ECOS
Ecologists Educators and Schools: Partners in GK-12 Education

# ECOS Inquiry

**1. Contributor's Name: Alison Perkins and Jen Marangelo**

**2. Name of Inquiry: Insect Needs and Insect Feeds**

**3. Goals and Objectives:**

**a. Inquiry Questions:** Do insects eat plants? What are they eating? (Can plant-eating insects be helpful?)

**b. Ecological Theme(s):** Insects have needs, such as food and space, that plants provide.

**c. General Goal:** To learn about the life cycles of several holometabolous insects (insects that completely change life forms) used as biological controls and to begin to understand that insects are often beneficial (e.g., as biological controls and pollinators).

**d. Specific Objectives:**

*Academic*: Insects have different life stages, and needs for food and shelter change as insects change life stages.

*Experimental*: Students will determine the kinds of insects that eat plants and explore the different life stages found on plants.

*Procedural/technical*: Students will learn about the life cycle of insects undergoing complete metamorphosis and parts of the plant.

*Social*: Students work as a team to develop stories about insect life cycles.

*Communication*: Students have the opportunity to share their ideas about life cycles with the rest of the class.

**e. Grade Level: 1-2**

**f. Duration/Time Required:** 90 minutes in 2 class periods (with 2-3 weeks between)

→ **Prep time** – requires printing insect life cycles and pasting them on to paper plates or other type of cardboard and cutting out puzzle pieces, and gathering knapweed collecting gear (gloves, bucket of soil, trowels, bag, tape)

→ **Implementing Exercise during Class**

Making observations of insects on plants (30 minutes)

Dissecting knapweed plants (30 minutes)

Insect life cycle puzzles (Day 1: 20 minutes; Day 2: 10 minutes)

→ **Assessment** – in class on Day 2

**4. Ecological and Science Context:**

Insects are very different from vertebrates; their skeletons are on the outside of their bodies – called exoskeletons. The rigid structure limits growth, and must be replaced periodically with a larger exoskeleton if the insect is to grow. Some insects simply (although by no means a simple process) go through a series of stages from little versions of themselves to larger versions; they are hemimetabolous insects. Holometabolous insects, on the underhand, are those that undergo a complete metamorphosis, completely changing life forms. Butterflies are the most commonly known holometabolous insects, but beetles, bees, and ants, among others, are all holometabolous, too. Holometabolous insects have taken the adaptation one step farther; their body forms are so different that they can exploit completely different habitats, for example larvae can live in the barky core of roots (where wings would get completely shredded), but the adults can fly from flower to flower.

Biological control tries to match natural enemies (such as parasites or herbivores) to pest species to help control populations of the pests. It is especially effective when a pest or exotic species (like mosquitoes and knapweed) has been introduced into a new geographic area where its natural enemies don't exist. Finding the right biological control requires first determining the origin of the introduced species and collecting the naturally occurring enemies that become agents of biological control. To ensure that it will not harm native or crop species, the biological control agent is quarantined and undergoes a series of tests. It is then reared and released onto the pest species. Biological control is long lasting and relatively inexpensive. Other than the original costs of the collection, importation, quarantine, testing, rearing, and releasing, little expense is included. When a biological control agent (such as the knapweed flower feeding weevil) is successfully established, it rarely requires additional care. For example, several of the knapweed biological control agents that have been released have spread to new areas all by themselves. Keep in mind that a single biological control agent rarely is so effective that it can destroy the entire population of a pest species, but research indicates that combinations of agents can have major impacts.

**5. Motivation and Incentive for Learning:**

Students get to explore the insects and plants in their schoolyards. They get to rear their own biological controls and release them into knapweed infested areas.

**6. Vocabulary:**

**holometabolous** – insects that undergo a complete metamorphosis, completely changing life forms

**hemimetabolous** – insects that undergo a series of metamorphoses but do not change life form, the just gradually get larger and larger

**biological control** – the idea that natural enemies, such as insects, can be used to control invasive species, such as knapweed

**larva (**plural larvae) – the juvenile form of an insect that undergoes metamorphosis

**gall** – a swelling in an area of a plant caused by various agents. Insect galls are usually caused by chemicals the larvae or adults injects while eating part of the plants.

