

**Standards-Based Module
(Lesson/Unit Plan)**

Cover Page

Content Area: Life Science

Grade Level: 6, 7, or 8

Title of Lesson/Unit: Aquatic Insects Found in Mountain Streams and Their Adaptations

Original Lesson by: Randy Newton
Belton-Honea Path High School
Honea Path, SC 29654

Revised by: Stephanie D. Stocks and Cora M. Allard

Contact person: Ginger Foulk

E-mail address: foulk@clemson.edu

School/Organization address: Clemson University SC Life Project
SC LIFE Project Office
132 Long Hall
Clemson University
Clemson, SC 29634-0314

Phone: (864) 656-4224

Website: www.clemson.edu/SCLife/



SC LIFE Project Office
Department of Biological Sciences
132 Long Hall
Clemson University
Clemson, SC 29634
864-656-4224

www.clemson.edu/SCLIFE/

This project is supported by an award to Clemson University from the Howard Hughes Medical Institute Undergraduate Biological Sciences Education Program.

**Standards-Based Module
(Lesson/Unit Plan)**

Content Area(s): Life Science **Grade Level:** 6, 7, or 8

Time to Complete: (3-4) 50 minute class periods plus a field trip

Title of Lesson/Unit: Aquatic Insects Found in Mountain Streams and Their Adaptations

1. South Carolina State Standards

Standards Addressed:

Grade 6

The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

6-1.1 Use appropriate tools and instruments (including a spring scale, beam balance, barometer, and sling psychrometer) safely and accurately when conducting a controlled scientific investigation.

6-1.2 Differentiate between observation and inference during the analysis and interpretation of data.

6-1.3 Classify organisms, objects, and materials according to their physical characteristics by using a dichotomous key.

6-1.5 Use appropriate safety procedures when conducting investigations.

The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

6-3.1 Compare the characteristic structures of invertebrate animals (including sponges, segmented worms, echinoderms, mollusks, and arthropods) and vertebrate animals (fish, amphibians, reptiles, birds, and mammals).

6-3.2 Summarize the basic functions of the structures of animals that allow them to defend themselves, to move, and to obtain resources.

6-3.4 Explain how environmental stimuli cause physical responses in animals (including shedding, blinking, shivering, sweating, panting, and food gathering).

Grade 7

The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

7-1.1 Use appropriate tools and instruments (including a microscope) safely and accurately when conducting a controlled scientific investigation.

7-1.5 Explain the relationships between independent and dependent variables in a controlled scientific investigation through the use of appropriate graphs, tables, and charts.

7-1.6 Critique a conclusion drawn from a scientific investigation.

7-1.7 Use appropriate safety procedures when conducting investigations.

Grade 8

The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

8-1.3 Construct explanations and conclusions from interpretations of data obtained during a controlled scientific investigation.

8-1.4 Generate questions for further study on the basis of prior investigations.

8-1.6 Use appropriate tools and instruments (including convex lenses, plane mirrors, color filters, prisms, and slinky springs) safely and accurately when conducting a controlled scientific investigation.

8-1.7 Use appropriate safety procedures when conducting investigations.

The student will demonstrate an understanding of Earth's biological diversity over time. (Life Science, Earth Science)

8-2.1 Explain how biological adaptations of populations enhance their survival in a particular environment.

2. Lesson/Unit Description:

Students will recognize, characterize, and describe three microhabitats of a mountain stream: riffle, run, and pool. They will also identify the abiotic factors that might affect the insects that live in the different habitats within the stream and in what way; and then discuss morphological adaptations that insects would need to prosper in each habitat. The students will then go out in the field, identify the microhabitats, and collect insects from those areas. The students will take the insects back to the lab, examine the insects under a microscope, identify them to order, and observe the adaptations they see in the insects they collected. They will then graphically represent their findings and write a paragraph explaining their graphs.

