to rivers. Streams and rivers have a particular structure with parts that provides habitats for a variety of organisms.

Objectives

1. Students will read the chapter and answer the questions.
2. Students will diagram and label the parts of a third-order stream and list the organisms that could live in each part.
3. Students will explain how the order of the stream influences what can live there.
4. Students will explain how the biotic and abiotic factors in a stream ecosystem function together.
5. Students will explain how organisms respond to the external stimuli in these different habitats.
6. Students will explain how this diversity contributes to sustainability of the stream ecosystem.
7. Students will diagram the organization within a first order stream ecosystem including organisms, population, community and ecosystem.
8. Students will explain how biotic and abiotic factors that make up the stream ecosystem function together.
9. Students will make connections to careers.

TEKS

6.2 C; 6.12 E, F; 7.2 C; 7.5 A, B; 7.7 C; 7.8 A; 7.10 A, B; 7.11 B; 7.13 A; 8.2 C; 8.11 B, C

Aquatic Science: 2 J; 3 B, E; 10 B; 11 A

Environmental Science: 2 K; 3 B, E

Estimated Time

Varies. Reading and answering questions may be done as homework or done in class as cooperative group projects.

30 minutes for *Diagramming Stream Parts*, and *Thinking Questions*

Materials

Student Guide

Student journals

Pens/pencils

Procedure

1. Student Reading

Have students read *Chapter 8: Streams and Rivers*. Introduce vocabulary terms as needed.

2. Questions to Consider

Assign the *Questions to Consider* as homework or use them in a cooperative learning activity.

1) What are the parts of a stream? How do they function together?

Channel—the part of the stream where water collects to flow downstream

Pools—the deeper, slower-moving places in the stream channel

Riffles—the shallow, faster flowing places in the stream channel

Stream banks—the shoulder-like sides of the stream channel

Riparian zone—the land next to the stream that has plants growing on it (starting at the top of the stream bank)

Floodplain—the flat land on both sides of the river or stream where extra water spreads out during a flood

See also FIG. 8.1 and section titled "Anatomy of a stream" in student guide Chapter 8

2) What is the riparian zone? Why is it important to have plenty of plants growing alongside a stream?

The riparian zone is the land next to the stream that has plants growing on it (starting at the top of the stream bank). A riparian zone with heavy plant cover 100 feet on either side of the stream may be the stream's best defense against pollution and other problems in the watershed. Plants growing in the riparian zone keep the stream healthy in many ways. Trees shade and cool the water, which increases the amount of dissolved oxygen the water can hold. Roots help hold the stream banks together. Leaves and branches falling into the water provide organic matter for aquatic food webs. Riparian plants offer habitat to birds, bats, and other wildlife.

3) What is the floodplain? Are floods natural disasters?

The floodplain is the flat land on both sides of the river or stream. During a flood, a stream's extra water spreads out to cover the floodplain. Flooding is a natural characteristic of all streams. By allowing excess water to spread out, floodplains reduce the floodwater's speed. As a result, less damage occurs in the stream and to regions downstream. While we tend to think of floods as natural disasters, they are really natural events and processes that have positive effects on stream ecosystems. The only disaster comes when humans build in the floodplains.

4) What is stream order? How can it help us understand the aquatic community living

in a particular place?

A first-order stream is a small stream with no tributaries coming into it. First-order streams combine to form larger second-order streams. These larger streams combine to form even bigger third-order streams and so on. A stream's order or size determines the aquatic community it can support. Headwaters, first- and second-order streams have few rooted or floating plants, so aquatic animals depend on debris that falls or is washed into the water. These conditions favor shredders and small fish. Third- through fifth-order streams have both rooted and floating aquatic plants and many more types of animals. In a big river, few rooted plants grow because the water is too deep and very cloudy. Big river conditions favor plankton, collectors, and large fish.

5) What can the presence or absence of aquatic invertebrates tell us about the health of a stream?

Water quality experts look for certain invertebrates that live in riffles on the stream bottom. Examples include the immature stages of stoneflies, caddisflies and mayflies. Many species of these insects are sensitive to pollution. The presence of such species generally indicates good quality water. When they are missing from a stream or when only pollution tolerant species such as black fly larvae and bloodworms are present, we know that something is wrong with the water. High biodiversity—the high number of species—as well as a high number of sensitive species living in a stream are good signs of a healthy stream.

6) How are plants and animals adapted to living in flowing water?

Plants living in moving water have long, thin, flexible stems that offer little resistance to the current and strong root systems to hold them in place. Mussels burrow to avoid the current and snails use a broad, flat foot to stick to rocks. Water birds have long legs for wading and hunting or webbed feet for swimming and diving. River otters have an oily coat to keep them dry and warm. Fish such as Texas shiners have streamlined bodies that allow them to remain stable in currents. Sculpins and many darter species are adapted as bottom clingers. They tend to have flattened heads and large pectoral fins that are angled to help them stay on the bottom in swift currents. With these advantages they can stay in the swift water of riffles and pick invertebrates from the rocks.

7) How can rivers and streams be kept healthy?

The healthiest streams are those with the least-altered natural processes. A riparian zone with heavy plant cover 100 feet on either side of the stream may be the stream's best defense against pollution and other problems in the watershed. Avoid building roads, houses and levees in floodplains. Remember that everything that happens on the land in a watershed affects the water body into which it drains. Use land and water resources wisely and protect your watershed. Join a Texas Stream Team and help clean up a stream in your community, learn to check water quality, learn more about watershed conservation, and take part in protecting rivers and streams for the future.

8) What do stream ecologists do?

Freshwater stream and river ecologists study the animal and plant life in rivers and streams, and how these organisms interact with their environment. They may conduct surveys of stream life, run statistical analysis, or do research studies. Ecologists usually have masters or doctorate degree in aquatic biology or a related field.

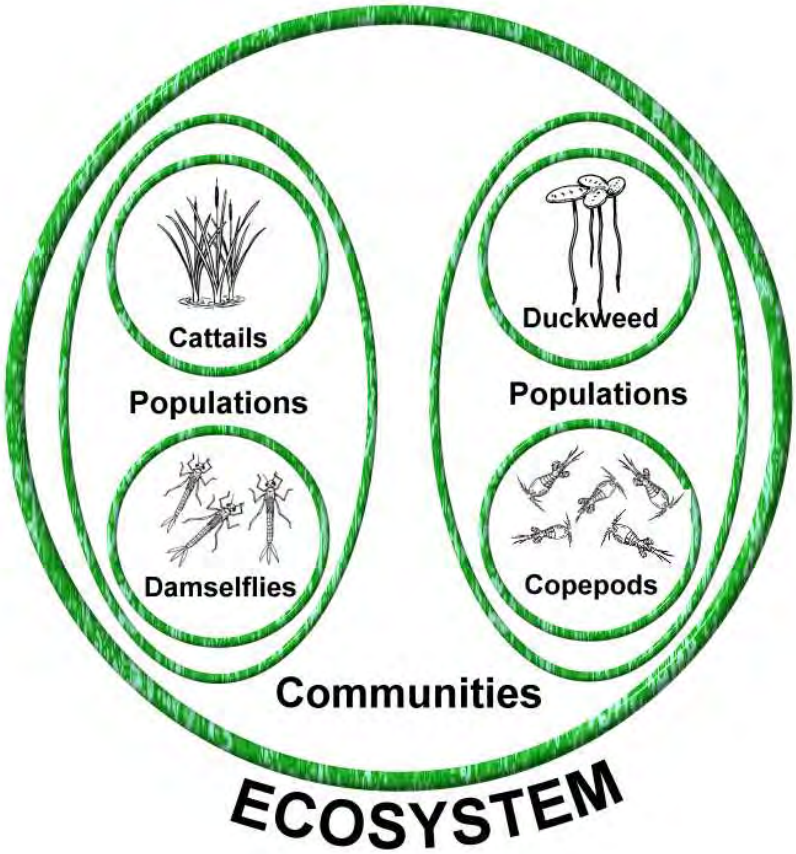
3. Using What We Learned: Diagramming Stream Parts

Ask students to diagram and label the parts of a third-order stream in their science journals.

Thinking Questions

- **List some organisms that would live in riffles, pools, channels, floodplains, stream bottoms, and riparian corridors.**
  1. Riffles: Mayfly nymphs, Stonefly nymphs
  2. Pools: Bluegills,
  3. Channels: plants with long flexible stems and strong roots, bleeding shiners
  4. Floodplains: grasses, bushes, maybe agricultural crops
  5. Stream bottoms: mussels
  6. Riparian Zones: cottonwood trees, willows
- **What are some examples of external stimuli in these different habitats to which aquatic organisms respond? (**Differences in oxygen level in riffles, amount of light for photosynthesis, number of insect larvae available for food, water depth for light penetration for plant growth, etc.)
- **How does the order of the stream influence what can live there?** (Each order of stream has its own set of characteristics such as flow rate, depth of water, amount of light getting to the bottom, amount of plants, amount of sediments, all of which determine the habitat characteristics available.)
- **How does this diversity contribute to sustainability of the stream ecosystem?** The more diverse the ecosystem, the more there are possibilities for provision of needs for survival of each population.

- **Diagram the organization within a first order stream ecosystem including organisms, population, community and ecosystem.**



- **Give an example of how biotic and abiotic factors that make up the stream ecosystem function together.** (**One Example:** Oxygen increases with increased water movement in riffles, allowing more insect nymphs that require more oxygen to survive.)

Vocabulary

- Channels
- First-order streams
- Floodplain
- Headwaters
- Pool
- Riffles
- Riparian corridors
- Rivers

- Run
- Second-order streams
- Stream banks
- Stream ecologist
- Stream order
- Streambed
- Third-order streams

Lesson 8.3: Where Do I Live? What Do I Eat?

Essential Concept

Stream order and stream anatomy affect habitat characteristics, which determine which organisms have their survival needs met.

Objectives

1. Students will use the *Aquatic Organism Cards* from Chapter 5 to make a food web for a stream.
2. Students will explain what will happen to the stream food web if pollution occurs.
3. Students will predict what will happen if a flood occurs or if all the trees are cut down along the riparian zone.
4. Students will make a model of the parts of a stream.
5. Students will explain the importance of stream order in aquatic food webs.
6. Students will diagram an aquatic food web for a specific stream order and label the producers, primary consumers, secondary consumers, and tertiary consumers.

TEKS

6.2 C; 6.3 B; 6.12 E; 7.2 C; 7.3 B; 7.10 A; 8.2 C; 8.3 B; 8.11 A

Aquatic Science: 2 H, J; 5 C; 11 A

Environmental Science: 2 I, K; 4 B; 8 A

Estimated Time

2 class periods

Materials

1 ball of yarn

1 set of Aquatic Organism Cards from Chapter 5

<u>For each group of 6 students</u>

1 set of stream anatomy cards

Student journals

Pens/pencils

Art materials such as:

Construction paper (white)

Tissue paper (blues and greens, browns and tans)

Scissors

Glue sticks

Markers

Colored pens/pencils

Chalk

Watercolors

Procedure

1. Aquatic Food Webs

Provide students with the aquatic animal cards from Chapter 5. Be sure to include all of the plant cards. Ask students to read the name of their organism and the information on their cards to the class. Have students sit in a circle on the floor. Allow one student to sit in the middle of the circle. This student will represent the Sun.

Give the "Sun" a ball of yarn. Ask the ***Sun*** to send energy to one of the plants, such as ***algae***, by holding on to the end of the ball of yarn and rolling the ball to a plant.

The ***algae*** will hold on to the yarn and roll the ball to send energy to one of the herbaceous consumers such as a ***copepod***. When that animal receives the yarn, it will roll the energy on to another consumer such as ***bloodworms.***

The ***bloodworms*** will send energy to a fish.

The fish will send energy to a decomposer such as a ***crayfish***.

Continue on sending energy to each new consumer. If you get to a top predator go from there to a decomposer and from a decomposer back to the plants until all the students are connected in an aquatic food web.

Have students hold up their part of the web so that they can all see how connected they are.

- **What would happen if a disaster struck such as pollution in the stream?** Have students who are stoneflies, which are sensitive to pollution drop their part of the web. Then have students, whose parts of the web touch stoneflies, drop their part of the web. Anyone who has a loose connection on one side of them should drop the web.

Students will see immediately that when one part of the food web is destroyed, it affects everything in the food web.

2. What Will Happen?

- **What will happen to the organisms in the stream ecosystem if flooding occurs?** (A flood could wash away some fish, plants, or other aquatic life, but would not cause long-term damage to the ecosystem. It could even have benefits, such as restoring wetland areas and bringing fresh nutrients.)
- **What will be the impact on the organisms in a stream ecosystem of cutting down all the trees and removing the plants from the stream banks and**

riparian zone? (Without plants to hold the rocks and soil in place, the stream banks would erode, filling the stream's pools with sediment. Major erosion and sedimentation can smother aquatic life and destroy their habitat.

Without plants growing in the riparian zone providing shade, the water would heat up in the sun, which would decrease the amount of dissolved oxygen the water can hold.

No leaves and branches falling into the water would deprive the stream food web of organic matter.

Lack of riparian plants would mean loss of habitat for birds, bats, and other wildlife.)

3. Cast Beyond Tomorrow

Conduct a class discussion to come to an understanding of the true significance of the phrase, **"Everyone lives downstream from someone else."**

- **What is the importance of keeping water flowing in streams and rivers?**
- **What are the threats and opportunities facing stream flow?**

4. Stream Anatomy

Provide the stream parts signs for each group of 6 students. Have each student take one sign and use the art materials to make a representation of that part of a stream. (They may wish to make a drawing, cut out paper shapes, or make a collage or use a combination of materials.) Ask students to arrange themselves in a way that would represent the stream's anatomy.

