LESSON 38

Spotted Knapweed and Gall Fly Lab

Grade level: 6-12
Subject Areas: Life science
Duration: 1 outdoor session, ongoing observation for 1-2 months, and several indoor class sessions
Setting: Outdoors/ Classroom
Season: Winter
Conceptual Framework Topics: Invasive species, weed management

OBJECTIVES

The students will be able to define the term noxious weed. They will be able to explain what a biological control agent is and how it is part of Integrated Pest Management. They will also be able to explain or draw the life cycles of spotted knapweed and a spotted knapweed gall fly.

METHOD

The students dissect a spotted knapweed seed head infected by the spotted knapweed gall fly, observing and drawing a gall and larvae. They collect data on the numbers of galls per seed head and predict the number of gall flies that will emerge from 100 seed heads. The students count the gall flies that actually emerge from 100 seed heads in a cage and compare what they predicted to what they found.

MATERIALS

- ✎ An outdoor area with spotted knapweed (*Centaurea stoebe*) infected by one or both of the spotted knapweed gall flies, that you can go to in the winter (In Montana, the gall flies occur almost everywhere knapweed occurs.)
- ✎ Clippers for harvesting plants
- ✎ Gloves
- ✎ Hand lenses and/or stereoscopes
- ✎ Hand dissection equipment: forceps (tweezers), teasing needles, scissors
- ✎ An insect cage (1 m square cages from Bioquip work well) **www.bioquip.com**
- ✎ Insect aspirators (bug suckers) (available from scientific supply companies)
- ✎ Insect pins (available from scientific supply companies)
- ✎ Textbooks with sections on insects and flowering plants (including the life cycles)
- ✎ Insect and plant field guides
- ✎ Trash bags (extra durable)
- ✎ **Spotted Knapweed and Gall Fly Lab sheet**

BACKGROUND

Spotted knapweed (*Centaurea stoebe*) is a Category 1 Noxious Weed in Montana. It is a native of Europe and Asia and was accidentally brought to North America by humans. However, the creatures (insects, bacteria, fungi, nematodes, etc.) that help keep its populations in check in Eurasia were not brought along with it to North America. Spotted knapweed, at least in part, outcompetes native North American plants in their native habitat because the native plants are constantly being fed upon by the many native creatures that

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have evolved with them over time. Spotted knapweed in Montana can become invasive unless humans intervene to control it.

To help solve this spotted knapweed problem, people have gone to Europe and searched for biological control agents that can help reduce spotted knapweed populations. These creatures are then rigorously tested to make sure that they are host specific (i.e., eat ONLY spotted knapweed). They are then brought back to North America, studied some more, and finally released into the field in hopes that they will help control this noxious weed. Integrated Pest Management (IPM) can use biological control agents along with a range of other available management strategies to help reduce the weed population.

In this lab you will be using two insects imported from Europe whose larvae form galls in the seed heads of spotted knapweed and reduce seed production of the plant. These small flies are *Urophora affinis* and *Urophora quadrifasciata* (Diptera: Tephritidae). In short, the flies lay their eggs in the seed heads of spotted knapweed in the summer and larvae soon hatch from the eggs. This causes the plant to form a callous-like swelling around the larvae called a gall (thus the name spotted knapweed seed head gall fly). The fly larvae feed on the *parenchyma* tissue inside of the galls. So their impact on the plant occurs by inducing the gall formation which causes the plants to put energy into gall production when they should put energy into seed production. The result is an energy sink that reduces seed production. These larvae stay in the seed heads all fall and winter. In late winter or early spring they pupate while still in the seed head and emerge as adults in late spring or early summer, to do it all again. Note that some of the other seed head biocontrol species do actually feed on the seeds directly.

PROCEDURE

1. Review the definition of a *noxious weed* and show students a picture or specimen of spotted knapweed, a common noxious weed in Montana.