3. Focus Question(s) for Students:

1. What are the three general microhabitats found in a mountain stream and what are their abiotic features?
2. What adaptations do insects need to enable them to live successfully in a stream?
3. What are the classifications used to refer to the insects based on these adaptations?
4. How do you use a dichotomous key?
5. Did the insects collected in each microhabitat have any of the adaptations the students predicted they would need in order to survive in that microhabitat?

4. Culminating Assessment:

1. Show the students pictures of riffles, runs, and pools of a typical mountain stream (refer to PowerPoint presentation). Discuss the abiotic features (dissolved oxygen, pH, temperature, stream bed description (sand vs. rocks vs. pebbles, etc.) water flow, sediment deposition patterns, etc.) of each of these microhabitats.
2. While viewing and discussing the stream characteristics, begin discussing the types of **adaptations** (an inherited trait that increases an organism's chances of survival in a particular habitat) an insect would need in order to survive in the water in general and in each microhabitat in particular.
3. Introduce the students to the classifications scientists use for these insects based on their adaptations.
4. Introduce the different orders of aquatic insects (pictures included in presentation).
5. Have the students write down every couplet they used in the dichotomous key to identify their insect.
6. Compare the number of specimens from the different orders found in each habitat and/or the makeup of the insect classifications observed in each habitat.

Student Directions:

1. Identify the abiotic features of a riffle, run, and pool found in a typical mountain stream.
2. Identify and then make a list of the morphological adaptations that would enhance the success of an insect living in a stream in general and in each of the habitats specifically (riffle, run, pool).
3. Each group will collect insect specimens from the habitat and note any adaptive observations they might encounter.

4. Identify the collected insects using a dichotomous key (student handout).
5. Create graphs displaying the class results for each habitat (1- number of individuals per order per habitat and/or 2 - number different classifications found in each habitat).
6. Did the insect classifications you found support what you thought they might find in the habitat sampled?

5. Materials/Equipment/Resources:

Per Class:

Basic water test kit (temperature, pH, dissolved oxygen, turbidity) (*in SC LIFE equipment footlocker*)
 Flow meter (*in SC LIFE equipment footlocker Fall 2005*)
 Kick nets, pans, and sieves (*in SC LIFE equipment footlocker*)
 DigiCam (digital stereoscope) (*in SC LIFE equipment footlocker*)
 Field guides of aquatic insects (see *Additional Resources*)
 Cooler

Per Group:

Collection sheet and pencil for labels
 Collection vials or plastic containers
 Forceps (*in SC LIFE equipment footlocker*)
 Clean water collection bottle
 Stereo microscope or Magnifying glasses

Per Student:

Student handout #1
 Student handout #2
 Colored markers or pencils and graph paper
 or create the graph in Excel

6. Teacher Preparation:

1. Read background information and be prepared to explain physical features of aquatic habitats as well as morphological adaptations of insects that live there (refer to teacher supplement if needed).
2. Make sure PowerPoint presentation is ready and make copies of the student handouts.
3. Identify a mountain stream area suitable for students to observe and collect aquatic insects. Recommended sites in upstate South Carolina are the East Fork of the Chattooga River in the Ellicott Rock Wilderness area in Oconee County or Jones Gap State Park in Greenville County. Be sure to check out any restrictions on specimen collection.
4. Prepare and obtain materials/equipment (refer to teacher supplement if needed).
5. Separate students into working groups of four. Arrange for at least one chaperone that is trained in First Aid and Community CPR and Outdoors Safety and bring a first aid kit.