- **Why are these parts of the stream important?** (Different organisms can survive in different parts of the stream, because each provides different habitat conditions.)
- **How does stream order influence aquatic food webs?** (Smaller streams have less diverse ecosystems because they have fewer resources on which organisms depend.

(**Example:** No aquatic plants means only pieces of plants that fall into the water are available for herbivores/primary consumers. Fewer herbivores means fewer secondary consumers, etc. Larger streams provide more diverse resources and therefore can support more diverse organisms than smaller streams.)

5. Using What We Learned

Have students use markers or colored pencils to draw an aquatic food web in their journals indicating the order of the stream in which this food web would exist. Label: plants/producers, herbivores/primary consumers, omnivores or carnivores/secondary consumers, top predators/tertiary consumers, decomposers or scavengers.

Vocabulary

- First-order stream
- Floodplain
- Headwaters
- Pool
- Primary consumers
- Producers
- Riffles
- Riparian zone
- Run
- Secondary consumers
- Second-order stream
- Stream banks
- Stream channel
- Stream order
- Tertiary consumers

Stream Anatomy Cards

Stream Channel

The channel of the stream is where water concentrates to flow downstream. It includes the bed, the gravel bars and the stream banks. Stream channels always follow a downhill path.

Flood Plain

A relatively level area on one or both sides of the stream channel that carries excess water the channel cannot handle during a flood. Allowing excess water to spread out reduces the floodwater's speed, reducing damage downstream.

Pools

Deeper, slower-moving places in the stream channel.

Riffles

Shallow and fast-flowing water in the stream channel. Riffles mix oxygen into the water.

Riparian Zone

The land bordering a stream channel that begins at the top of the stream banks. A riparian zone at least 100 feet wide and full of plants helps protect the stream ecosystem from sediment and pollution.

Stream Bank

The stream banks are the shoulder-like sides of the stream channel from the water's edge up to the adjacent higher ground. Stable stream banks have plants growing on them that help hold the soil in place and minimize erosion

Lesson 8.4: The Key
to Invertebrate Identification

Essential Concept

We can assess the health of aquatic ecosystems by identifying the macro-invertebrates that live there.

Objectives

1. Students will move through a three dimensional key to identify aquatic macro-invertebrates.
2. Students will use what they learned to key out organisms from the class native aquarium.

TEKS

6.1 A; 6.2 C; 6.4 A; 7.1 A; 7.2 C; 7.4 A; 7.11 A; 8.1 A; 8.2 C; 8.4 A; 8.11 A

Aquatic Science: 1 A; 2 G, J; 10 A; 11 A

Environmental Science: 1 A; 2 G, K; 4 A

Estimated Time

1 class period

Materials

2 Copies of drawings of macro-invertebrates on card stock and laminated (1 set for the signs and 1 set for students

Signs with instructions for each step in the key

25 wooden stakes approximately 4 feet in length, or music stands, or masking tape

String or painter's tape

A large open area to set up the key/maze

Science journals

Pencil/pens/colored pencils

Special Instructions

See *Leader Instructions* at the end of this lesson.

Safety Precautions

This is not a running game. Students should take their time and make decisions about direction to go at each sign.

Procedure

1. Getting Ready

This key was designed for use with the specific invertebrates provided with this activity. Pictures of invertebrates are included with the key. You can match the invertebrate to the answer key to check student answers.

Note: The teacher should walk through the maze with a few different invertebrates to ensure that the maze is set up correctly.

Ask students to handle the drawings carefully so that they can be reused. Drawings should be printed on card stock and laminated before students receive them, and should not be rolled or folded.

Review with the class the important points of invertebrate anatomy before starting. These include: head, thorax, abdomen, gills, wing covers, prolegs, and segmented legs.

Clues for Identifying Invertebrates

To identify the organisms, use body shape, size and other characteristics (number of legs and tails), because the same family can vary in size and color. Ask yourself the following questions to identify an organism:

- How large is the organism?
- Is the body long and slender, round, or curved?
- Does the organism have any tails? How many?
- Does the organism have any antennae?
- Does the organism have legs? How many? Where?
- Is the body smooth and all one section or is it segmented (two or more distinct sections)?
- Does the organism have any gills (fluffy or plate-like appendages)?
- Where are the gills located? Sides, back, underside, under its legs?
- Does it have pinching jaws like a beetle larvae?
- What color is the organism?
- Does the organism swim underwater or remain on the surface?

2. Who Am I?

Today you are going to use an unusual key. This key is like a maze that you walk through. You will read the signs to make decisions about which way to go based on the characteristics of your invertebrate. **Your goal is to work your way through the maze and find the name of your organism.**

Allow students to select an invertebrate and review its anatomy. (You may want to have students draw an organism out of a hat or box to select the critter they will work with in the maze.) The key to success in the maze is in looking at the correct body part and noticing details.

Go over the first clue with the students and explain how to follow the maze. Tell them to read both options before making any decisions.

Each student should walk through the maze with the picture of the invertebrate in hand so that they can compare its features with those on the key signs. Students will make choices and eventually reach a dead end in the maze at the sign with the name of their invertebrate. (A drawing should also be posted at the answer, but should be face down on the back of the sign so that students can't just look for the picture.)

Sometimes students will need correction on a selection. Encourage them to back up or return to the start of the maze until their invertebrate is correctly identified.

If there is time, encourage students to select another invertebrate and repeat the process.

Note: Students can work with a partner to move through the maze or work individually, depending on the level of the students.

3. Using What We Learned

Have students look at the classroom aquarium and choose one of the organisms. Use colored pencils to draw a picture of it in their journals, noting important characteristics and details, and labeling parts. Use this drawing to let your fingers do the walking through the key in an aquatic field guide to find the name of the organism.

- What is the scientific name of your organism? (Write it under the drawing in your journal.)

Vocabulary

- Abdomen
- Gills
- Key
- Larva
- Nymph
- Proleg
- Segmented legs
- Thorax
- Wing covers

The Key to Invertebrate Identification

Instructions and Materials

Teacher Instructions for

The Key to Invertebrate Identification

This activity uses a kinesthetic method of helping students understand how a dichotomous key works to help identify an organism.

Instead of flipping pages in a book, students read signs and physically walk through the key, answering questions and checking descriptions of their organism until they find the name of their organism. The key can be set up outside with signs on stakes or can be set up inside the gymnasium using music stands for the signs or taping signs to the wall. Once students have keyed out a few organisms kinesthetically by walking through the key, they should be better prepared to use an identification key in a field guide and let their fingers do the walking.

Materials

- 2 Copies of drawings of macro-invertebrates (1 set for the signs and 1 set for students)
- Signs with instructions for each step in the Dichotomous Key
- 25 wooden stakes approximately 4 feet in length, or music stands, or masking tape
- String or painter's tape to connect signs
- A large open area to set up the Key/maze
- Diagram for physical set up of the Key
- Teacher's Answers to the Key

Setting Up the Key

This activity is a maze that uses a large open space such as a grassy field or a gymnasium. You may wish to have students help set up the maze. Use string and stakes to set up the key outdoor as shown in the diagram. Attach the signs with staples or Velcro and drive stakes into the ground for each station. Indoors you can use music stands or tape signs to the walls, and use painter's tape on the floor to guide students from one sign to the next.

Print drawings and signs on paper or cardstock and laminate or place drawings and signs in plastic page protectors.

It helps to keep students from getting caught in cross traffic if you make lines connecting the stations at right angles. Use string connecting signs outdoors or painter's tape on the floor inside.

An example of the key sign layout is included with these instructions to help with the set up.

Attach pictures of invertebrates to the appropriate signs in the key with blank sides out so answers aren't obvious but where students can check their organisms' identification when they have found the name.

Safety Precautions

This is not a running game. Students should take their time and make decisions about the direction to go at each sign.

Teacher Note

This key was designed for use with the specific invertebrates provided with this activity. Pictures of invertebrates are included with the key. You can match the invertebrate to the answer key to check student answers.

The teacher should walk through the maze with a few different invertebrates to ensure that the maze is set up correctly.

Student Instructions

Ask students to handle the drawings carefully so that they can be reused. Drawings should be laminated before students receive them, and should not be rolled or folded.

Review with the class the important points of invertebrate anatomy before starting. These include: head, thorax, abdomen, gills, wing covers, prolegs, and segmented legs.

<u>The key to success in the maze is in looking at the correct body part and noticing details.</u>

Go over the first clue with the students and explain how to follow the maze. Tell them to read both options before making any decisions.

Each student should walk through the maze with the picture of the invertebrate in hand so that they can compare its features with those on the key signs. Students will make choices and eventually reach a dead end in the maze at the sign with the name of their invertebrate. (A drawing should also be posted at the answer, but should be face down on the back of the sign so that students can't just look for the picture.)

Sometimes students will need correction on a selection. Encourage them to back up or return to the start of the maze until their invertebrate is correctly identified.

Aquatic Organism Key

Directions for the Teacher

This key consists of pairs of opposite choices or descriptive statements.

Answering one will take you to the next pair of statements.

Repeat the procedure until the organism is identified.

If you reach a point in the selection of descriptive statements at which neither of the statements apply, you can work your way back through the preceding pairs of statements and perhaps reconsider the choices.

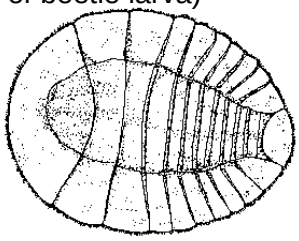
1 A Segmented legs..... Go to 2
B No Segmented legs..... Go to 10

2 A 6 legs..... Go to 3
B More than 6 legs..... Go to 17

3 A No wings, or wings not fully developed and do not cover entire body..... Go to 4
B Wings cover entire body, but not legs, may appear beetle like..... Go to 20

4 A Body longer than it is wide..... Go to 5
B Body oval and flat; head and legs concealed beneath body..... **Water Penny**
(a type of beetle larva)

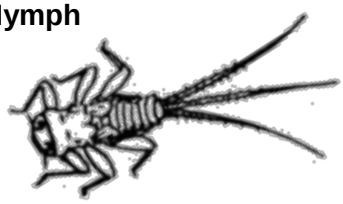
Order Coleoptera, Family Psephenidae
Feeding group: Scraper



5 A 2 or 3 distinct hairlike tails; tails not fleshy or hooked, but may be fringed with hairs..... Go to 6
B Not as above..... Go to 7

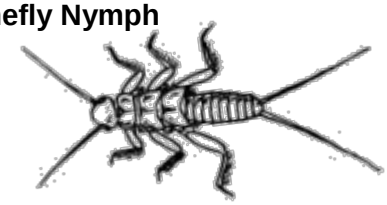
6 A 2-3 tails; platelike or hairlike gills along sides of abdomen; one hook on end of each leg..... **Mayfly Nymph**

Order Ephemeroptera
Feeding Group: Varies

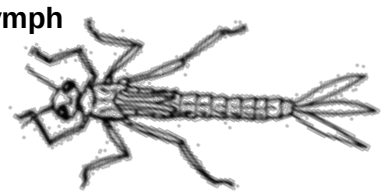


B 2 tails; may have hairy gills under thorax; 2 hooks on end of each leg..... **Stonefly Nymph**

Order Plecoptera
Feeding Group: Varies



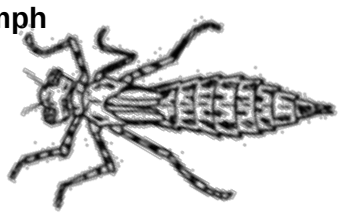
7 A 3 oar-shaped tails (gills) at *end of abdomen; no gills along* sides of abdomen..... **Damselfly Nymph**



Order Odonata, Suborder Zygoptera
Feeding group: Predator

B Not as above..... Go to 8

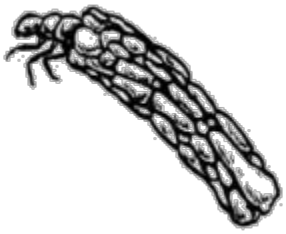
8 A Fat abdomen; large eyes; mask-like lower lip..... **Dragonfly Nymph**



Order Odonata, Suborder Anisoptera
Feeding group: Predator

B Not as above..... Go to 9

9 A May be in a case made of gravel or plant parts; abdomen ends in pair of prolegs which may be hidden by hairs; Each proleg has a single hook on end sometimes fused together..... **Caddisfly Larva**



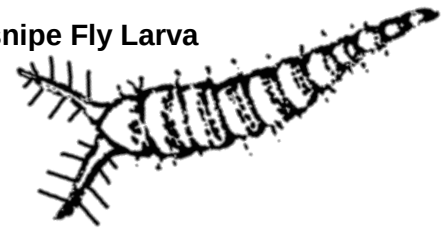
Order Trichoptera
Feeding Group: Varies

B Not as above..... Go to 10

10 A Fleshy caterpillar-like body..... Go to 11

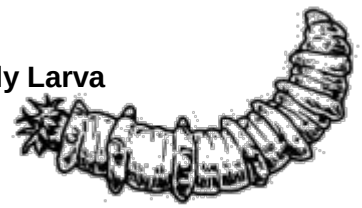
B Body not caterpillar like..... Go to 12

11 A Two feathered "horns" at back end; caterpillar-like legs..... **Watersnipe Fly Larva**



Order Diptera, Family Athericidae
Feeding Group: Predator

B Can be up to 4" long; head not apparent because it is retracted into body; may have fleshy finger-like extensions at one end..... **Cranefly Larva**

