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

ECOS Inquiry

1. Contributor's Name: Jen Marangelo, Brooke McBride, Alison Perkins

2. Name of Inquiry: Looking for Larvae: Collecting Data on Over-wintering Insects

3. Goals and Objectives:

a. Inquiry Questions:

Where do insects go in the winter?

Do insects live in the knapweed (in your schoolyard, at a local park)?

b. Ecological Theme(s):

Over wintering strategies of insects

Data collection

c. General Goal:

Review how to identify an animal as an insect and how insects develop

Understand that if an insect lives here in the summer and does not migrate, it lives with us in the winter

Understand the importance of collecting data to answer a scientific question

d. Specific Objectives:

Students will learn different strategies of over wintering insects

Students will see over wintering larvae

Students will collect data and draw conclusions

e. Grade Level: 1-2

f. Duration/Time Required:

→ **Prep time –** collect knapweed, make copies

→ **Implementing Exercise during Class –** 50 minutes

→ **Assessment –** 10 minutes

4. Ecological and Science Context:

a. Background (for Teachers):

This inquiry uses the knapweed plant and should be done in the late fall, winter, or early spring when you can find larvae in the seed heads.

<u>What is an insect?</u>

Insects are a class of organisms in the kingdom Animalia and the phylum Arthropoda. All arthropods (which include insects, spiders, millipedes, centipedes and crustaceans) have an exoskeleton, a segmented body and jointed limbs. All insects have **3 body parts** (head, thorax and abdomen) and **3 pairs of legs**. The head of an insect has one pair of antennae (sensory organ), compound eyes, up to three simple eyes and mouthparts. The thorax is the point of attachment for all 6 legs and the wings, if present.

<u>The Insect Life Cycle</u>

The word metamorphosis means a change in form and is an appropriate word to describe how an insect develops. Some insects change a great deal as they grow from an immature insect into an adult. There are 2 general types of metamorphosis – complete and simple.

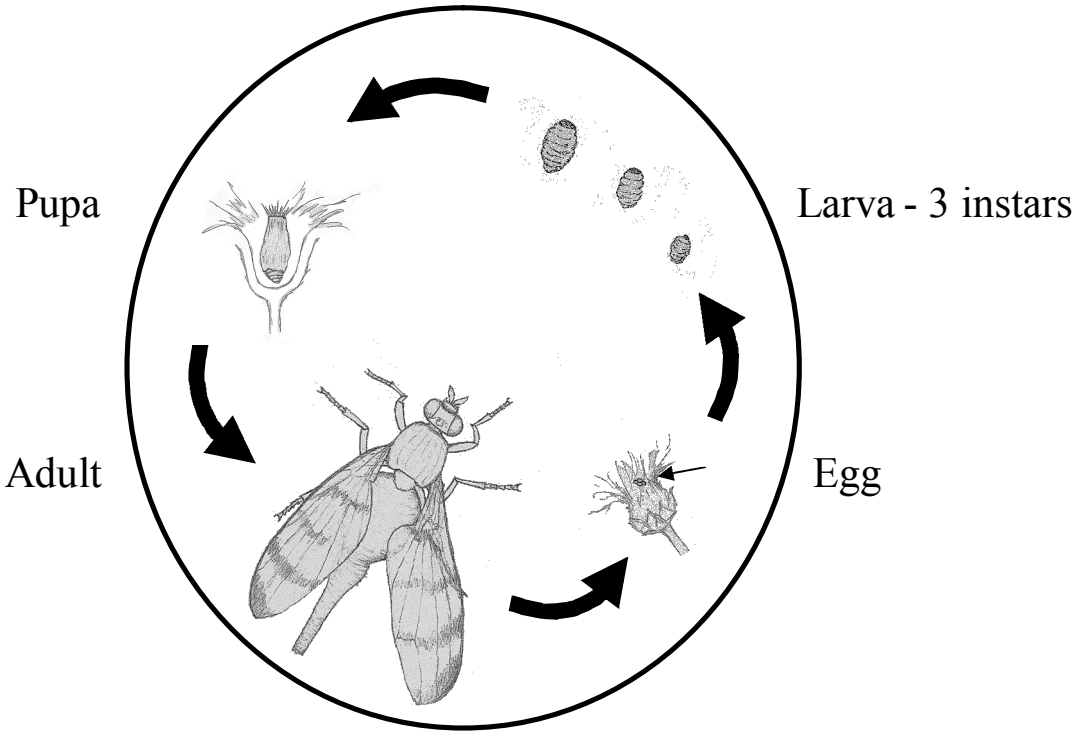
Complete Metamorphosis

Insects with complete metamorphosis (also called holometabolous insects) go through four stages: egg, larva, pupa and adult. These four stages are very different from one another - the animal looks and behaves different, may eat different types of food and usually lives in different places.