Background Information

1. **Abiotic features** (any contribution to the environment that is of a non-living nature) of a typical mountain stream
 - A. Mountain streams are generally cold (not exceeding 65°F during the summer) and acidic (average pH is 6 to 6.5)
 - B. Because the water is cold, they have more dissolved oxygen than the same body of water at a higher temperature
 - C. Because the water stays cold and they are already wet, aquatic insects are active throughout the year
2. There are certain **microhabitats** (smaller habitats found within a larger one) found within a typical mountain stream.
 - A. Riffles
 - i. Area where accumulated gravel, rocks, or stationary objects (logs, etc.) that cause breaks in the water flow resulting in white water.
 - ii. Highly oxygenated
 - iii. Fast moving, swirling water
 - iv. Light weight sediment and organic matter (sand, leaves) usually gets washed away leaving larger sizes (rock, pebbles, logs) behind
 - a. Surface breaking rocks or logs may trap some of the lightweight sediment temporarily, but usually gets washed away with next big rain storm
 - B. Pools
 - i. Areas that are have deeper, stiller water where sediment is deposited.
 - ii. Sand particles and lightweight organic matter gets deposited here
 - iii. Less oxygen, may even have an **anaerobic** (without oxygen) mud area
 - iv. Slower moving water
 - C. Runs
 - i. Fast moving section of the stream that is free of obstructions that break the flow of the water, no white water.
 - ii. Good oxygen levels
 - iii. Swift moving water
 - iv. Light weight sediment and organic matter (sand, leaves) usually gets washed away leaving larger sizes (rock, pebbles, logs) behind but, again, these do not break the water surface
 - D. In addition, there are even smaller habitats that can occur within the microhabitats of a mountain stream.
 - i. Leaf-mats (an accumulation of leaves and other organic debris on some stationary object in a stream) can occur in a pool or be part of a riffle.
 - ii. Root wads, found in the undercut of the stream banks, can also be found in a pool or part of a riffle.
3. There is an abundance of aquatic insect species well adapted to living in the many microhabitats of mountain streams.
 - A. They live in or on the water for part or all of their lives.
 - i. You can find both adults and larval insects living in the stream.
 - B. They are well equipped to fit their specific niches and thrive within the habitats of mountain streams.

- C. They feed on a variety of food sources
 - i. **Carnivores** (feed on other organisms)
 - ii. **Herbivores** (feed on live plant material)
 - iii. **Detritivores** (feed on dead plant material)
- D. Aquatic insects help reorganize the organic matter in aquatic **ecosystems** (an ecological system that includes all the organisms and their environment within which they occur naturally), making nutrients available for other organisms.
 - i. Since insects are so abundant, they can process enormous amounts of nutrients, enhancing the health of aquatic ecosystems.
- E. The presence or absence of certain aquatic insect groups can also give an indication of the quality of the water in the stream.
- F. Typical aquatic insect orders (see teacher supplement for more details)
 - i. Coleoptera
 - ii. Diptera ephemeroptera
 - iii. Hemiptera
 - iv. Neuroptera
 - v. Odonata
 - vi. Plecoptera
 - vii. Trichoptera
- 4. One of the fascinating things about all insect species is their **morphology** (the study of their form)
 - A. All adult insects have 3 pairs of legs and are comprised of three parts: head, thorax (legs are only attached to the thorax), and abdomen, most juveniles also have these characteristics, with some notable exceptions (fly larvae especially).
 - B. The morphology of insects varies to meet the requirements for different species to thrive in their habitats.
 - C. To live in running water, aquatic insects have evolved one or more following general morphological features
 - i. Gills
 - a. Feather or leaf looking structures that help take oxygen out of the water
 - ii. Flattening of body surface
 - a. Allows species to live on top of flattened stones and allows them to crawl through closely compacted substrate
 - iii. Streamlining
 - a. Offers less resistance to fluids
 - iv. Reduction of projecting structures
 - a. Projecting structures only increases water resistance
 - v. Suckers
 - a. Provide attachment to smooth surfaces
 - vi. Friction pads and marginal contact with substrate
 - a. Close contact with substrate increases frictional resistance and reduces the chances of being dislodged by the current
 - vii. Hooks and grapples
 - a. Help attach to rough areas of the substrate
 - viii. Small size
 - a. Small sizes permit them to crawl through closely compacted substrate
 - ix. Silk and sticky secretions