2. Spotted knapweed seed head collecting: Identify a spotted knapweed-infested site. Get landowner permission and find out if other seed head insects have been released in the area (they may interfere with your class data if they are present and damaging the seed heads). Few landowners mind if you take weed seeds off their property! Gather tools: clippers, gloves, bags for seed heads (use strong bags so as not to leak seeds). Right before or soon after winter break, go to your spotted knapweed site and randomly collect enough seed heads that each student will have 5 and you have the 100 you need for the cage, plus 100 or so extra for practicing dissection. Transport these immediately to a secure

location so as not to risk spreading seeds. Be sure and use gloves as the plants are sharp and the plants have toxins you will not want in contact with bare skin. Transport without spreading the seeds. *Note: Do not collect them too early in the fall as the larvae need an extended period of cold before they will emerge. Also, do not wait and collect them too late in late winter as they will start to pupate and the students cannot see the larvae.*

3. Set up dissection and observation equipment. Demonstrate then have each student dissect at least one practice seed head, count the galls, and observe and draw the galls and larvae.

4. Have students go to lab stations, dissect 5 seed heads, count the galls in each, and record this. They will use these data to figure the average number of galls/ seed head.

5. Place 100 seed heads in an insect cage. Place the cage in a warm, well-lit area that does not receive direct sunlight. Lightly mist seed heads with water weekly.

6. Have the students use the class average to predict the number of gall flies they expect to emerge from the seed heads in the cage. For instance, if the class average was 4.32 galls/seed head, they should expect 432 flies to emerge from the 100 seed heads in the cage (class average # of galls/seed head x # of seed heads = expected # of flies).

7. Have the class observe the cage each day. After several weeks, flies are expected to start to emerge. The students should aspirate (remove from cage with a bug sucker) and count the flies each day. They should record the number emerged each day and keep a total number of flies emerged. Flies will emerge for about a month. Note: it will be too early to release the flies into the environment (there are plenty of flies!!) so preserve them in a freezer or in alcohol. The students can mount them for display and study. When the flies are through emerging, have the students use their data to complete their lab write up.

Name _____ **Due Date** _____

Spotted Knapweed and Gall Fly Lab

Procedure:

1. Observe the teacher demonstrate how to dissect a seed head and count the galls.
2. Practice a seed head dissection on the practice seed head. Data: Using a hand lens or a stereo microscope, draw a gall. Break a gall carefully open and draw the larvae.
3. Carefully dissect 5 seed heads and count the galls in each. Data: Record these 5 pieces of data and list them on the board.
4. Data: Record all the data for the whole class.
5. Find the average number of galls/seed head (the sum of the # of class galls divided by the total number of seed heads).
6. As a class, place 100 (or more) seed heads in an insect cage. Place the cage in a warm lighted area not in direct sunlight. Lightly mist seed heads with water weekly.
7. Predict: using the formula **(class average x #seed heads = expected # of flies)** predict the number of flies that should emerge from the seed heads in cage.
   _____ = expected # of flies (show your work).
8. Observe the cage each day. After several weeks, flies will start to emerge. Aspirate (remove from cage with a bug sucker) and count the flies each day. Data: record the number emerged each day and keep a total number of flies emerged. Flies will emerge for about a month. Note: it will be too early to release the flies into the environment (there are plenty of flies!!) so preserve them in a freezer or in alcohol.
9. After the flies seem to stop emerging, wait about two more weeks to be sure all are out.
10. Mount (or display) a gall fly as your teacher directs.

Results: Describe WHAT HAPPENED while you were completing the lab.

Questions:

1. Draw and label the life cycle of spotted knapweed *Centaurea stoebe* (a flowering plant). Include: flower, fruit, seed, seedling, stem, leaf, root, pollen, stamen, pistil, and ovule. Remember, a cycle makes a complete circle.

2. a. What is a weed? What is a noxious weed?

   b. Why is spotted knapweed considered a weed? A noxious weed?

   c. What characteristics of a plant might make it become a weed?

3. a. Draw and label the life cycle of a spotted knapweed gall fly (complete metamorphosis). Include: egg, larvae, pupa, and adult.

   b. Attach (or redraw) your drawings of a larvae and a gall.

4. a. What is Integrated Pest Management (IPM)?

   b. What is a biological weed control agent?

   c. Using information your teacher provides for you and/or additional research on your own, list and briefly describe 3 other ways besides biological control that people use to control spotted knapweed.

5. The spotted knapweed gall flies generally lower seed production of spotted knapweed by 10% to 40%. They cause the plant to use some of its stored food reserve to form galls in its seed heads. Will they be able to control this weed? Why or why not?

6. a. Did more or fewer flies emerge from the caged seed heads than expected?

   b. List 3 possible reasons why you think the number differed from your expected number.