Adult females usually lay eggs near the food the larvae will need to eat. After the eggs hatch, the main job of larvae is to eat and grow. Due to its rigid exoskeleton, as a larva grows it must shed or molt the exoskeleton. Each time the larva does this we call the different stages instars. Different species go through different numbers of instars.

When it is time for the larva to become an adult it goes into the pupa stage, which sometimes involves forming a protective case. On the outside it appears that pupae don't really do anything because they aren't eating or moving. They are actually very active as the larva transforms into an adult. After pupation, adults emerge to mate and lay eggs.

This is the life cycle for a fly (*Urophora* species):



This type of fly lays its eggs in the seed heads of knapweed. When the egg hatches the larva will develop and feed inside the seed head. This fly larva will go through 3 instars before becoming a pupa. After pupation, the adult will emerge from the seed head to mate and lay eggs.

Many different groups of insects go through complete metamorphosis including butterflies, moths, flies, beetles, ants, bees and wasps.

Simple Metamorphosis

Insects with simple metamorphosis go through 3 stages: egg, larva (sometimes called nymphs or naiads) and adult. The wings on these insects develop on the outside of the body. If the adult insect has wings small wing pads can be seen on immature insects.

There are three types of simple metamorphosis: ametabolous, paurometabolous and hemimetabolous.

Ametabolous (meaning "no" metamorphosis) is the type of metamorphosis that primitive insects go through. Immature springtails, diplurans, proturans, bristletails and silverfish look like small versions of the adults but are not sexually mature.

Paurometabolous insects (meaning "gradual" metamorphosis) include insects whose larvae and adults live in the same habitat, eat the same food and generally look alike except the adults have full wings. Larvae have small wing pads that get larger each time the insect molts. Some common insect groups with this type of metamorphosis include grasshoppers, crickets, true bugs and cockroaches.

Insects with **hemimetabolous** metamorphosis (meaning "incomplete" metamorphosis) are those whose larvae, sometimes called naiads, are aquatic and adults are terrestrial. The larvae have small wing pads and may look very different from the adults. Examples include dragonflies, mayflies and stoneflies.

Where do insects go in the winter?

Many people think that insects die in the winter. If an insect lives here during the summer, and does not migrate, it lives here in the winter too. It may not be the adult that spends the winter with us, it may the egg, larva or pupa.

Insects are cold blooded which generally means that their bodies are the same temperature as the environment. In winter, or other harsh conditions like drought or extreme heat, insects must respond to the weather behaviorally and/or physically.

Behaviorally

In winter, insects move to locations where the surrounding temperatures are warmer. Some insects like monarch butterflies and painted lady butterflies migrate long distances. Other insects move down into the ground below the freezing line or to other protected places. Most of these insects enter a resting stage, called diapause (see below). Some communal species, like honeybees, are able to regulate the temperature inside their hives through activity that generates heat.

Physically

Insects are often able to survive extreme weather conditions by entering a resting stage called diapause, which is similar to hibernation in vertebrates. Diapause can occur at any life stage but is most common at the egg and pupa stage. Other insects are able to lower their bodies' freezing point with a chemical similar to antifreeze.

Knapweed/biocontrol background

Knapweed is a non-native plant and its natural enemies that normally keep the plant populations in check do not live here. As a result, knapweed out competes native plants in a wide range of habitats. One of the many methods used to control knapweed is biocontrol. Biocontrol is the use of natural enemies to control an organism. In this case, 13 types of insects have been introduced to reduce the distribution of knapweed. It is thought that using several species that cause different stressors to the plant will have a greater impact than any species used alone.

For this inquiry you will focus on the insects commonly found in the seed head during the late fall through early spring. You will find larva of flies and moths and evidence of beetles (large holes in the seed head), which developed in seed heads but have already emerged.