- a. Allows attachment to substrate in swift currents
 - x. Ballast
 - a. Using large, heavy stones (relative in size to the insect) to make their cases makes the insects less likely to be swept away
 - xi. Attachment claws and dorsal processes
 - a. Stout claws aid in attachment and fixation to plants
 - xi. Hairy bodies
 - a. Keeps sand and soil particles away when burrowing in the substrate
5. Aquatic insects can also be placed in categories based on specialized adaptations which help them to exploit the microhabitat within the stream in which they are found
- A. Skaters
- i. Are adapted to skating across the surface of the water with their tarsi specialized for pushing water to propel them forward in pools within the stream.
 - ii. Ex. Water strider (Hemiptera)
- B. Divers
- i. Are adapted for swimming in mountain stream pools by "rowing" with their hind legs.
 - ii. Ex. members of the family Dytiscidae have hind legs that are flattened and fringed with hairs to form paddles. These predaceous diving beetles can remain submerged for long periods of time because they carry air in a chamber under the forewings.
 - iii. Ex. members of the family Corixidae (water boatmen) lack gills and obtain air at the surface. They swim rapidly, usually in a somewhat erratic fashion, and they have to come to the surface to get oxygen.
- C. Swimmers
- i. Are adapted for swimming in pools and runs much like fish and may cling to submerged objects in between bouts of swimming.
 - ii. Ex. Minnow mayflies (Ephemeroptera in the families Siphonuridae and Leptophlebiidae)
- D. Clingers
- i. Are adapted with long, curved tarsal claws, dorsoventral flattening, and ventral gills arranged as suckers for attaching to surfaces in stream riffles
 - ii. or they can have a fixed retreat
 - iii. Ex. Water pennies (Coleoptera)
 - iv. Ex. Net spinning caddisflies (Trichoptera in the family Hydropsychidae)
 - v. Ex. Blackfly larvae (Diptera in the family Simuliidae)
- E. Sprawlers
- i. Are adapted for staying on top of leaves and debris or fine sediments found in pools within the stream while keeping their respiratory surfaces free of silt.
 - ii. Ex. Dragonflies (Odonata in the family Libellulidae)
 - iii. Ex. Stonefly larvae (Plecoptera in the family Perlidae)
- F. Climbers
- i. Are adapted for moving up roots, sticks, and branches along the stream's edge (along runs) or stream bank undercuts (in pool areas).
 - ii. Ex. Dragonflies (Odonata in the family Aeshnidae)

- iii. Ex. Damselflies (Odonata in the family Calopterygidae)
- G. Burrowers
- i. Are adapted to living in the fine sediments of stream pools
 - ii. May even construct burrows of sand grain tubes which may extend above the surface of the substrate
 - iii. Ex. Burrowing mayflies (Ephemeroptera in the family Ephemeridae)
 - iv. Ex. Caddisflies (Trichoptera in the family Sericostomatidae)

<i>Adaptation</i>	<i>Order</i>	<i>Family</i>	<i>Example</i>
<i>Skaters</i>	Hemiptera	Gerridae	water strider
<i>Divers</i>	Hemiptera	Corixidae	water boatman
	Coleoptera	Dytiscidae	adult diving beetle
<i>Swimmers</i>	Ephemeroptera	Siphonuridae	minnow mayflies
<i>Clingers</i>	Coleoptera	Psephenidae	larval water penny
	Trichoptera	Hydropsychidae	caddisfly larva
	Diptera	Simuliidae	blackfly larvae
<i>Sprawlers</i>	Odonata	Libellulidae	dragonfly larva
	Plecoptera	Perlidae	stonefly larvae
<i>Climbers</i>	Odonata	Aeshnidae	dragonfly larvae
	Odonata	Calopterygidae	damselfly larvae
<i>Burrowers</i>	Ephemeroptera	Ephemeridae	burrowing mayfly
	Trichoptera	Sericostomatidae	caddisfly larvae

7. Procedures:

1. Introduction to the Topic:
 - A. Use the PowerPoint presentation to point out a typical mountain stream and the different habitats found within the stream.
 - B. Use the PowerPoint presentation to introduce the term morphology. Explain that aquatic insect species have morphological adaptations that enable them to survive and thrive in these challenging habitats.
2. Teacher Directed Discussion:
 - A. As you view the presentation, ask the students to describe the mountain stream environment in terms of its physical characteristics. Ask them to relate any personal experiences they may have had while visiting a mountain stream.
 - B. Explain stream features and describe specific microhabitats within the streams.
 - C. As you view the presentation, ask students to describe general adaptations they think aquatic insects might need in order to be successful in cold, running mountain streams and explain why they need them.
 - D. Introduce the insect adaptations (general and specialized) listed in Background Information. Describe the various locations where these insects live and move. Lead a class discussion about specific adaptations that might enhance insect survival in each location. Include feet, legs, claws, gills, mouthparts, etc.
3. Equipment and Skills Demonstration:

- A. Demonstrate how to use the various test kits to collect data on abiotic stream conditions and how to record this information on the data sheet provided (student handout #1).
 - B. Demonstrate how to use the kick net and sieve to collect specimens from the stream and transfer them to the white pan for individual collection. Show how to transfer specimens to collecting vials.
 - C. Show the student show to use the stereoscope. Present the steps for placing live specimens in petri dishes and viewing with dissecting microscope (if applicable).
 - D. Observe the aquatic insects live and make video recordings or take digital pictures of the specimens using DigiCam (if applicable).
4. Student Activity:
- A. Field Trip:
 - i. Place students in their groups: data collector, insect collector #1, insect collector #2, and insect sorter (places the specimens collected in their vials and makes sure the label is correct).
 - ii. Have the students identify the target habitats within the stream and take abiotic data for each of the habitats and record them on the data sheet.
 - iii. Have students place insects and stream water in labeled collecting vials and store vials in cooler if bringing back live specimens.
 - B. Experimental Design:
 - i. Have the students observe the collected insects under a stereoscope, taking note of adaptations. Were any of these adaptations discussed by the students earlier? Any new or unexpected ones? Did any observed adaptations correlate to the ones expected for each of the habitats?
 - ii. Discuss possible procedures for collecting and organizing data into a graph.
 - iii. Instruct students on how they can report their findings.
 - C. Independent Practice:
 - i. Each student will write a paper explaining what adaptations they expected to find, what adaptations they did find, and if the adaptations they found correlated with what they expected (and display this information graphically).
 - ii. Each student will also graphically represent the number of individuals from each insect order that were found in the habitat they sampled.

8. Differentiation of Instruction:

1. Gifted and talented students can access web sources from the recommended list to enrich their learning experience.
2. Students unable to participate in field experiences can access virtual field trips through various websites and CDs.

9. References

Borror, Donald J., Charles A. Triplehorn, and Norman F. Johnson. 1989. An Introduction to the Study of Insects. Harcourt Brace College Publishers, New York.

Lehmkuhl, Dennis M. How to Know the Aquatic Insects. 1979. WCB/McGraw-Hill, Boston.

Merritt, Richard.W. and Kenneth W. Cummins. 1978. An Introduction to the Aquatic Insects of North America. Kendal Hunt Publishing Company, Dubuque, Iowa.

10. Additional Resources

Web Sources:

<http://virtual.clemson.edu/groups/SCLife/weblinks/Animal%20Links.htm>

<http://www.nearctica.com/>

<http://www.zo.utexas.edu/faculty/sjasper/beetles/index.htm>

<http://www.ipm.iastate.edu/ipm/hortnews/1992/5-6-1992/water.html>

http://www.ent.iastate.edu/list/k-12_educator_resources.html

<http://www.streamnet.org/>

<http://entweb.clemson.edu/database/trichopt/>

<http://www.famu.org/mayfly/>

Books:

Bland, Roger G. and H.E. Jacques. 1978. How to know the Insects. 3rd Edition. WCB/McGraw Hill, Boston.

Brigham, Allison R., Warren U. Brigham, and Arnold Gnilka, editors. 1982. Aquatic Insects and Oligochaetes of North and South Carolina. Midwest Aquatic Enterprises, Mahomet, Illinois.