**7. Safety Information:**

Some people may react to knapweed resins, and anyone handling knapweed should wear work gloves.

**8. Materials List (including any handouts or transparency masters):**

magnifying glasses or jars
bucket of soil
clear plastic bags (large)
duct tape
gloves
hand trowels or shovels
paper plates
life-cycle cutouts

**9. Methods/Procedure for students:**

**a. Pre-investigation work:**

Take students outside to observe plants; their objective is to find insects and draw and describe how the insects are using those plants (e.g., are they feeding on pollen? hiding in the flower or leaves? feeding on other parts?) Have the students imaging how insects use plants as food and shelter. They should draw the insect and part of plant the insect used in their journal along with their ideas about the insect's needs and how those needs might be met.

Bring the students back together and ask them to describe what they saw and share their pictures. Ask them why the insects were where they were. What do the insects get from the plants [food, shelter, space]?

**b. Investigation work:**

First, take a break and talk about insect life cycles. Explain the life cycle of holometabolous insects and have the students brainstorm about why different life forms may be valuable adaptations. Provide each student with a life cycle puzzle piece. Give them 15 minutes to sort themselves into teams by putting their puzzle together and then come up with a story for the life cycle and describe it to the rest of the class. Get them to focus on where these different life stages might be found (e.g., where would the eggs be? The larvae? The adults?). See if they have some idea about how long each stage may last. Some insects have long larval periods, even overwintering as larva, and others have short larval periods, overwintering as adults. (The arrows on the plants show relative lengths of each stage.)

Next, have each student collect at least one whole knapweed plants (including dead flower heads) by firmly pulling the plant out of the ground from near the base. Ask students if they think any insects are on the knapweed plants they've collected. Have students explain where they would expect to find insects, and why we may not be able to see these insects. See if they can relate the puzzles they just fit together with where they might find insects on the knapweed plants.

Have students carefully dissect knapweed plants to see what they find (be sure to save some whole plants!) Students can gently break apart the flower heads with their fingers using their thumbnails to split it in half and then in half again. The roots may require a little bit more effort, but larvae can be found in the outer or inner layers. If they find a larval insect, have them use a hand lens and draw the larva in their journal. Make sure they note where they found the plant, where the larva was on the plant, and the date they found the larva.

Once a number of larvae have been found and all of the students have had a chance to look at them, plant 2-3 of the whole knapweed in the buckets of soil. Cover the bucket completely with a clear plastic bag, secure the edges of the bag around the bucket with duct tape, use a push pin to add a bit of ventilation, and leave it in a warm, sunny location. (In about 2-3 weeks, at least one species of adult insects should emerge.) Alternatively, just break off some intact seed heads and place them in a knotted plastic bag (like a vegetable bag from the grocery).

**c. Building on it:**

In about 2-3 weeks (once you've started to see adults emerge in the knapweed plants), return to the life cycles puzzles. Give each student a puzzle piece, have them sort themselves into groups based on completed puzzles, and ask each team to describe their life cycle puzzle. Introduce the students to the adults that have emerged on the knapweed plants and have them talk about the adults in relation to the puzzles. See if they can determine which puzzle matches the life cycle of the adults they see.

Releasing the insects: take the plastic-bag covered knapweed plants out to an area of infestation near the schoolyard. Remind the students of their earlier investigation into knapweed plants and larva. Get the students to brainstorm about the needs of insects and other animals, such as food and space, and whether plants provide for any of those needs.

Get students to think about whether insects help humans fulfill any of our needs. In fact, 25-33% of all our food and drinks come from plants pollinated by insects! Now discuss biological controls and noxious weeds such as knapweed. If insects are feeding on these plants, what do students think the effect on the plants will be?

**10. Assessment:**

Have students write a story about a day in the life of an insect.