Some of the fly larva will be in galls – one species has a very hard gall and another species has a papery gall. Once you find the larva you can tell the difference between fly and moth larva by a defined head capsule and obvious legs. The flies do not have an obvious head or

legs and will be very still while the moth larva have a head capsule, legs and will move quite a bit.

Type of Biocontrol	What will you see?	What does it do to knapweed?
Flies 4 species Knapweed banded gall fly *Urophora affinis* Knapweed seedhead fly *Urophora quadrifasciata* *Terellia virens* *Chaetorellia acrolophi*	The 2 *Urophora* larvae develop in a gall. One is thick and hard with a pointed tip. Getting in to this gall can take some effort. The other gall is light and papery. Fly larvae are creamy white and barrel shaped. They do not have a distinct head capsule or legs. The wide end of the larva with a dark spot is actually the anal plate.	All damage to the plant is due to feeding on the seeds or other tissues in the seed head. Two of the flies form a gall, which further drains nutrients from the plant.
Moth Spotted knapweed seedhead moth *Metzneria paucipuctella*	Creamy white with a distinct head capsule, legs and prolegs.	Larvae eat developing seeds. Each larva can destroy 8 seeds and decrease the viability of others.
Beetles Knapweed flower weevil *Larinus minutus* *Larinus obtusus* *Bangasternus fausti*	You will know a beetle developed in a seed head if you see large hole at the top. The adult emerged in Sept. or Oct. and is spending the winter in the ground at the base of the plant.	Larvae eat the seeds and pappus hairs. Adults eat leaves and may defoliate plant.

b. Background (to present to Students): See methods/procedure for students below.

5. Motivation and Incentive for Learning: Students get hands-on experience locating biological controls in knapweed. They get to collect data and make a decision based on what they found.

6. Vocabulary:

Abdomen – body region behind thorax, usually has 10 segments, can have appendages at the tip

Biocontrol – the use of natural enemies to control an organism

Diapause – a period of arrested development, can occur in response to harsh conditions such as cold weather, lack of food or dry conditions

Gall – abnormal growth of plant tissue stimulated by insect or pathogen attack

Larva – plural = larvae. Usually considered the immature stage (between egg and pupa) of an insect that goes through complete metamorphosis

Prolegs – fleshy abdominal legs

Pupa – plural = pupae. The stage of an insect between larva and adult for those that go through complete metamorphosis

Thorax – the body region behind the head that bears wings and legs; divided into three segments: prothorax, mesothorax and metathorax

7. Safety Information: n/a

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

- Life Cycle Diagram
- What is Inside a Knapweed Seed Head? Illustration
- Looking for Larvae: How Insects Spend the Winter Worksheet
- Knapweed plants (try to collect knapweed from a location students are familiar with – the schoolyard or a popular park)
- Something to dissect the knapweed plants on (dark paper works well but you can also use paper towels or paper plates)
- Magnifying glasses and/or microscopes (optional)

9. Methods/Procedure for students:

This inquiry is meant to be done in the winter.

a. Pre-investigation work:

Prior to this inquiry you should have reviewed what an insect is and the insect life cycle using the attached insect life cycle. To lead into the inquiry, it is fun and helpful to lead students through the following points of discussion and reflection:

- What do you do to protect yourselves from winter weather? We will be discussing where *insects* go/what *insects* do in the winter. (Elaborate on your students' ideas based on the background information presented above). Insects don't just die in the winter. Any insect that lives here in the summer, and doesn't migrate, lives with us in the winter.

- We will have an opportunity to see some insects that spend the winter with us inside a plant. (Show them the knapweed and ask them if they know what it is and tell them where you got it). Two types of insects, flies and moths, might use this plant as their home during winter. (Briefly describe/review the life cycle of these insects. Adults fly around in spring and summer looking for a place to lay eggs. They lay their eggs in the seed head or flowers, the eggs hatch into larva after just a few days and it's the larva that spend the winter with us inside the seed head. In the spring and summer, the larva will turn into pupa. Finally, the adults will emerge to eat, mate, and lay eggs and the same life cycle occurs again, year after year).