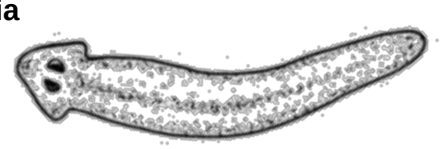


Order Diptera, Family Tipulidae
Feeding Group: Shredder or Predator

12 A Body without hard shell..... Go to 13

B Body with hard shell..... Go to 15

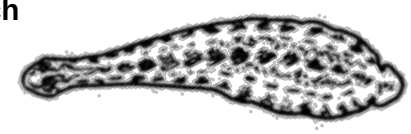
13 A Flattened, unsegmented, worm-like body; distinct eye spots; gliding movement ..... **Planeria**



Flatworm, Class Turbellaria
Feeding Group: Predator or Parasite

B Segmented body Go to 14

14 A Flattened body with suckers at each end..... **Leech**



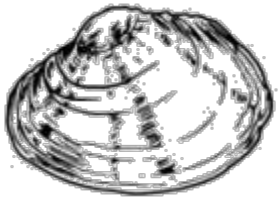
Flatworm, Class Hirudinea
Feeding Group: Predator or Parasite

B Segmented, earthworm-like body..... **Aquatic Earthworm**

Class Oligochaeta
Feeding Group: Gatherer Collector

15 A Snail-like..... Go to 16

B Body enclosed within two hinged shells..... **Freshwater Clam or Mussel**

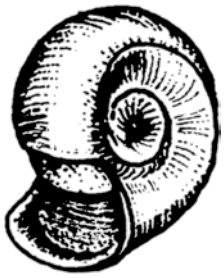


Class Pelecypoda
Feeding Group: Filterer Collector

16 A Has operculum (hard covering used to close the opening)..... **Gilled Snail**

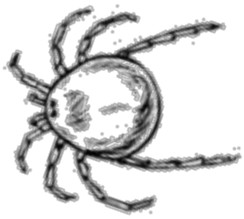
Class Gastropoda, Order Prosobranchia
Feeding Group: Scraper

B No operculum; may be spiral-shaped, limpet-like, or coiled in one plane..... **Lung-Breathing Snail**



Class Gastropoda, Order Pulmonata
Feeding Group: Scraper

17 A Looks like spider; may be very tiny has 8 legs..... **Aquatic Mite**

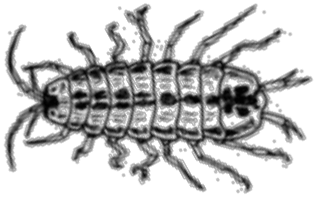


Class Arachnida, Order Hydracarina
Feeding Group: Predator

B Not as above..... Go to 18

18 A Lobster or shrimp-like..... Go to 19

B Armadillo shaped body, wider than high; crawls slowly on bottom..... **Aquatic Sowbug**

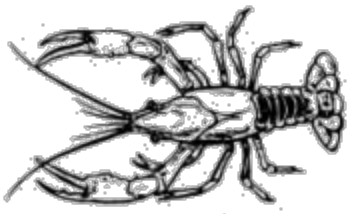


Subphylum Crustacea, Order Isopoda
Feeding Group: Shredder

19 A Looks like tiny shrimp; swims quickly on its side..... **Scud**

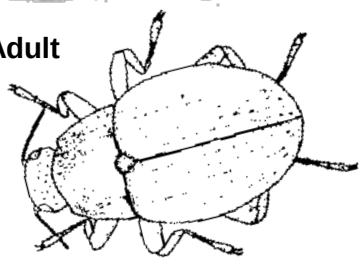
Subphylum Crustacea, Order Amphipoda
Feeding Group: Shredder

B Looks like small lobster; has 2 large front claws (10 legs total)..... **Crayfish**



Subphylum Crustacea, Order Decapoda
Feeding Group: Gatherer Collector

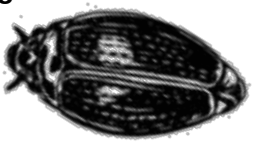
20 A Beetle-like, crawls slowly on bottom..... **Riffle Beetle Adult**



Order Coleoptera, Family Elmidae
Feeding Group: Scraper or Gatherer Collector

B Beetle-like, swims quickly..... Go to 21

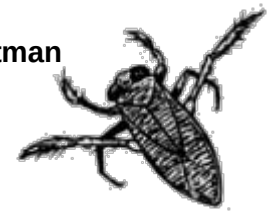
21 A Wings meet along the midline of back side of body, they do not overlap..... **Whirligig Beetle Adult**



Order Coleoptera
Feeding Group: Most Are Predators

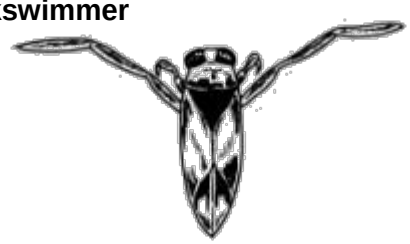
B Wings overlap on backside, usually form a visible triangular pattern just below head..... Go to 22

22 A Front legs shorter than mid and hind legs; propels itself with oar-like strokes..... **Water Boatman**



Order Hemiptera, Family Corixidae
Feeding Group: Varies

B Similar to backswimmer but swims upside down, on its back..... **Backswimmer**



Order Hemiptera, Family Notonectidae
Feeding Group: Predator

Directions for Use
Aquatic Organism Key and Signs for student activity

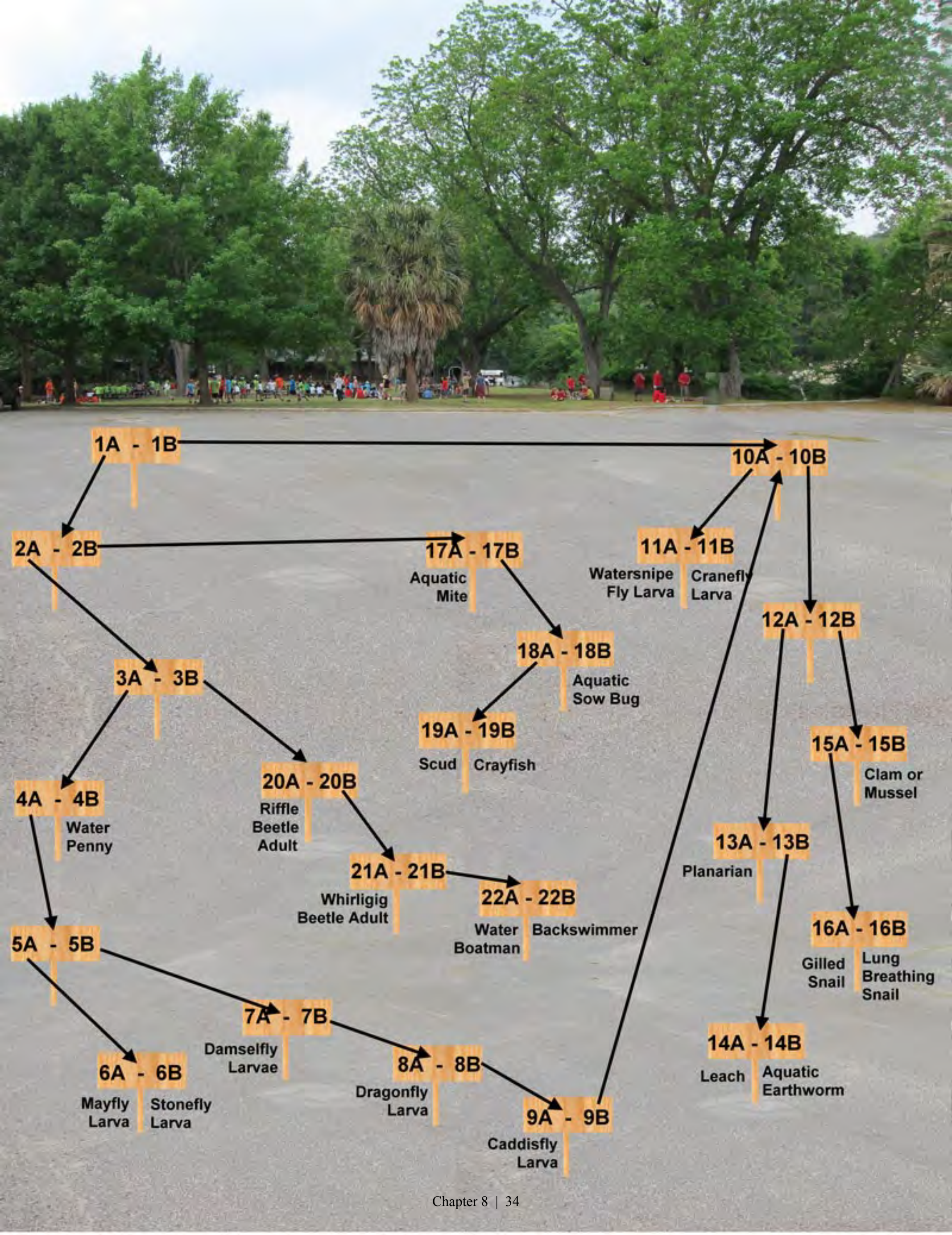
This Aquatic Organism Key consists of pairs of opposite choices or descriptive statements.

To use this key, start at the sign with NUMBER 1 and read the two statements. Decide which statement best describes the organism and walk to that number.

This will take you to the next pair of statements. Repeat the procedure until the organism is identified.

You will find the* organism *name and picture on the back of the sign under the flap.

If you reach a point in the selection of descriptive statements at which neither of the statements apply, you can work your way back through the preceding pairs of statements and reconsider your choices.


1A - 1B
10A - 10B
2A - 2B
17A - 17B
Aquatic Mite
11A - 11B
Watersnipe Fly Larva
Cranefly Larva
12A - 12B
18A - 18B
Aquatic Sow Bug
3A - 3B
19A - 19B
Scud
Crayfish
15A - 15B
Clam or Mussel
20A - 20B
Riffle Beetle Adult
4A - 4B
Water Penny
13A - 13B
Planarian
21A - 21B
Whirligig Beetle Adult
22A - 22B
Water Boatman
Backswimmer
16A - 16B
Gilled Snail
Lung Breathing Snail
5A - 5B
7A - 7B
Damselfly Larvae
14A - 14B
Leach
Aquatic Earthworm
6A - 6B
Mayfly Larva
Stonefly Larva
8A - 8B
Dragonfly Larva
9A - 9B
Caddisfly Larva

NUMBER 1

A Segmented legs..... Go to 2

B No Segmented legs..... Go to 10

NUMBER 2

A 6 legs..... Go to 3

B More than 6 legs..... Go to 17

NUMBER 3

A No wings, or wings not fully developed and do not cover entire body.....Go to 4

B Wings cover entire body, but not legs, may appear beetle like..... Go to 20

NUMBER 4

A Body longer than it is wide..... Go to 5

B Body oval and flat; head and legs concealed beneath body.....Water Penny

Order Coleoptera, Family Psephenidae
Feeding group: Scraper

NUMBER 5

A 2 or 3 distinct hairlike tails; tails not fleshy or hooked, but may be fringed with hairs..... Go to 6

B Not as above..... Go to 7

NUMBER 6

A **2-3 tails; platelike or hairlike gills along sides of abdomen; one hook on end of each leg.....** **Mayfly Nymph**

Order Ephemeroptera
Feeding Group: Varies

B **2 tails; may have hairy gills under thorax; 2 hooks on end of each leg.....** **Stonefly Nymph**

Order Plecoptera
Feeding Group: Varies

NUMBER 7

A 3 oar-shaped tails (gills) at *end of abdomen; no gills on* sides of abdomen..... Damselfly Nymph

Order Odonata, Suborder Zygoptera
Feeding group: Predator

B Not as above..... Go to 8

NUMBER 8

A Fat abdomen; large eyes; mask-like lower lip..... Dragonfly Nymph

Order Odonata, Suborder Anisoptera
Feeding group: Predator

B Not as above..... Go to 9

NUMBER 9

A **May be in a case made of gravel or plant parts; abdomen ends in pair of prolegs which may be hidden by hairs; Proleg have a single hook on end sometimes fused together..... Caddisfly Larva**

Order Trichoptera
Feeding Group: Varies

B **Not as above..... Go to 10**

NUMBER 10

A Fleshy caterpillar-like body..... Go to 11

B Body not caterpillar like..... Go to 12

NUMBER 11

A **Two feathered "horns" at end; caterpillar-like legs……. Watersnipe Fly Larva**

Order Diptera, Family Athericidae
Feeding Group: Predator

B **Can be up to 4" long; head not apparent because it is retracted into body; may have fleshy finger-like extensions at one end……. Cranefly Larva**

Order Diptera, Family Tipulidae
Feeding Group: Shredder or Predator

NUMBER 12

A Body without hard shell..... Go to 13

B Body with hard shell.... Go to 15

NUMBER 13

A Flattened, worm-like, unsegmented body; distinct eye spots; gliding movement ..... Planeria

Flatworm, Class Turbellaria
Feeding Group: Predator or Parasite

B Segmented body..... Go to 14

NUMBER 14

A Flattened body with suckers at each end..... Leech

Flatworm, Class Hirudinea
Feeding Group: Predator or Parasite

B Segmented body, earthworm-like..... Aquatic Earthworm

Class Oligochaeta
Feeding Group: Gatherer Collector

NUMBER 15

A Snail-like..... Go to 16

B Body enclosed within two hinged shells..... Freshwater Clam or Mussel

Class Pelecypoda
Feeding Group: Filterer Collector

NUMBER 16

A **Has operculum (hard covering used to close the opening)..... Gilled Snail**

Class Gastropoda, Order Prosobranchia
Feeding Group: Scraper

B **No operculum; may be spiral-shaped, limpet-like, or coiled in one plane..... Lung-Breathing Snail**

Class Gastropoda, Order Pulmonata
Feeding Group: Scraper

NUMBER 17

A Looks like spider; may be tiny, has 8 legs..... Aquatic Mite

Class Arachnida, Order Hydracarina
Feeding Group: Predator

B Not as above..... Go to 18

NUMBER 18

A Lobster or shrimp-like..... Go to 19

B Armadillo-shaped, wider than high; crawls on bottom..... Aquatic Sowbug

Subphylum Crustacea, Order Isopoda
Feeding Group: Shredder

NUMBER 19

A **Looks like tiny shrimp; swims quickly on its side..... Scud**

Subphylum Crustacea, Order Amphipoda
Feeding Group: Shredder

B **Looks like small lobster; has 2 large front claws (10 legs total)..... Crayfish**

Subphylum Crustacea, Order Decapoda
Feeding Group: Gatherer Collector

NUMBER 20

A Beetle-like, crawls slowly on bottom..... Riffle Beetle Adult

Order Coleoptera, Family Elmidae
Feeding Group: Scraper or Gatherer Collector

B Beetle-like, swims quickly..... Go to 21

NUMBER 21

A **Wings meet along midline of back of body, and do not overlap.....** **Whirligig Beetle Adult**

Order Coleoptera
Feeding Group: Most Are Predators

B **Wings overlap on backside, usually form a visible triangular pattern below head.....** **Go to 22**

NUMBER 22

A **Front legs shorter than mid and hind legs; propels itself with oar-like strokes..... Water Boatman**

Order Hemiptera, Family Corixidae
Feeding Group: Varies

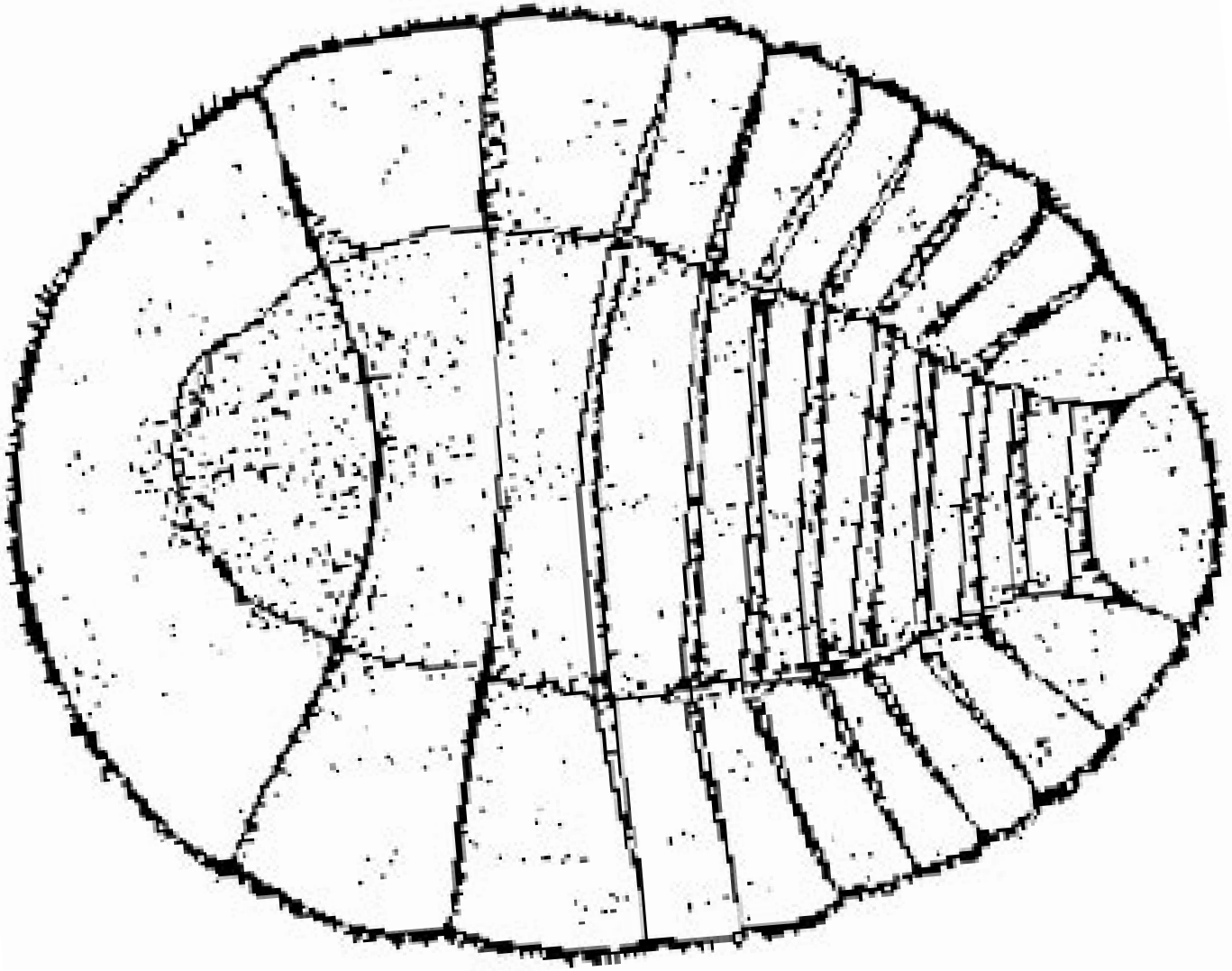
B **Similar to backswimmer but swims upside down, on its back..... Backswimmer**

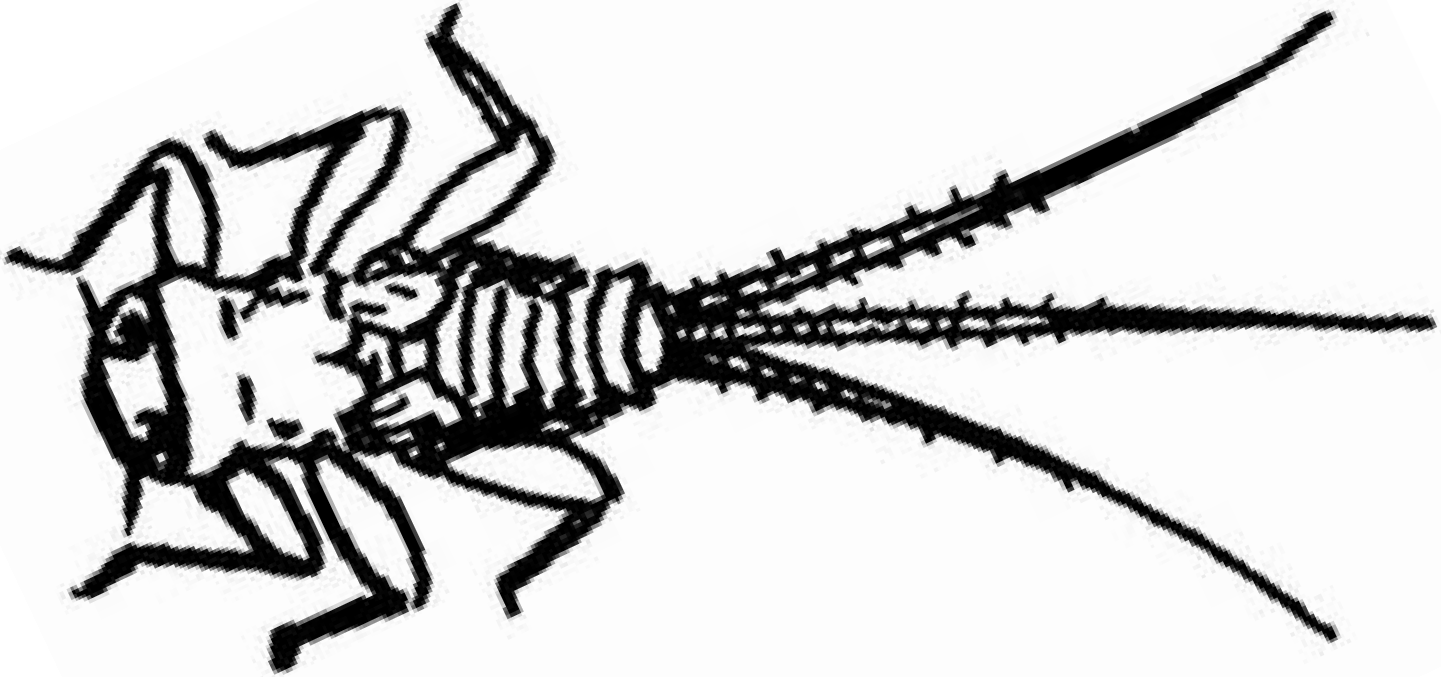
Order Hemiptera, Family Notonectidae
Feeding Group: Predator

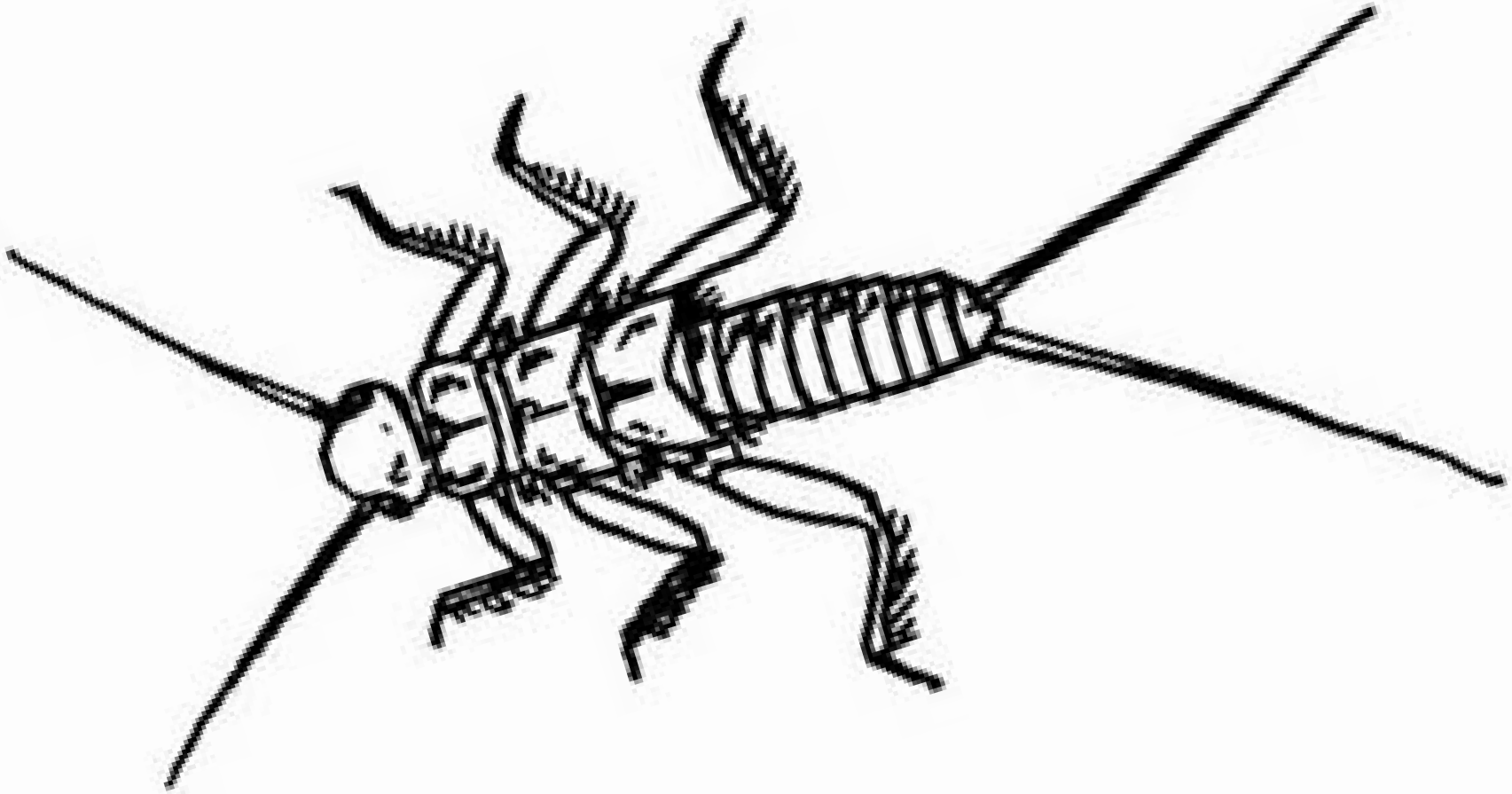
DRAWINGS

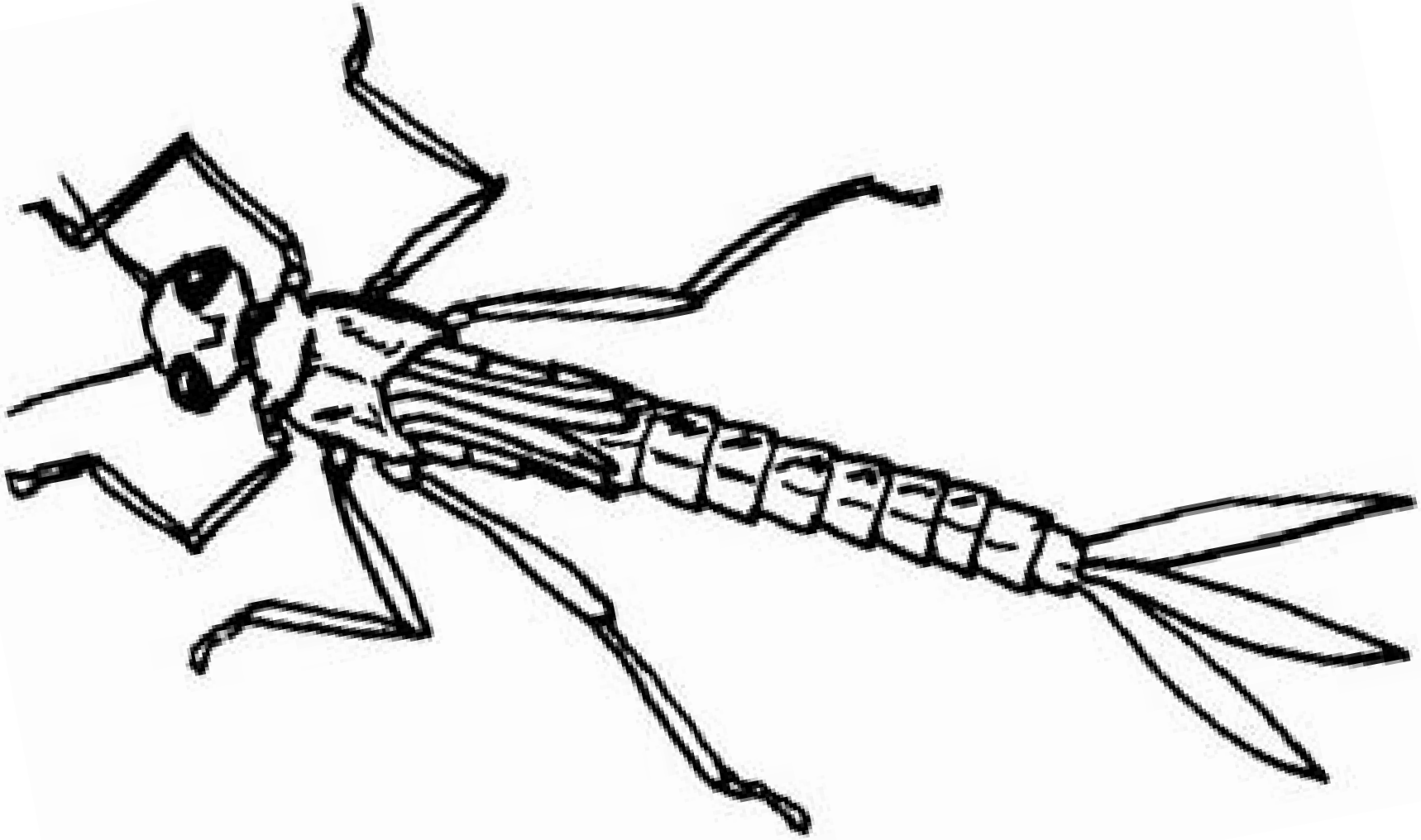
For students and for answers on back of sign

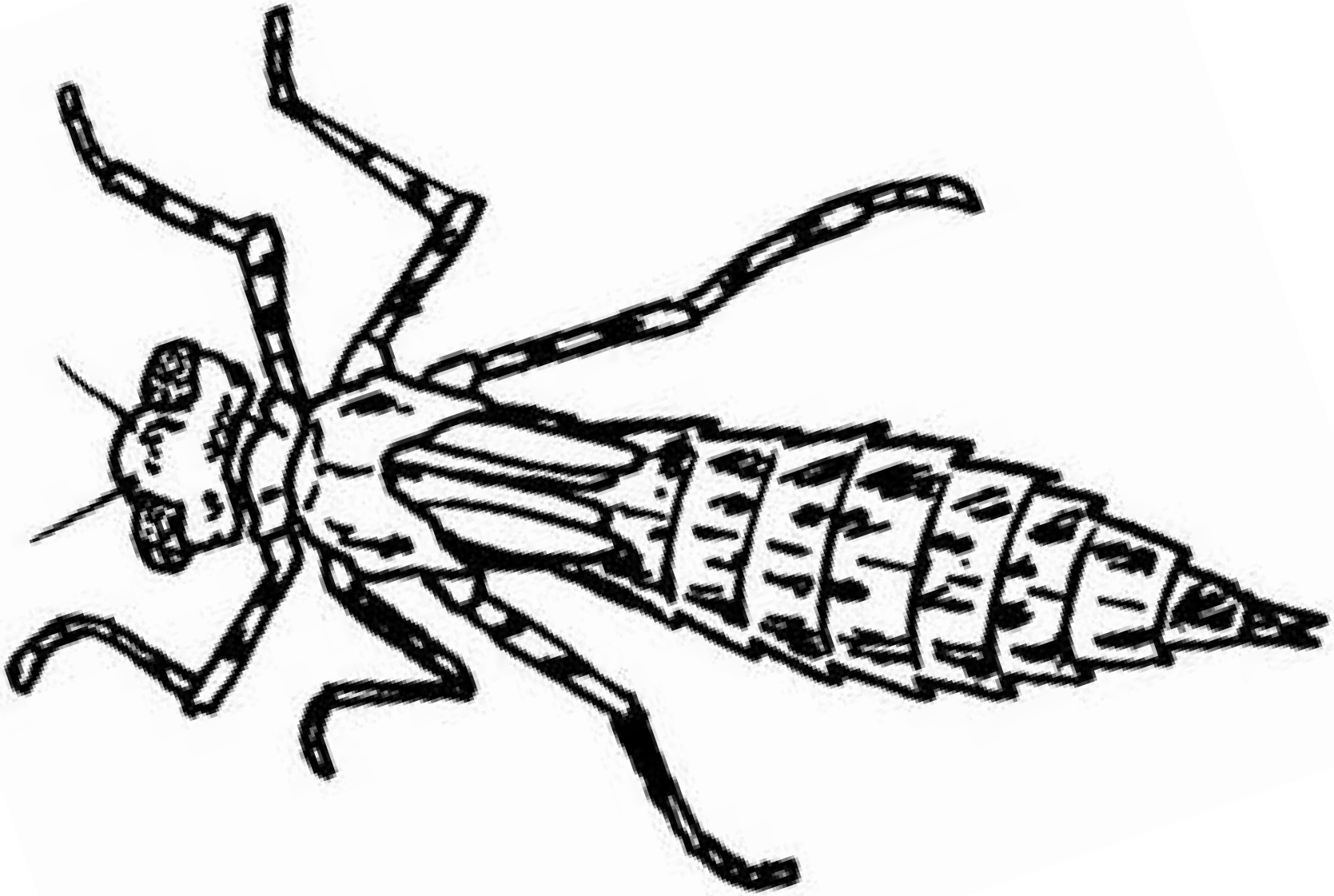
(Make 2 copies)

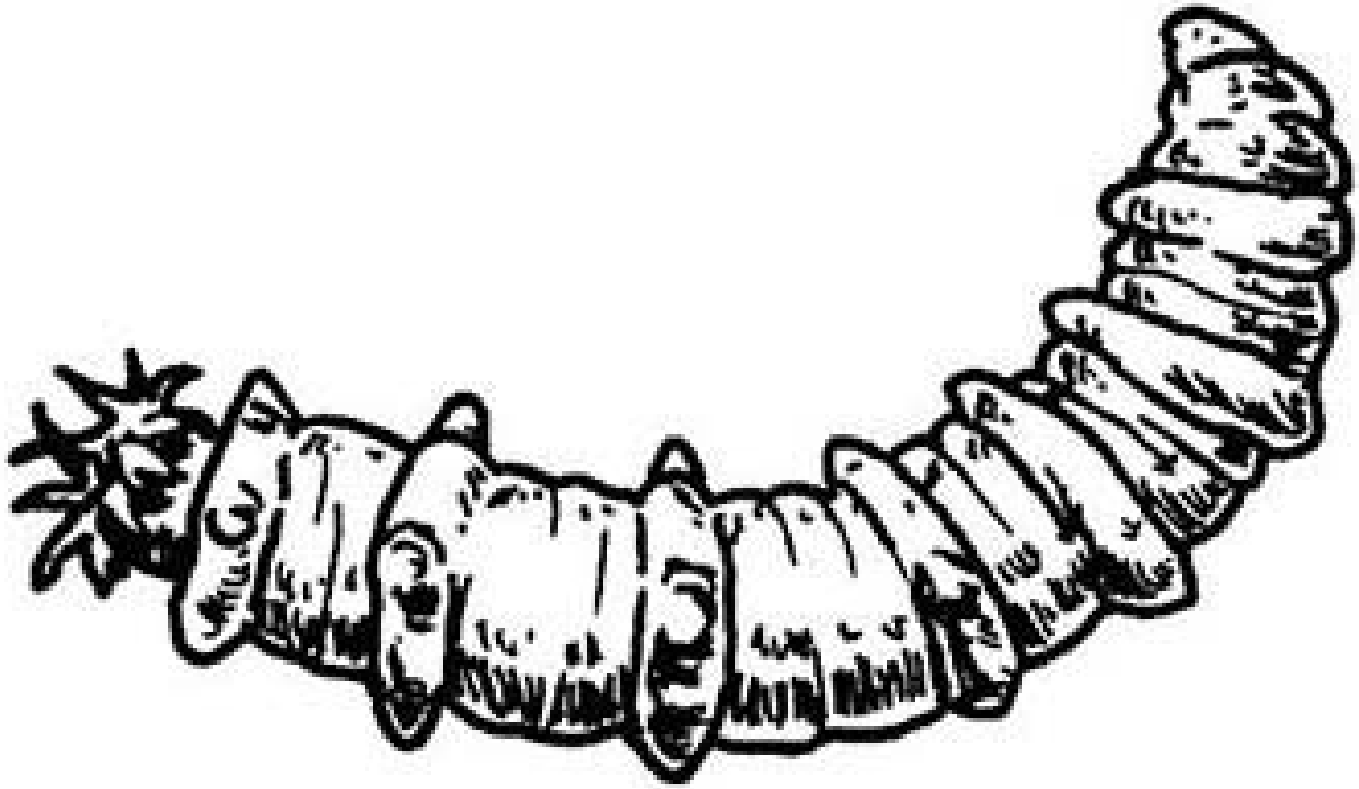


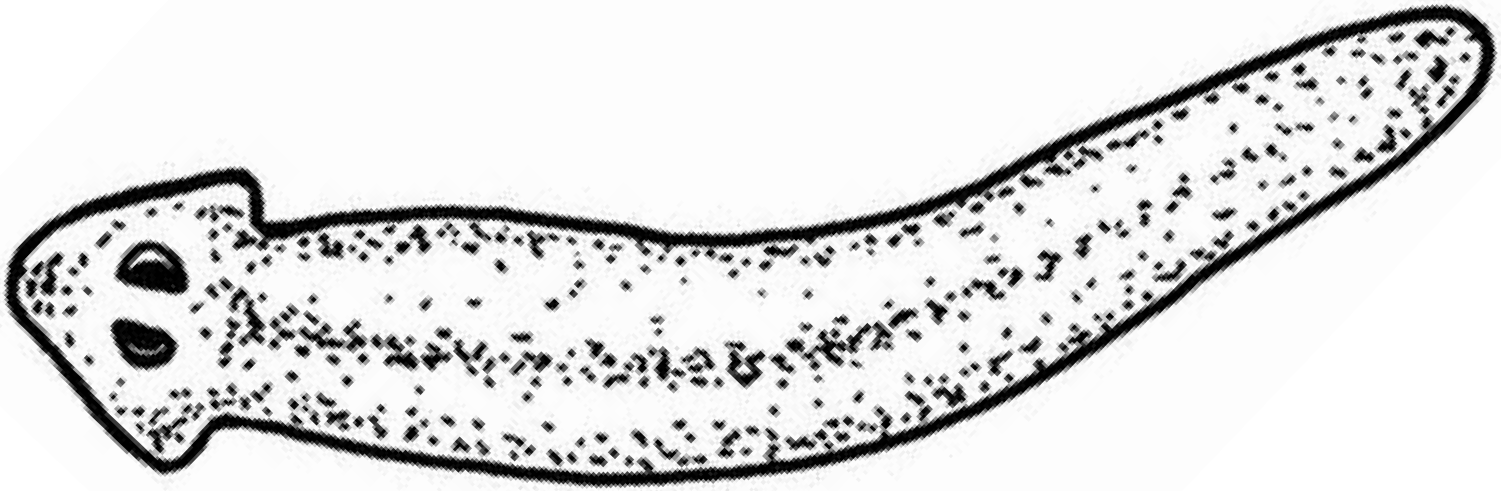


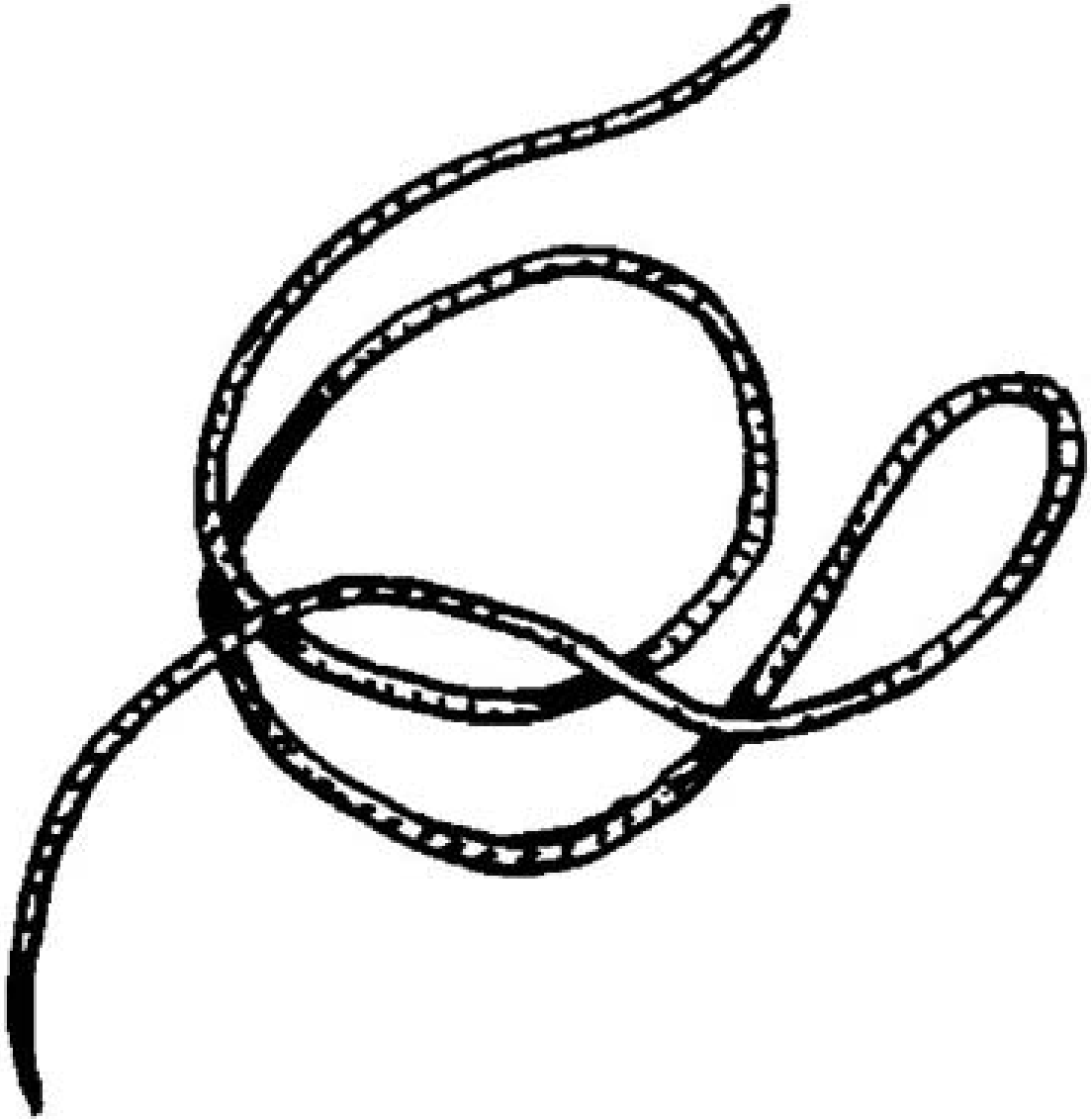


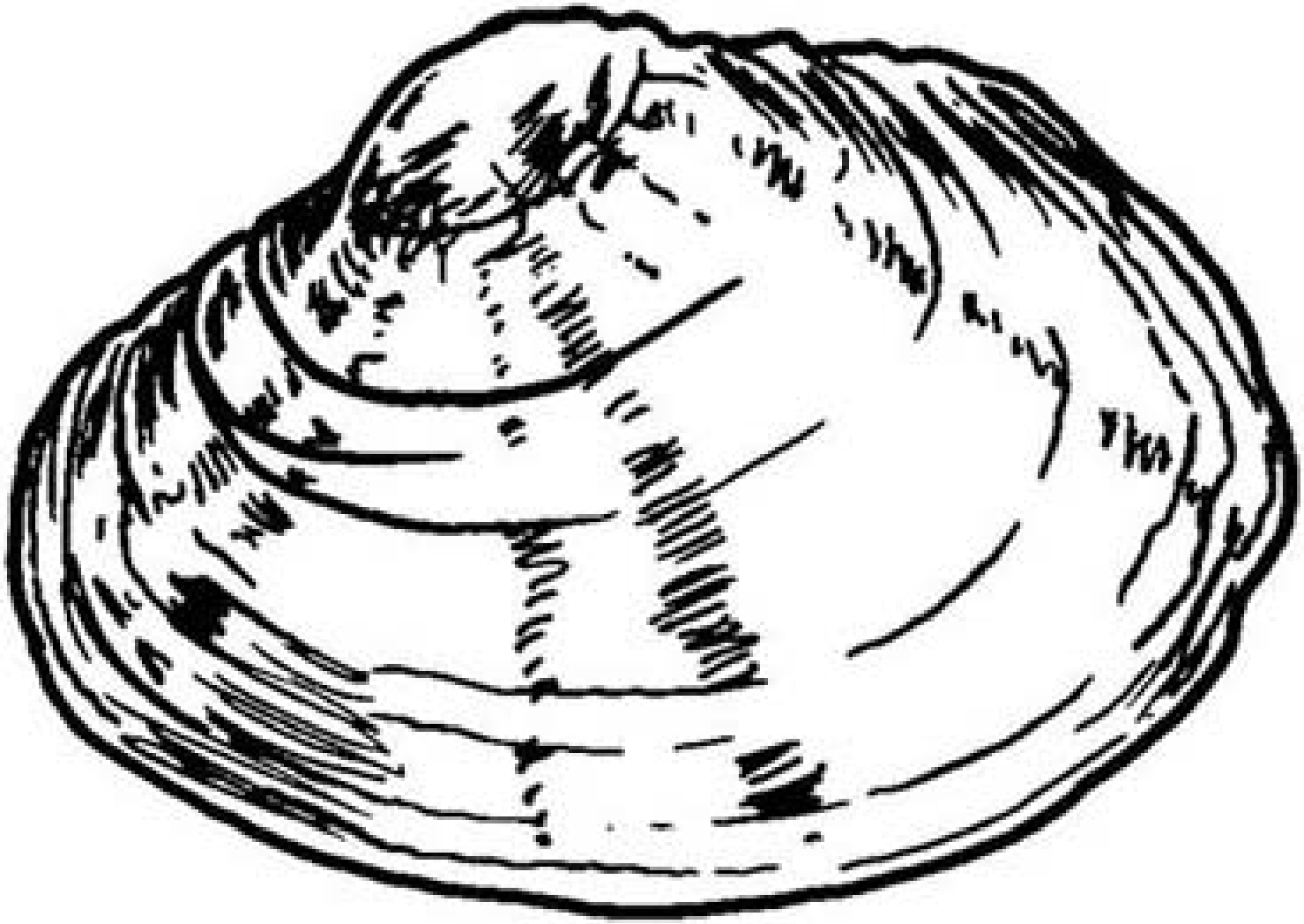


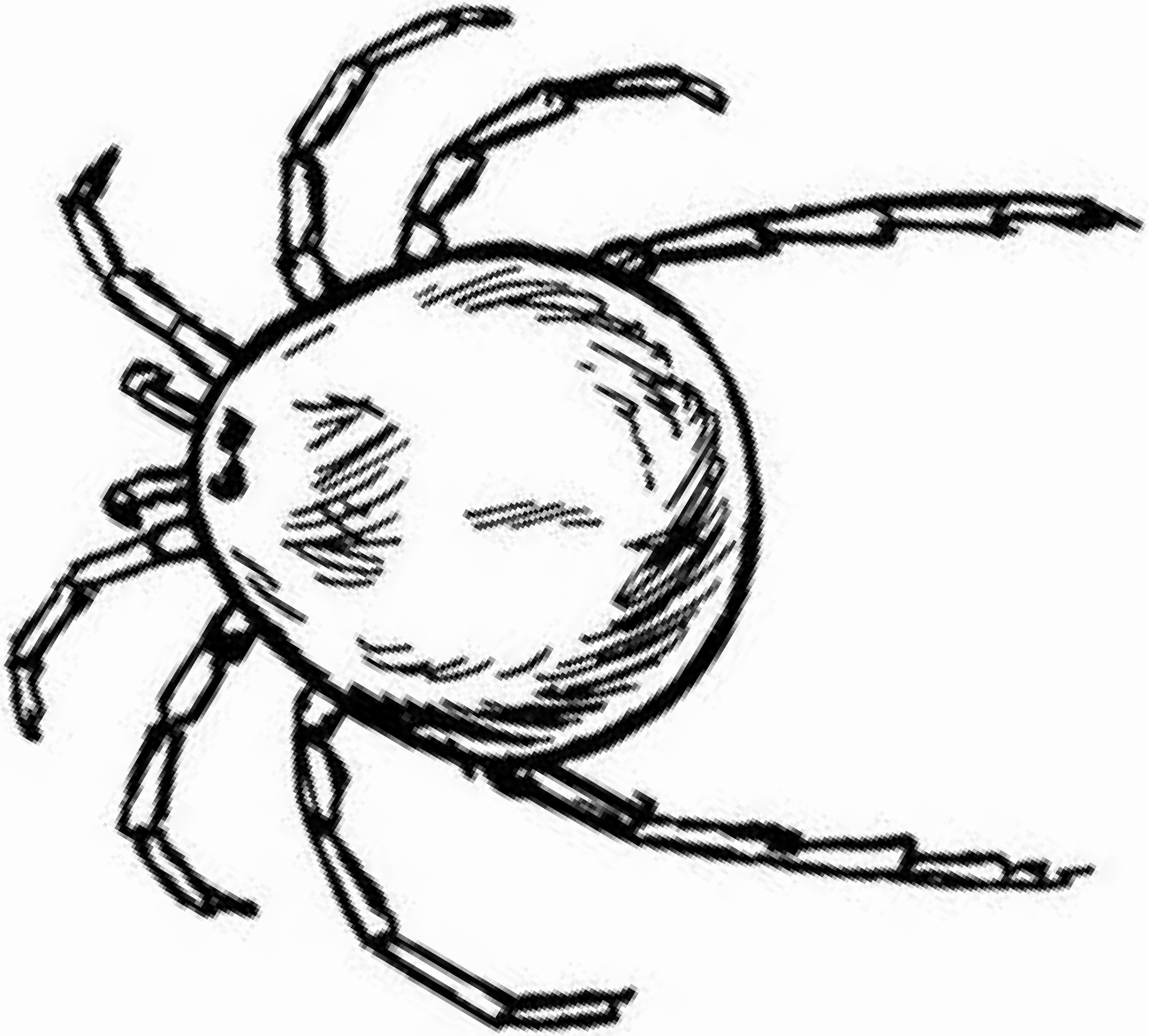


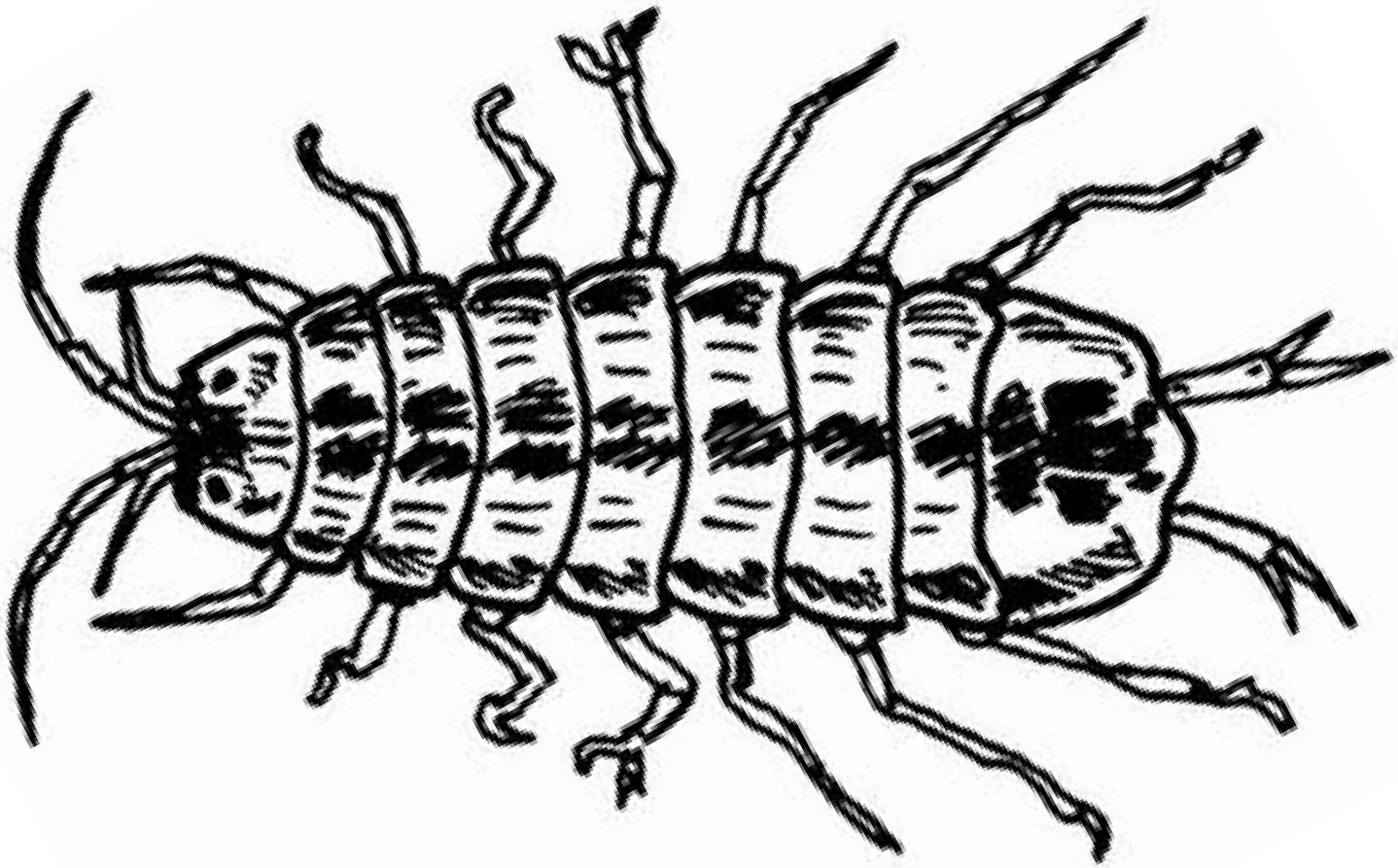


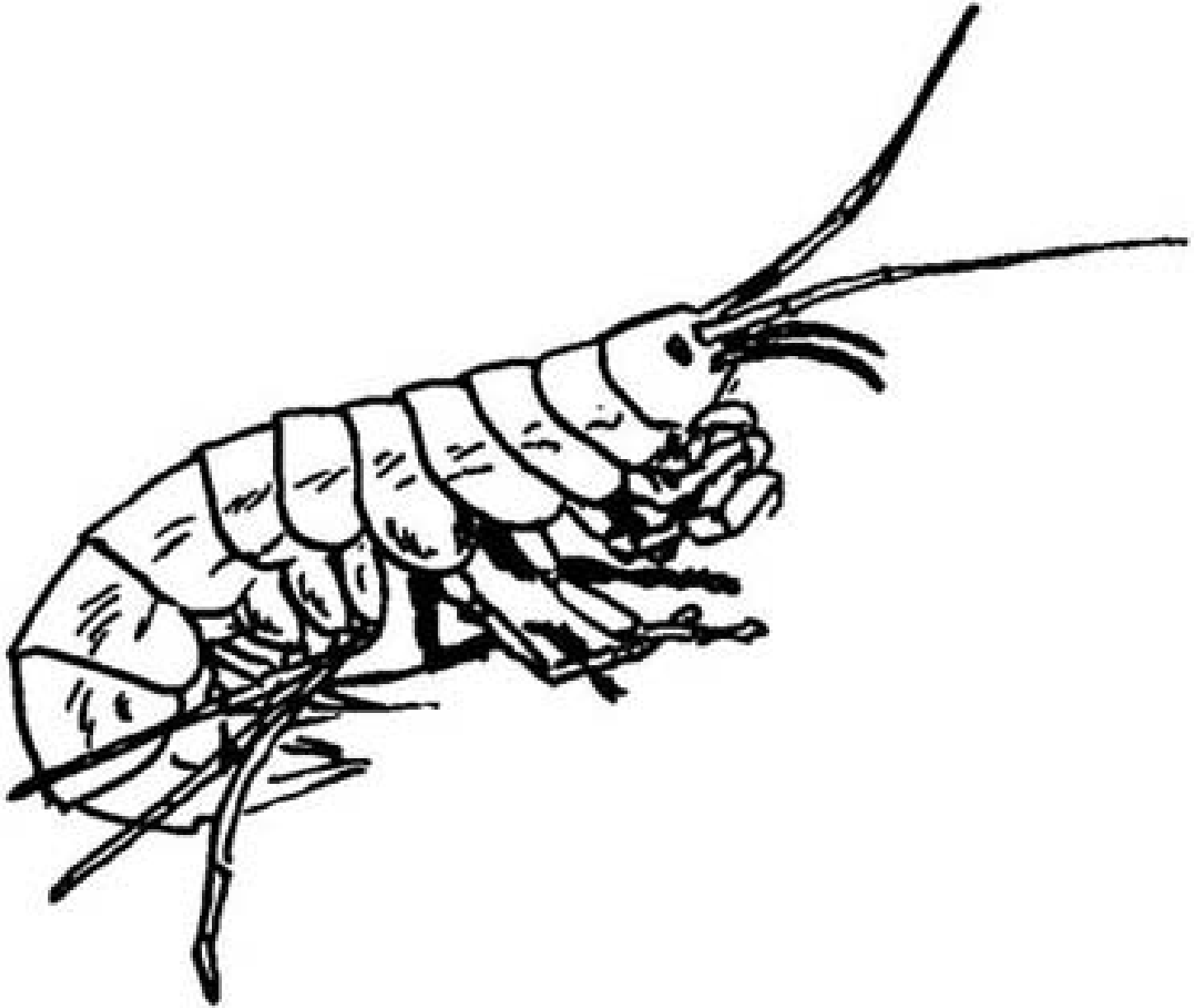


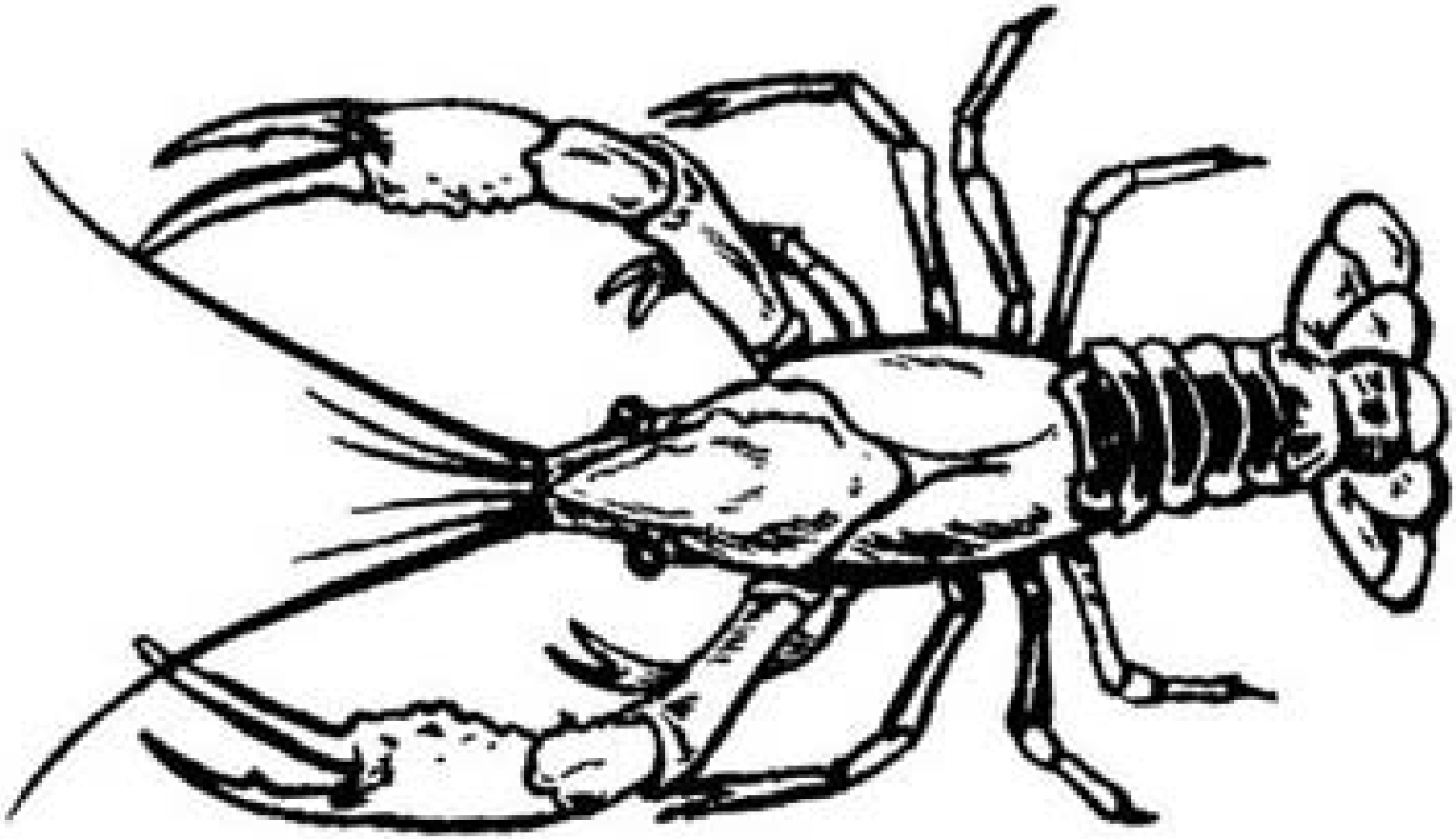


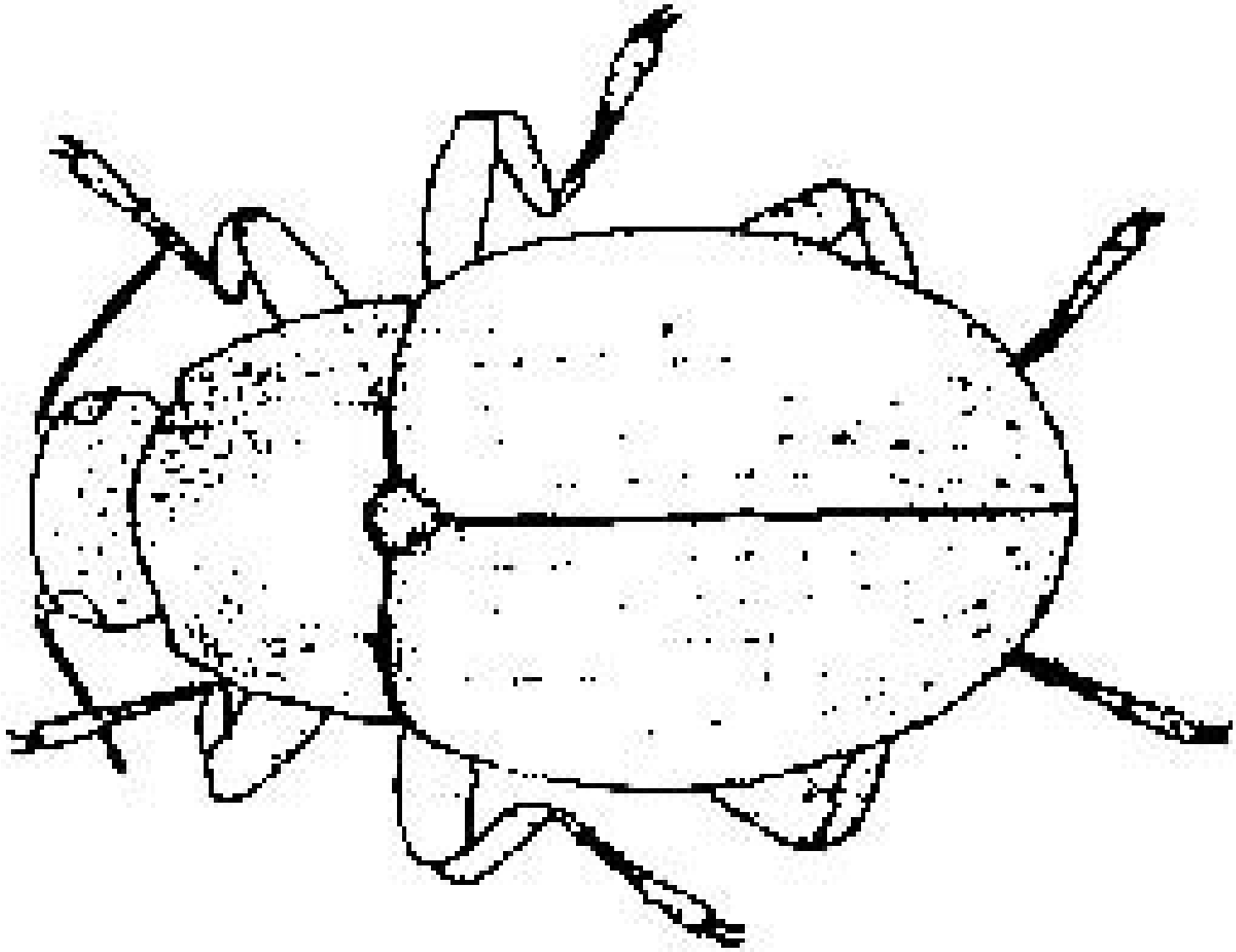


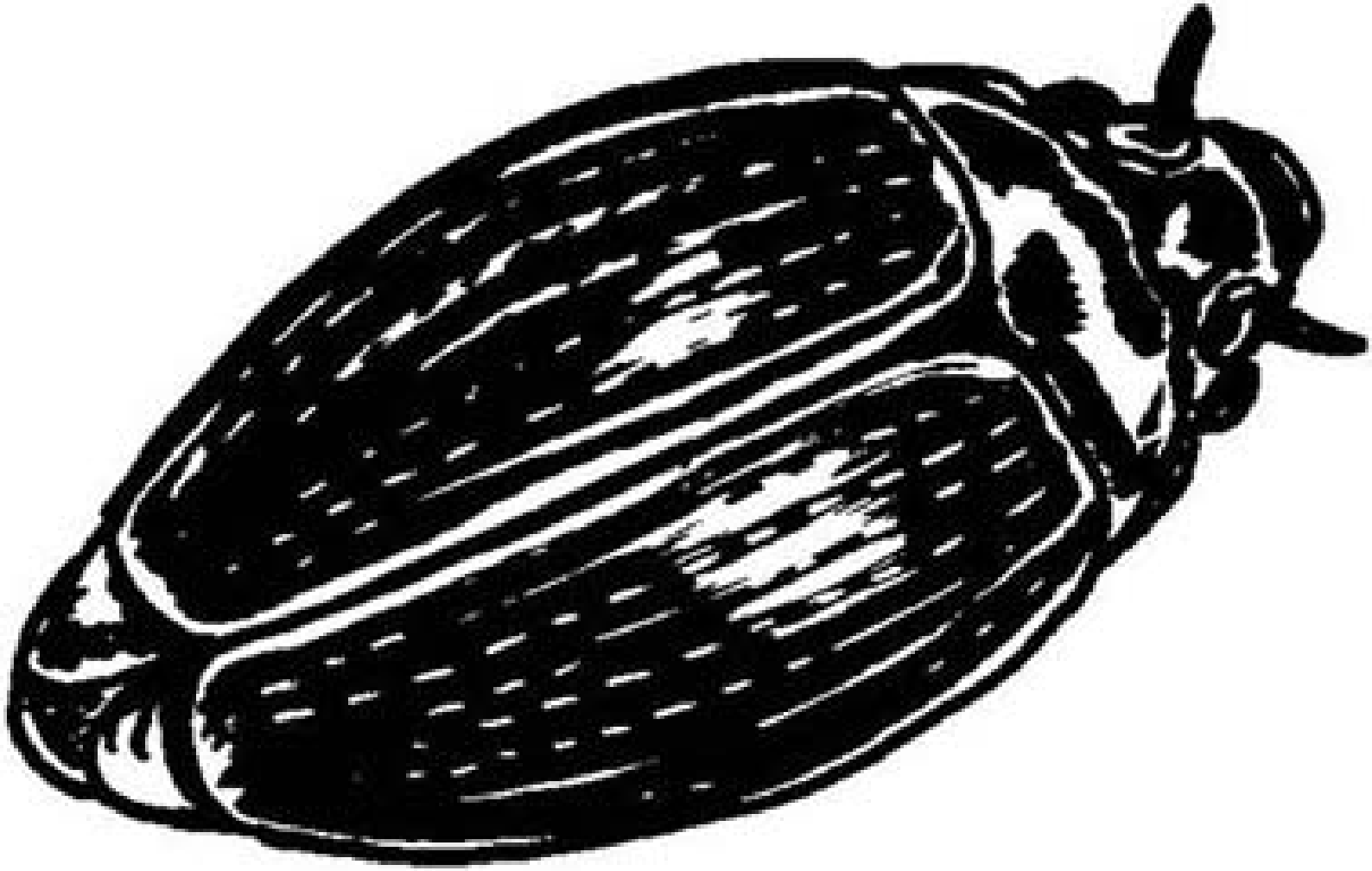


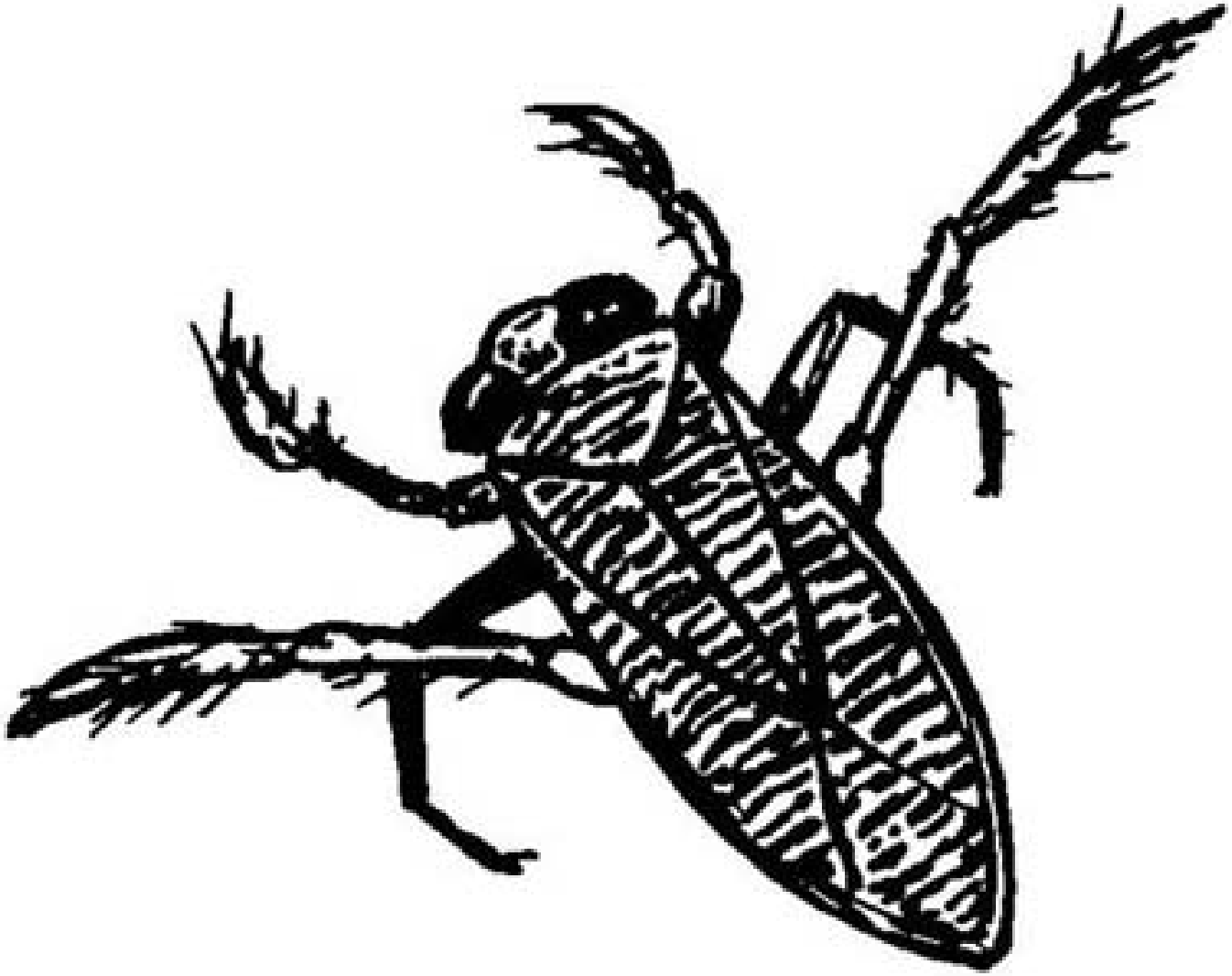












Lesson 8.5: Assessing Stream Health with Invertebrate Sampling

Essential Concept

The great diversity of aquatic life in Texas' rivers and streams reflects the great diversity of habitats found in these aquatic ecosystems. This diversity is an indication of the health of the river or stream.

Objectives

1. Students will review their KWHL chart and add questions if they feel there are questions that they have not included.
2. Students will look at maps or aerial photographs to find what order their local stream or river is and predict the types of organism to be found based on the stream order.
3. Students will conduct a field investigation to determine what organisms live in the nearest stream or river.
4. Students will assess the health of the stream or river near them based on the aquatic invertebrates found there.
5. Students will investigate which organisms live in riffles, pools, stream banks, on the stream bottom, and in channels of their stream or river.
6. Students will compare adaptations of organisms from different stream habitats.
7. Students will use safe practices and conservation of resources in the field.
8. Students will collect data and record information in tables.
9. Students will draw conclusions based on data.
10. Students will identify ways human activity can affect aquatic environments.

In Addition High School Students:

11. Will continue recording weather, chemical and physical characteristics of their stream or river for their long-term study.
12. Will demonstrate the use of course apparatuses, equipment, techniques, and procedures.
13. Will collect quantitative data from an aquatic environment, including pH, salinity, temperature, mineral content, nitrogen compounds, and turbidity.
14. Will identify water quality in a local watershed.
15. Will predict effects on the living and nonliving components of an aquatic ecosystem of chemical, organic, physical, and thermal changes caused by humans.

TEKS

6.1 A, B; 6.2 A, C, D, E; 6.4 A, B; 6.12 E; 7.1 A, B; 7.2 A, C, D, E; 7.4 A, B; 7.10 A; 7.11 A; 7.13 A; 8.1 A, B; 8.2 A, C, D, E; 8.4 A, B; 8.11 A, B, C

Aquatic Science: 1 A, B; 2 E, F, G, H, J; 5 A, B, C, D; 7 C; 10 A, B; 11 A, B; 12 A, B, C, D

Environmental Science: 1 A, B; 2 E, F, G, H, I, K; 4 A, B, E, F; 5 A, B, C; 7 A, C, 8 A; 9 A, B, C, E

Estimated Time

Depending on the distance to the site, the field trip could take from 1 class period to 1 full day

Materials

Seines and nets including D-frame aquatic dip net and kick seine

Containers for specimen such as:

White trays

Ice cube trays

Hand magnifiers or magnifier boxes

Forceps

Journals

Pens/pencils

Field Guides

Thermometers and weather instruments

Physical Water Quality Indicators check sheet

Bug Picking Water Quality Indicators

High school students should also have secchi disc, stopwatch, tennis ball or wood,

salinity test, water chemistry test kits

Safety goggles

Gloves

First aid kit

Special Instructions

Copy and laminate the *Invertebrate Key* from Lesson 8.4 to take on the field trip.

Safety Precautions

Remind students of safety precautions in the field. See Field Trip Guidelines in the *Introduction* to the curriculum.

Procedure

1. Field Trip

Review with the class Indicators of Good Water Quality in Chapter 8 in the Student Guide. Review KWHL charts with the class to make additions or deletions as needed. Look at the maps or aerial photographs to find what order their local stream or river is and predict the types of organism to be found based on the stream order.

Ask students to determine what organisms live in the nearest stream or river by collecting organisms from various parts of the stream with seines and nets. Also have students check on the underside of rocks.

Using the *Bug Picking Sheet* from Lesson 1.9, assess the health of the stream or river near them based on the aquatic invertebrates found there.

- **Which organisms live in riffles, pools, near stream banks, on the stream bottom, and in channels of their stream or river and what adaptations do they have for life in that habitat?**

Ask students to compare adaptations of organisms from different stream habitats.

- **What human uses do they observe along the stream? How might these human uses affect the organisms in the river or stream?**

Have high school students continue recording weather and chemical and physical characteristics of their stream or river for their long-term study.

2. Field Study Data and Report

Ask students to record data and observations in appropriate tables for their science journals. When you return to the classroom ask students to analyze their observations and other data to draw conclusions about the quality of the water and any changes you have noticed to the stream since your last investigation. Use this information to write a report on your field investigation. (See Report Rubric.)

Vocabulary

- Channel
- Macro-invertebrates
- Pool
- Riffle
- Riparian zone
- Stream bank
- Stream bottom
- Stream order

Student Page

Rubric for Field Reports

I. Works well with cooperative group. 25 points

1. Gets along with others, taking part in discussions, but doesn't take over.
2. Completes assigned task for the group
3. Helps develop data tables.
4. Helps draw conclusions.

II. Takes part in field activities and keeps Science Journal up to date. 25 points

1. Presents data clearly and neatly in tables and graphs.
2. Develops tables with appropriate headings.
3. Develops graphs with appropriate labels, title, and intervals for data.

III. Uses data to make generalizations. 30 points

1. Discusses data with group.
2. Draws logical conclusions supported by the group's data.
3. Writes accurate field report including:
   A. Summary of what was done on the field study including a sentence about what the purpose of the field study was.
   B. Summary of observations made and data collected.
   C. Reasonable conclusions drawn from observations. Is there other information you need to know about the aquatic ecosystem studied? How could you obtain that information?
   D. Evaluate techniques for gathering and recording data. Is there something you could improve in your next field study? Were there potential sources for error in your data? How might this affect conclusions?
   E. Restate the question or questions you were investigating from the KWHL chart. Answer the question and justify your answer based on your data.
   F. What environmental problems did you find? How could you help solve the problem or conserve the aquatic ecosystem you studied?

IV Final Product 20 points

1. Science Journal is neat.
2. All entries are neatly written in clear language.
3. Written entries are correctly spelled.
4. Math is accurately computed.
5. Area around field site is cleaned-up.

Total Possible Points 100 points

Chapter 8: Assessment

Directions

Select the best answer for each of the following multiple-choice questions.

1. Predict the impact of flooding on the organisms in a stream ecosystem.

A Some fish, plants or other aquatic life could be washed downstream.

B It will promote subsequent growth of wetlands plants and animals once floodwaters recede.

C Fresh nutrients would be brought in.

D All of the above

2. Predict the types of organisms in a fourth-order stream.

A Few rooted plants grow because the water is too deep and very cloudy; there are more collectors than shredders. Example: black willow, smartweed, buttonbush, cottonwood, sycamore, mayfly, gilled snail, stonefly, crayfish, green sunfish, creek chub and fathead minnow.

B Both rooted and floating aquatic plants and many types of animals have a niche in which to live. Example: algae, water willow, coontail, sycamore, mayfly, snail, crayfish, damselfly, scud, channel catfish, bluegill, largemouth bass and gar.

C There is little aquatic plant growth; animals depend on what falls or is washed into the stream.

D None of the above.

3. Sculpins and many darter species are adapted as bottom clingers. They:

A Have streamlined bodies that allow them to remain stable in currents

B Have flattened heads and large pectoral fins that are angled to help them stay on the bottom in swift currents

C Have upturned eyes and mouths to slurp down mosquito larvae

D None of the above

4. Which of the following statements is true:

A In a straight stretch of river, the main force of the current is usually in the middle. The deepest water is also usually in the middle.

B When there is a sharp bend in the river, the strongest current and deepest water is at the outside edge of the bend.

C In flowing water, there is less current near the bottom.

D All of the above

5. Plants living in moving water have:

A Long, thin, flexible stems that offer little resistance to the current and strong root systems to hold them in place

B Are tiny, free-floating species of algae, and are the food base of the ecosystem

C Are tall because they have greater support, enabling them to rise above other plants to reach the sun

D None of the above

Chapter 8: Assessment

Directions

Write your own answer for each of the following questions.

1. **Describe how technological solutions to problems can have risks and unintended consequences. Justify your answer by using one of the following as an example:**

   - **Building a levee in the floodplain**
   - **Damming a stream**
   - **Channelizing (straightening) a river**

2. **Suggest a possible solution to potentially harmful environmental changes within a stream ecosystem caused by the technical solution you chose in the previous question.**

3. **Diagram the parts of a stream and explain how biotic and abiotic factors that make up the stream ecosystem function together.**