→ Did students understand that plants are part of insects' habitats? What do insects get from plants (air, water, food, and space)? Specifically, what are insects eating? How do insects get water? How are they distributed spatially on plants (e.g., some are in roots, some are in flowers)?

Have the students draw an insect life cycle.

→ Did students understand that insects go through several life stages that may vary considerably in their appearance? Did students understand that different life stages of insects may have different needs? What would happen if an adult fly tried to live inside a root like its larva does? Do all insects have exactly the same life cycles? Why not? What about insects in warm climates versus insects in cold climates?

→ Did students enjoy the activity?

**11. Extension Ideas:**

Using water insects could be another way to address the issue of life cycles of insects. If mayflies and stoneflies are collected from a still section of a stream or pond, they could be reared in an aquarium indoors until the adults emerge.

**12. Scalability:**

This lesson was designed specifically to go with the FOSS insect kit for grades 1 and 2. It could easily be scaled to higher grades by focusing on the life cycles of different insects, how these life cycles differ and why, and the needs of each life stage.

**13. Science Standards Accomplished:**

From the *National Science Education Standards* (http://www.nap.edu/readingroom/books/nses/)

UNIFYING CONCEPTS AND PROCESSES STANDARD:

- *Systems, Order, and Organization*: The natural and designed world is complex; it is too large and complicated to investigate and comprehend all at once. Scientists and students learn to define small portions for the convenience of investigation.
- *Evidence, models, and explanation*: Evidence consists of observations and data on which to base scientific explanations. Using evidence to understand interactions allows individuals to predict changes in natural and designed systems.
- *Form and function*: Form and function are complementary aspects of objects, organisms, and systems in the natural and designed world. The form or shape of an object or system is frequently related to use, operation, or function. Function frequently relies on form.

CONTENT STANDARD A (Science as Inquiry):

- *Abilities necessary to do scientific inquiry*
- *Understanding about scientific inquiry*

CONTENT STANDARD C (Life Sciences):

- *The characteristics of organisms*
- *Life cycles of organisms*
- *Organisms and environments*

MISSOULA COUNTY PUBLIC SCHOOLS SCIENCE CURRICULUM:

- *Standard #1 – Science as Inquiry*
  - Ask questions, find answers, and compare the known and unknown involved in scientific investigations
  - Use different methods to investigate
  - Demonstrate use of instruments and other devices for measuring and observing
- *Standard #2 – Unifying Concepts of Science*
  - Use grade-level appropriate strategies to apply scientific concepts, processes, and vocabulary which include the following:
    - Models, evidence, and explanation
    - Form and function
    - Design innovation
- *Standard #3 – Humans and Science*
  - Investigate natural resources and environments
- *Standard #5 – Life Science*

- Observe insects and develop a growing curiosity and respect for them as living things
- Recognize the similarities and differences of insects that go through complete metamorphosis
- Compare the behaviors of insects at different stages of their life cycles
- Provide for the needs of insects (air, water, food, and space)
- Acquire the vocabulary associated with insect life
- Distinguish between living and non-living things

**14. References:**
Montana War on Weeds Montana War on Weeds (http://mtwow.org/) is a great site covering all of the biological controls (Biological Control Agents, By Weed) being introduced in Montana, including photographs, effects, and monitoring protocols.

**15. List of Experts and Consultants:**
Marijka Wessner, Weed Education Coordinator, Missoula County Weed District ( http://www.mslacountyweed.org/)
Nancy Sturdevant, Entomologist, USDA Forest Service ( http://www.fs.fed.us/r1/centennial/index.shtml)

**16. Evaluation/Reflection by Fellows and Teachers of how it went:**
Students had a great time dissecting the knapweed plants. They were very adept at finding the larva in the roots and the seed heads. They also enjoyed the life cycle puzzles, and figuring out what pieces went with what species was quite a challenge!

PASTE THESE LIFE CYCLES ONTO A PAPER PLATE (OR SOME OTHER TYPE OF CARDBOARD AND CUT THEM INTO PUZZLE PIECES (SEE THE INSET FOR AN EXAMPLE).