- So, it's very possible that there are insects in the seed heads of this plant and we really want to know if there are insects living in the knapweed of our schoolyard (or wherever you collected it)! It is your job to determine if there are insects living inside these plants. As scientists, we are going to collect data to find out if the knapweed in (their schoolyard, park or wherever you collected the knapweed) has insects living in it. As scientists collecting data, it is very important to gather accurate information, so we can report back about whether or not there are insects living in the knapweed plants.

- Using the attached diagram *What's Inside of a Knapweed Seed Head?* explain what students will find inside the seed head – seeds, larvae and galls with larvae in them. Explain what these look like. Explain that galls are hard and if they find something that's dense and not a seed, it might be a gall – and they should pick those apart.

- Demonstrate how to pick apart the seed head (essentially, just peel away the layers). When done, ask students to look at the larvae and seeds and sketch one of each.

- Hand out worksheet and 5 knapweed seed heads to each student. Try not to give students heads with holes in them. They are unlikely to find larvae in these.

What if we wanted to answer that question but only opened one seed head to find out the answer. Would we know the answer? Maybe, but maybe not because some students opened seed heads with no larvae in them. If we wanted to answer that question but only opened one seed head and it didn't have any larva, we would think that the population of knapweed didn't have any insects in them. Would that have been correct? No. As scientists, it's important to collect enough data to be as accurate as possible with our results, so we wouldn't formulate an answer by looking in just one seed head.

b. Investigation work:

1) What evidence (data, samples) do students collect? Students will determine presence/absence of larvae in 5 seed heads.

2) How do students present the evidence (data)? Students will record information on worksheets and discuss findings as a class. When students are done dissecting the seed heads, ask them to raise their hands if they found larvae in their seed heads. (These insects are common and most students will have found at least one larva). Ask how many students found larvae in one of their seed heads, in two of their seed heads, etc. (Some students will have more seed heads with larvae than others). Then ask them to remember the question you wanted them to answer:

- "Are larvae present in knapweed from (location)?" Ask them the answer to that question. (Yes).
- "Some students only had one seed head with larvae in it. If we wanted to answer our question but only opened one seed head, would we have been able to accurately answer that question?" (Maybe, maybe not—scientists often have to collect a lot of data to answer their questions).

3) What conclusions are drawn from the evidence students collect? Students will determine if larva are present or absent in a sample of knapweed. Students will discuss how much data needs to be collected in order to draw conclusions (answer the question at hand).

10. Assessment: Assessment can take place during the exercise and class discussion. You may collect worksheets to assess individual student's understanding of the inquiry.

11. Extension Ideas: You may want to put the class data in a bar graph or have students determine if the larva they find are flies or moths.
See *Assessing the Effects of Insects* inquiry (http://www.bioed.org/ecos/NewPrograms.htm) to have students determine the effectiveness of these insects as biological controls.

12. Scalability: This inquiry has been scaled-up for 3rd-6th graders (see *Assessing the Effects of Insects* http://www.bioed.org/ecos/NewPrograms.htm).

13. Science Standards Accomplished:

National Science Standards

Unifying Concepts and Processes
Evidence, Models, and Explanation

K-4
Science as Inquiry
Abilities necessary to do scientific inquiry
Understandings about scientific inquiry
Life Science
The characteristics of organisms
Life cycles of organisms
Organisms and their environment
Science in Personal and Social Perspectives
Changes in environments

14. References:
Wilson, L.M. and C.B. Randall. 2003. Biology and Biological control of Knapweed. USDA-Forest Service FHTET-2001-07. 2nd Edition. http://www.invasive.org/weeds/knapweed/

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 LOVED picking apart the seed heads and were thrilled to find the tiny larvae inside. Many took this knowledge home to share with their families and friends. Teachers were excited by this inquiry and felt that it would be fun and easy to conduct on their own. It was a great example of "bringing the outdoors in," and was especially well-received on days when the weather was bad!

Looking for Larvae: How Insects Spend the Winter

Name: _____

Seed Head #1	Did you find a larva (circle one)?	Yes	No
Seed Head #2	Did you find a larva (circle one)?	Yes	No
Seed Head #3	Did you find a larva (circle one)?	Yes	No
Seed Head #4	Did you find a larva (circle one)?	Yes	No
Seed Head #5	Did you find a larva (circle one)?	Yes	No

Draw a seed here:	Draw a larva here: