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Acknowledgements

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**Beyond
Ready**

Information Page

Your Name: _____

4-H Age: _____

County: _____

Club Name: _____

Guardian's Signature: _____

Leader's Signature: _____

Please write the date when you completed each activity below:

Activity Number

Date

Units 1 and 2

Level 1 Additional (p. 9) _____

Level 1 Activity 1 (p. 10) _____

Level 1 Activity 2 (p. 11) _____

Level 1 Activity 3 (p. 11) _____

Level 1 Activity 4 (p. 11) _____

Unit 3

Level 2 Additional (p. 13) _____

Level 2 Activity 1 (p. 14) _____

Level 2 Activity 2 (p. 15) _____

Level 2 Activity 3 (p. 16) _____

Level 2 Activity 4 (p. 16) _____

Level 2 Activity 5 (p. 16) _____

Unit 4

Level 2 Additional (p. 17) _____

Level 2 Activity 1 (p. 18-20) _____

Level 2 Activity 2 (p. 21) _____

Level 2 Activity 3 (p. 22-23) _____

Level 2 Activity 4 (p. 24) _____

Level 2 Activity 5 (p. 24) _____

Level 2 Activity 6 (p. 24-25) _____

Activity Number

Date

Unit 5

Level 3 Additional (p. 27) _____

Level 3 Activity 1 (p. 27--28) _____

Level 3 Activity 2 (p. 29) _____

Level 3 Activity 3 (p. 30) _____

Level 3 Activity 4 (p. 30) _____

Level 3 Activity 5 (p. 30-31) _____

Unit 6

Level 3 Additional (p. 33) _____

Level 3 Activity 1 (p. 33) _____

Level 3 Activity 2 (p. 34) _____

Level 3 Activity 3 (p. 34) _____

Level 3 Activity 4 (p. 34) _____

Level 3 Activity 5 (p. 35) _____

Unit 7

Additional (p. 36) _____

Activity 1 (p. 37-39) _____

Activity 2 (p. 40-41) _____

Activity 3 (p. 42-47) _____



Instructions for Using This Workbook Supplement for the 4-H Entomology Project

Place your workbook in a sturdy binder or notebook along with your Entomology e-Record. For Units 1-6, you may also add the activities you completed from the *Teaming with Insects* manual. **You only need to print out and include workbook pages that are for the Level and Unit that you are enrolled in this year.**

Using a binder will help in the following ways:

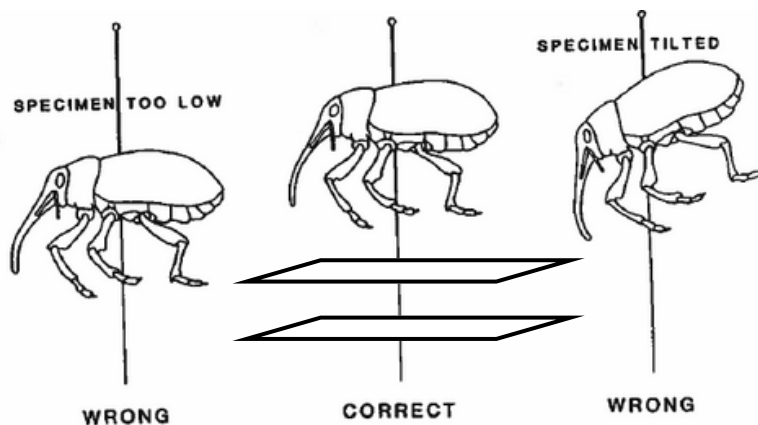
- the member's manual and record sheets always remain together,
- additional materials can be inserted easily,
- pages turn easily and completely to display material, and
- advanced units can be added to the same book as you progress in 4-H entomology projects.

Exhibit Requirements

Review the Entomology exhibit requirements for your level and unit at <https://co4h.colostate.edu/statefair/StateFairExhibitReq.pdf>. Box sizes for storing collections and the number of insects/collection sizes for each unit are in the exhibit requirements.

Use of Insect Labels

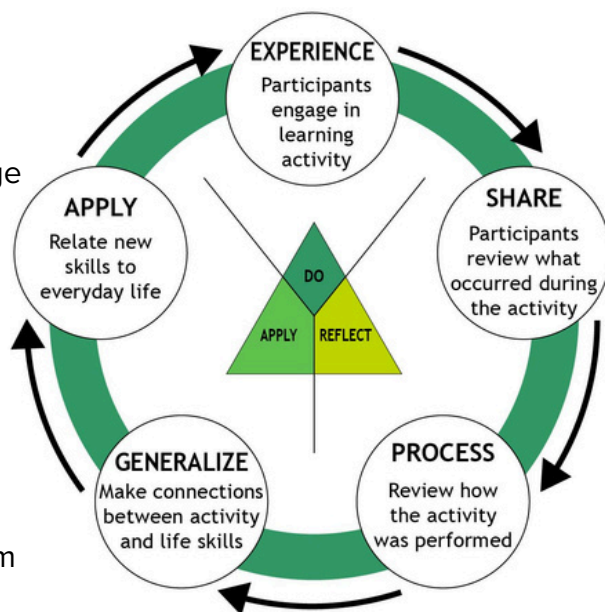
When making labels for your collection, try to keep them the same size and print them out on heavy paper. You can either type or hand-write your labels, but be sure they are readable and neat. Have a system you can use each year as you add insects to your collection. On Unit 2 through Unit 7 classes, the insect display must include two labels attached to insect pins. The first label should have the date and location where insects were collected. The second label should have the family/common name of the insect pinned.



Experiential Learning Process

The 4-H program utilizes a process where adult leaders ask open-ended questions that challenge youth to think. Through this inquiry, youth can propose hypotheses and determine their own solutions. The Experiential Learning Model developed by Pfeiffer and Jones (1985) and modified by 4-H includes five specific steps that can be summarized into three main processes: Do, Reflect, and Apply.

The Experiential Learning Model encourages discovery with minimal guidance from others. A situation, project or activity is undertaken for individual thought and problem solving. Minimum outside assistance is provided, but support is offered to the individual by questioning at each stage. The youth participating in an activity reflect on what they did and then assess how what they learned can be applied to a life situation. Below are questions that might help during each stage of learning.



1) Experience (Doing)

Questions: What sources of information are available? What is possible? What do you expect to see? How is it working? What else might you try?

2) Share (Reflecting on what occurred)

Questions: What was your goal for this project/activity when you began? What happened? What were the results? What was most difficult? How do you know? What did you learn? What surprised you? How did you share this project/activity with others?

3) Process (Reflecting on what's important)

Questions: What problems seemed to reoccur? How did you solve them? What similar experiences have you had? How was the experience like or unlike experiences others had? Would you do anything differently? What did you learn about making decisions? What suggestions would you have for someone else who wanted to do a similar project/activity? What life skills were you developing through your project? Why are life skills important? What new questions do you have about yourself, others, and future goals?

4) Generalize (So what?)

Questions: What did you learn about yourself or about the activity? What key points have you learned? How did you decide what to do? What else could you have done? How does this relate to something else in life? Where have you faced similar challenges in your life? Where might this situation occur in the future? Why is it important to have plenty of information before making decisions? What did you learn about your own skill in communicating with others?

5) Apply (Now what?)

Questions: How does this project/activity relate to your everyday life? Why is this project/activity important to you? Where else can this skill be used? How will you use this in the future? What will you do differently after this experience? How can I make an impact? What will I create next? In what ways do people help each other learn new things? What are qualities you think are important in a leader? If someone helped or mentored you in this project, what would you tell them you learned and what difference it has made in your life? How would you express your appreciation?



Image: Hendricks, P. (1998) "Developing Youth Curriculum Using the Targeting Life Skills Model" <http://www.extension.iastate.edu/4H/skls.eval.htm>

Targeting Life Skills

A skill is a learned ability. Life skills are those abilities that assist individuals to lead successful, productive, and satisfying lives. In 4-H, we use the Targeting Life Skills Model to help youth become competent and prepared for adulthood. The Targeting Life Skills Model categories are based on the four H's from the 4-H clover (Head, Heart, Hands, and Health). Under each of these main categories, there are four categories and eight subcategories listing specific skills youth learn in 4-H. The main goal in 4-H positive youth development is to provide developmentally appropriate opportunities for youth to experience life skills and to be able to use them throughout a lifetime. By understanding the importance of the 4-H framework and its structure, 4-H members, parents, professionals, and leaders will know the expectations and will be able to effectively use 4-H delivery methods to help youth learn these life skills.

About the 4-H Thriving Model

The 4-H Program Leaders' Working Group developed the 4-H Thriving Model to advance and support the accomplishment of the 4-H Youth Development 2025 National Strategic Plan. They describe the 4-H Thriving Model as follows:

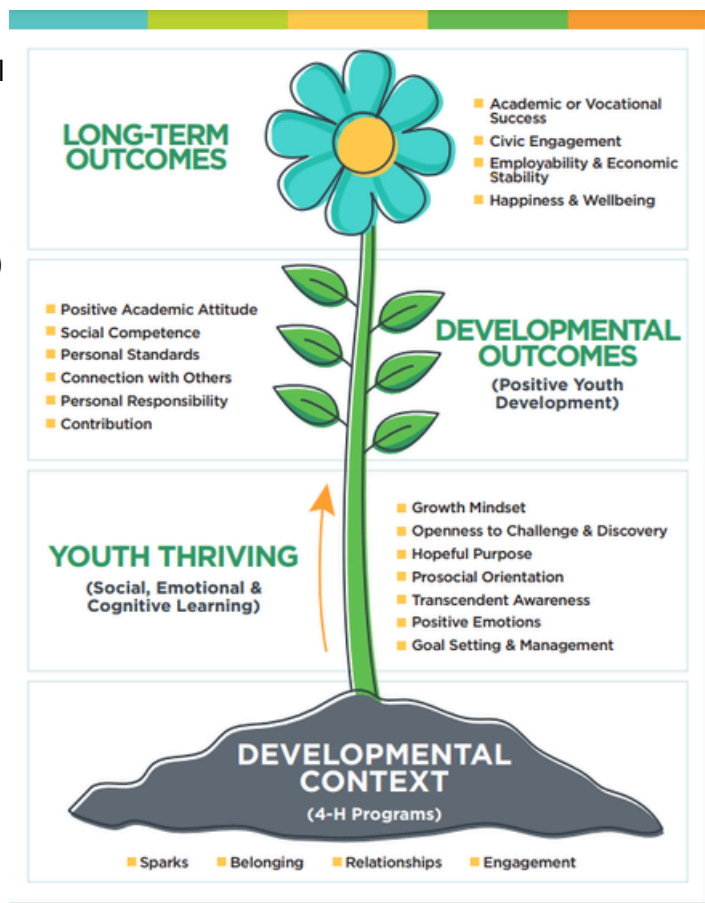
The 4-H Thriving Model illustrates the process of positive youth development in 4-H programs by connecting high quality program settings to the promotion of youth thriving.

High quality 4-H program settings provide youth a place to belong, matter and explore their personal spark. High quality settings foster developmental relationships with youth, relationships that express care, challenge growth, and share power. These components help ensure that 4-H programs provide a nourishing developmental context – a place where youth can belong and grow.

High quality 4-H programs contribute to Positive Youth Development (PYD) through the intentional promotion of social, emotional, cognitive, and behavioral habits of mind. In the 4-H Thriving Model this process of PYD is described by seven indicators of thriving: Openness to challenge and discovery, growth mindset, hopeful purpose, pro-social orientation, transcendent awareness, positive emotionality and self-regulation through goal setting and management.

Youth who experience high quality developmental settings in 4-H with an emphasis on these key social-emotional skills achieve key positive youth development outcomes including academic motivation and success, social competence, high personal standards, connection with others, personal responsibility, and contribution to others through leadership and civic engagement.

Youth who achieve positive developmental outcomes are more likely to also achieve long-term outcomes marked by vocational or academic success, civic engagement, employability, economic stability, happiness, and well-being. (Learn more at <https://helping-youth-thrive.extension.org/>.)



Entomology Resources

This video from “The Bug Chicks” is tailored to junior entomologists.

<https://www.youtube.com/watch?v=YhLZKTUeQpc>

They also have a website with more educational videos on insects geared towards a younger audience.

<https://www.thebugchicks.com/videos>

Here is a good video from Kentucky 4-H on how to make a collection:

<https://www.youtube.com/watch?v=Qe1g8kPdtq8>.

You can use the Kentucky 4-H Entomology Key to Common Insect Orders at

<https://entomology.ca.uky.edu/sites/entomology.ca.uky.edu/files/stfairorder.pdf>.

How to build a tumble trap:

[http://7474fab53f1b6ee92458-](http://7474fab53f1b6ee92458-8f3ac932bad207a00c83e77eaae8d15c.r12.cf1.rackcdn.com/TUMBLE-TRAP.jpg)

[8f3ac932bad207a00c83e77eaae8d15c.r12.cf1.rackcdn.com/TUMBLE-TRAP.jpg](http://7474fab53f1b6ee92458-8f3ac932bad207a00c83e77eaae8d15c.r12.cf1.rackcdn.com/TUMBLE-TRAP.jpg)

How to build an insect home (Level 1 Unit 2):

<https://www.pbs.org/parents/crafts-and-experiments/bug-box>

Safe, DIY Insecticides (Level 3 Unit 6):

<https://safepropest.com/diy-kid-friendly-effective-pest-management-solutions/>

How to Build an Insect Pooter:

<https://crunchyontheoutside.com/2022/06/06/make-your-own-pooter/>

Synchronous Firefly Simulator:

<https://ncase.me/fireflies/>

Spider Coloring Book:

<https://coloringwithspiders.wordpress.com/>

Insect Origami:

<https://www.amentsoc.org/bug-club/fun/origami.html>



Teaming with Insects - Level 1 - Unit 1 and Unit 2

4-H members in grades 3-5 should start with TEAMING WITH INSECTS—LEVEL 1: DISPLAY BOARD—UNIT 1 if they do not have an insect collection. If they do have an insect collection, they can start with TEAMING WITH INSECTS—LEVEL 1: BEGINNER INSECT COLLECTION—UNIT 2. Unit 2 may be repeated to introduce youth to entomology, define insects, and learn how to exhibit a beginning collection.

4-H members in grades 6-8 may start with TEAMING WITH INSECTS—LEVEL 2—UNIT 3 and then progress to TEAMING WITH INSECTS—LEVEL 2—UNIT 4 and higher units. Youth will learn how to expand an insect collection using labels and pins to organize insects in boxes. In addition, you will learn how to keep proper records for the project and your activities.

4-H members in grades 9-12 should be ready to enroll in TEAMING WITH INSECTS—LEVEL 3—UNIT 5 progressing to TEAMING WITH INSECTS—LEVEL 3—IMMATURE INSECTS AND LIFE STAGES - UNIT 6, and EXPLORING WITH INSECTS ADVANCED - UNIT 7. Having taken the prior levels will be extremely helpful, so teens could take a lower level if it is their first year or two in the Entomology project.

Project Outline for Completion of Level 1 - Unit 1 and Unit 2

Each year of Level 1, do a minimum of eight activities of any combination from your unit's *Teaming with Insects* manual and/or your unit's section of the *Entomology Workbook*. If you decide to have an insect collection, display no fewer than 25 and no more than 75 adult insects in at least four different orders. Standard-sized display boxes with removable glass covers and regular insect pins are required.

If you decide not to exhibit an insect collection, you can exhibit a display board representing some phase of your project work. This could include a chart or special equipment used or developed for the activities in the workbook. The standardized display board size of 4 ft. x 3 ft. is to be used with 4-H projects. No additional items may be included in front of the display board. Some ideas include the following things you may learn this year:

- Constructing and operating a pitfall trap
- Studying how insects communicate
- Learning about beneficial and destructive insects (invasive insects)
- Studying the biodiversity of insects in different habitats
- Learning about integrated pest management
- Observing cricket behavior and communication

Exhibit your insect collection or display board along with your e-Record and any manual or workbook activities completed at the county fair.



Suggested Additional Level 1 Activities

1. Make items useful for collection and display of your insect collection, such as an insect net, pinning block, killing jar, or spreading board.
2. Attend a meeting related to a subject on insects. Your county Colorado State University Extension office is a good place to learn of such activities. Museums, local colleges, biology teachers, and libraries provide insect-related programs.
3. Read bulletins, pamphlets, and books on entomology. Check your county Colorado State Extension office and local libraries. Include these in your unit record.
4. Keep records of when and where you caught the insects that are in your collection.
5. Start working with keys that can separate the different scientific orders of adult insects.
6. Keep a record of things you learn through Level 1 that you think would be most useful for future 4-H Level 1 members to know.
7. Capture an insect and create a home for it. Watch your insect, noting what it does. See page 7 for a guide on how to make an insect home.





Teaming with Insects - Level 1 - Unit 1 and/or Unit 2

If you are in Level 1, complete the following activities.

Activity 1

From entomology books and pamphlets, make a study of the life history of one insect found in your area. Record the information on this page.

Common name of the insect: _____

Scientific order in which the insect is included: _____

Give a brief description of the insect you chose for special study:

How big is it? _____

How would you describe its coloration or markings?

What kind of mouth parts does it have? _____

What kind of wings does it have? _____

Any other interesting features of this insect? _____

Why did you choose this insect for this activity?

How does this insect develop (check one)?

☐

Simple metamorphosis Egg - Nymph - Adult

☐

Complete metamorphosis Egg - Larva - Pupa - Adult



Teaming with Insects - Level 1 - Unit 1 and/or Unit 2

Activity 2

Learn the differences between insects and other arthropods.

Insects are a kind of animal known as arthropods. But there are several other arthropods that are not insects, such as millipedes, centipedes, pill bugs, and spiders (arachnids). Find two differences between an insect and some other arthropod you have observed.

Pick an arthropod that is not an insect. What is it? _____

How does it differ from an insect?

Activity 3

Record any insect-related books and materials (such as television programs, documentaries, YouTube videos) you have looked at as part of your Level 1 project.

Activity 4 (For Level 1: Unit 2 only.)

For Level 1: Beginner Insect Collection-Unit 2, you are asked to make an insect collection of at least 25 but not more than 75 insects. Include insects that represent at least four different orders and arrange them in your display within their correct groups. Boxes used to display the insects should be of sturdy design and should be approximately 12 inches by 16 inches by 3 inches. Here is a good video from Kentucky 4-H on how to make a collection:

<https://www.youtube.com/watch?v=Qe1g8kPdtq8>. You can use the Kentucky Key to Order Insects at <https://entomology.ca.uky.edu/sites/entomology.ca.uky.edu/files/stfairorder.pdf>.

Use of regular insect pins is required. It is also useful to record when and where you found the insects that are included in your collection.

Number of insects in your display: _____ Number of scientific insect orders: _____



Teaming with Insects - Level 2 - Unit 3

4-H club members eleven years of age or older may elect to start with this unit rather than Level 1: Display Board Unit 1 or Level 1: Beginner Insect Collection Unit 2. In Level 2 - Unit 3, you will learn how to expand an insect collection using labels and pins, and how to keep proper records and exhibit your collection. In addition, you will learn some things about how insects are classified. You will work out an insect control program for one destructive insect, using information from books, pamphlets, or insect control guides. Appreciating beneficial insects is also part of this level (unit). Each year of Level 2, do a minimum of eight activities of any combination from your unit's *Teaming with Insects* manual and/or your unit's section of the *Entomology Workbook*.

Project Outline for Completion of Level 2 - Unit 3

Make an insect collection of at least 50 but not more than 100 insects. Pin and display insects according to directions in the manual. Use labels to describe when and where you found new insects collected during this level (unit). Include specimens from at least six different orders, including one that develops in water (Trichoptera/ caddis flies, Plecoptera/ stone flies, Odonata/dragon flies, or Ephemeroptera/may flies) and one that has an incomplete metamorphosis (egg-nymph-adult). Use regular insect pins. You may use commercially available boxes in standard sizes (see exhibit requirements) or acceptable sizes of handmade Entomology display boxes include:

- a. 12" W x 16" L x 3" deep
- b. 12" W x 18" L x 3 ½" deep
- c. 18" W x 24" L x 3 ½ "deep

Include a special collection of at least eight different kinds of insects. Place this collection in a separate area of your display box or in a separate box. Insects in the special collection count toward the total number of insects needed for this unit.

For Activity 1, select an insect which is a useful or beneficial species found in your area. For Activity 2, select another insect which is a pest in your area on plants or animals. Complete the information in the activity sheets for this unit.

For Activity 3, fill in the outline about five insects that live in your area. Give their common name, identify their scientific order, and describe what they eat and how they live. One order should be developed in water and one should have an incomplete metamorphosis (egg-nymph-adult). Record this information in the table found on the activity sheet. Activity 4 is working on your collection. In Activity 5, record in your e-Record any materials that you bought to create your insect collection.



Suggested Additional Level 2 - Unit 3 Activities

1. Read additional books and pamphlets on insects. Add these to your record.
2. Attend meetings on insects held in your area that are sponsored by local Colorado State Extension offices, libraries and schools. Report on these in your record book.
3. Learn more about the methods used to control pest insects. Find out something about Integrated Pest Management (IPM) and how it is applied to manage a problem with a local pest insect. Report what you have learned.
4. Practice using the identification key from the University of Kentucky until you can correctly identify the scientific order to which all the specimens in your collection belong. The key can be found at <https://entomology.ca.uky.edu/sites/entomology.ca.uky.edu/files/stfairorder.pdf>.
5. Keep a record of things you learned in this unit. Particularly important are things you think would be most useful for other 4-H Level 2 members to know. Share your experiences with others involved in earlier units of entomology and record in your record sheets any materials that you have bought or made used to create your insect collection.





Teaming with Insects - Level 2 - Unit 3

If you are in Level 2 - Unit 3 complete the following activities.

Activity 1

Study the life history of one beneficial insect found in your area. Learn about its habits and describe what benefits this insect produces. Record the information below.

A Beneficial Insect

Common name of the insect: _____

Scientific order in which the insect is included: _____

Give a brief description of the insect you chose for special study:

How big is it? _____

How would you describe its coloration or markings?

What kind of mouthparts does it have? _____

What kind of wings does it have? _____

Any other interesting features of this insect? _____

What are the beneficial habits of this insect?

What can be done to conserve and encourage this insect?

How does this insect develop (check one)?

☐

Simple metamorphosis (Egg-Nymph-Adult)

☐

Complete metamorphosis (Egg-Larva-Pupa-Adult)



Teaming with Insects - Level 2 - Unit 3

Activity 2

Study the life history of one pest insect found in your area. Learn about its habits and describe why it is considered to be a pest. Investigate control measures, including biological controls and insecticides if appropriate. Record the information below.

A Pest Insect

Common name of the insect: _____

Scientific order in which the insect is included: _____

Give a brief description of the insect you chose for special study:

How big is it? _____

How would you describe its coloration or markings?

What kind of mouthparts does it have? _____

What kind of wings does it have? _____

Any other interesting features of this insect? _____

What are the insect's damaging habits that make it a pest?

What can be done to control or manage this insect? You may wish to include information on biological, cultural, and chemical controls.

How does this insect develop (check one)?

☐

Simple metamorphosis (Egg-Nymph-Adult)

☐

Complete metamorphosis (Egg-Larva-Pupa-Adult)



Teaming with Insects - Level 2 - Unit 3

Activity 3

Fill in the outline about five insects that live in your area. Give their common name. Identify the scientific order they are in and describe what they eat and how they live. At least one insect/order should be developed in water and one should have incomplete metamorphosis (egg-nymph-adult). Record this information on the table below.

Insect	Scientific Order	Where Collected
<i>Example: Alfalfa Weevil</i>	<i>Example: Coleoptera</i>	<i>Example: On Alfalfa</i>

Activity 4

For this level (Unit 3) you are asked to make an insect collection of at least 50 but not more than 100 insects. Pin and display insects. Include specimens from at least six different scientific orders, including one that develops in water (Trichoptera/caddis flies, Plecoptera/stone flies, Odonata/dragon flies, or Ephemeroptera/may flies) and one with incomplete metamorphosis. Label the pinned insects describing when and where you found newly collected insects for this level.

Number of insects in your display: _____ Number of scientific insect orders: _____

Refer to: <https://entomology.ca.uky.edu/sites/entomology.ca.uky.edu/files/stfairorder.pdf>

Activity 5

Record in your e-Record expense sheets any materials that you used to create your insect collection like the following: Insect Net Killing Jar Pinning Block

Spreading Board Display Case



Teaming with Insects - Level 2 - Unit 4

In this level (Unit 4), you will learn more about external insect anatomy from Activity 1 and more about using predator or parasitic insects as a biological control in Activity 2. You can also make a special collection in this unit. For example, insects that show camouflage, insects from a single site or habitat, beneficial insects, crop pests, or specialize in one type of insect that has variable features, like the “miller moth.”

Project Outline for Completion of Level 2 - Unit 4

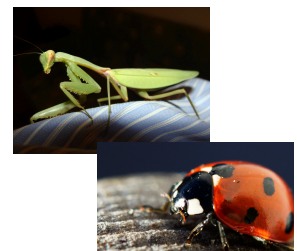
Make an insect collection of at least 75 but not more than 125 insects. At least eight scientific orders should be represented. Pin and display insects in accordance with manual directions. Use purchased or homemade display boxes approximately the standard size indicated in the exhibit requirements. Regular insect pins are required. All new insects collected as part of Unit 4 must be labeled detailing when and where they were found. Do a minimum of eight activities of any combination from the *Teaming with Insects* manual and/or this section of the *Entomology Workbook*.

In Activity 1, discover more about external insect anatomy by labeling a grasshopper’s parts. Activity 2 is a virtual beetle dissection. Activity 4 is about integrated pest management. Learn about biological controls of insect pests using insects that live off of or eat other insects. In Activity 5, you will experiment around with which foods ants are most attracted to. Activity 6 is working on your collection. Lastly, report on at least three “Dig Deeper” special activities in the *Teaming with Insects* Level 2 manual that you completed and include them in the e-Record before the story. You can use the “Dig Deeper” sheet on page 25.

Suggested Additional Level 2 - Unit 4 Activities

1. Forensic entomology: Investigate insects that colonize meat at different stages of decay. Place some kind of meat outside, secured to the ground with chicken wire. Check on the meat over several days or weeks. Record the insects observed during the decay process.

2. Lady beetles and mantids are good examples of biological control. Spend some time observing them and watch what they eat, how active they are, and where they occur most commonly. You may want to temporarily take your study indoors for no longer than a day or two, so you can make better observations.



3. Insects often end up in the news in one way or another. Look online to see if you can find any news articles, cartoons or other items that feature insects. Make a scrapbook and report on what you found.



Teaming with Insects - Level 2 - Unit 4

Activity 1

Internal Insect Anatomy

Let's explore anatomy using an insect that everyone is familiar with: the grasshopper. Examine the diagram below to learn what each body part is called.

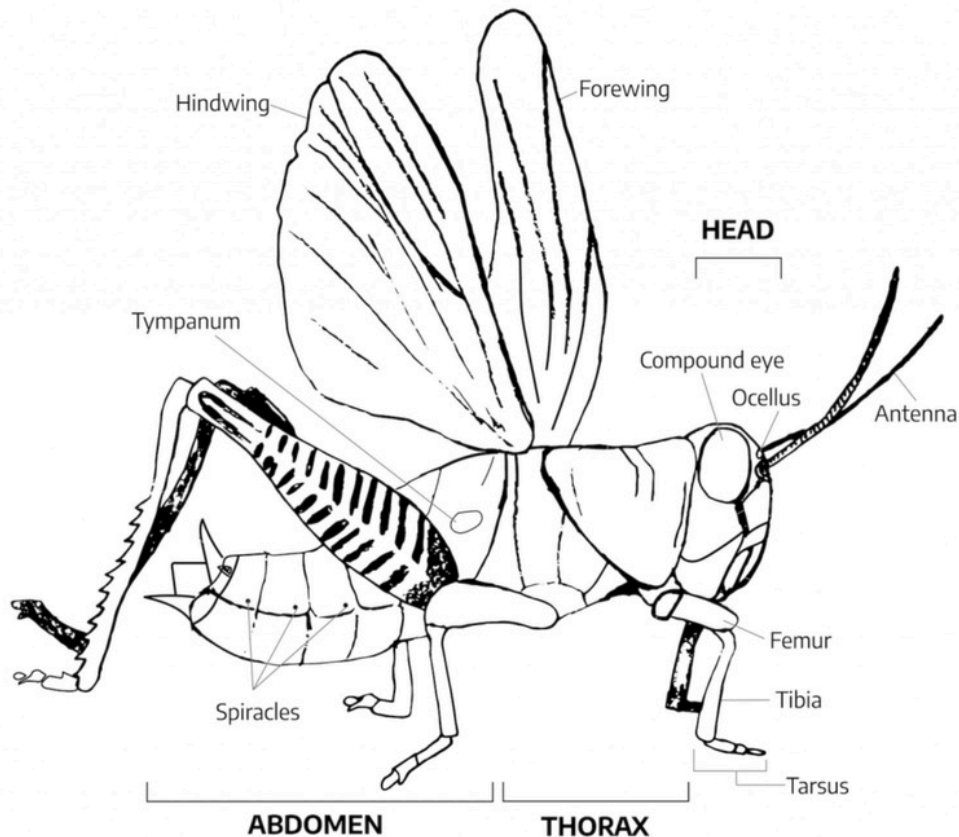


Image from Virginia Cooperative Extension Gardener Handbook
Chapter 3: Entomology
<https://pressbooks.lib.vt.edu/emgtraining/chapter/3/>.

How do insects **smell** and **feel**? Insects use their antenna at the front of their head to smell the air and feel objects in front of them.

How do insects **see**? Insects have two large compound eyes made of many small lenses which allows them to see colors and movement. Did you know insects have more than two eyes? They also have three smaller eyes at the front of their heads called an ocellus. These eyes are much more simple and can only see light and dark.



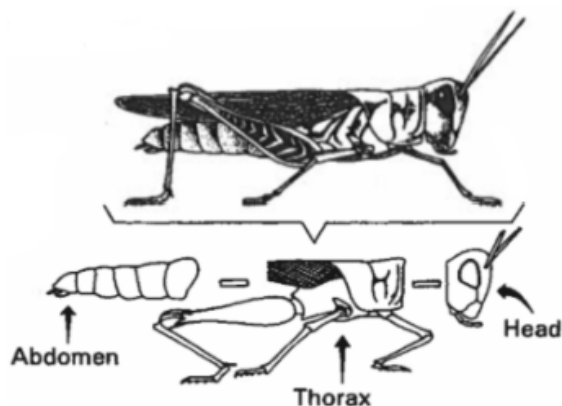
Activity 1 Continued

How do insects **hear**? Most insects have a tympanum right behind their back leg to detect sound waves.

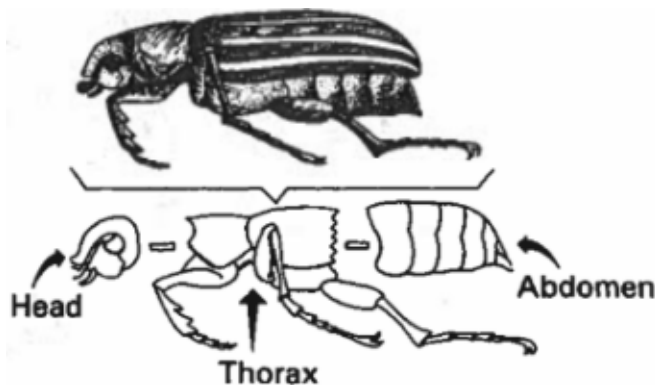
How do insects **breathe**? Insects don't breathe through their mouths like we do. Instead, they have small holes along the side of their abdomen called spiracles. These holes allow air to enter and travel through tubes inside the body.

The legs of all insects are attached to the thorax, the middle segment of the body.

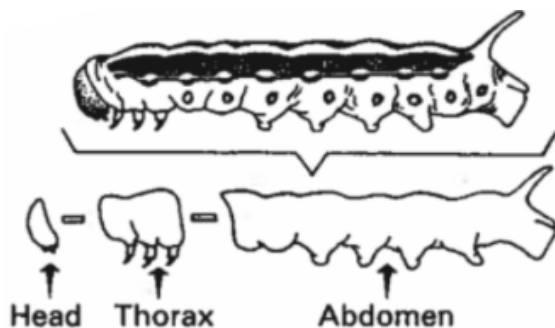
Insects have two pairs of wings, and both are also attached to the thorax. The thorax has a lot of parts attached!



On some insects, such as beetles, it may be difficult to see where the legs are attached, but when you separate the body parts, you will find the legs are still on the thorax.



Notice how even the larva of insects still follow the same body plan! The three hard legs are attached to the thorax. Here, the larva have some additional "legs" on the abdomen. These are not true legs, as they are lost when the larva becomes an adult.





Activity 1 Continued

Now that you are an anatomy expert, let's label this grasshopper! Draw lines to each body part and label everything shown in the cartoon drawing two pages ago. (Some parts like the ocellus and tympanum may be hard to see, so do your best to label as close as you can to the right area.) Label all the parts in the word bank.

Word Bank

antennae
tarsus

compound eye
tibia

femur
tympanum

ocellus
wings

spiracles



Image Sources

- <https://pressbooks.lib.vt.edu/emgtraining/chapter/3/>
- Previous Colorado 4-H Entomology manual (1996)
- <https://www.rawpixel.com/image/9232083/yellow-grasshopper-png-transparent-background> (free image license to use)



Teaming with Insects - Level 2 - Unit 4

Activity 2

Explore this online dissection tool:

<https://askabiologist.asu.edu/sites/default/files/games/beetle-dissection/play.html>

Use the different tools (scalpel, x-ray, zoom, etc.) to explore different parts of the insect. You can use the scalpel to remove the wings and get a closer look at the spiracles and flight muscles. Using the x-ray, try to figure out where are the head, thorax, abdomen? Can you tell which part of the leg is the femur and which is the tibia? What differences are there in the males and females? Take note of anything that surprised you.

Beetle Dissection


Scalpel


Glue


Zoom In


Zoom Out


Inspect


Move


Center


Reset

Beetle parts have been glued back together.


Normal


X-ray


Illustration

Sex: **Male** | Female

View: **Top** | Bottom | Side | Front

Scale: **100%** | 200% | 400%



Credits

Top (dorsal) view of a 4.5 cm (1.8 inch) male beetle

What do you notice that is different from the female? Can you figure out where the thorax and abdomen are? Why do you think they have a scutellum? Use your Inspect tool to find the eyes, horn, antennae, and pronotum.



Teaming with Insects - Level 2 - Unit 4

Activity 3

Insects as Biological Controls of Pests

For many pest insects, the most important factor keeping their populations in check are the activities of other insects. The use of predators and parasites of insect pests is known as **biological controls**. Some insects develop as predators of other insects that actively hunt and feed on several other insects as prey. Adult stages may also be predators, although some, such as green lacewings and flower flies, feed on pollen.

Some flies or wasps lay eggs on certain kinds of insects. Their young feed inside the insect host, killing it and emerging in the adult parasite form. Another group is hunting wasps. These wasps capture and paralyze insects and take them to their nests, which may be dug in the ground, cut into wood, or are constructed of wood or paper. Insects can be very important in controlling plant pests. For example, lady beetles may eat several hundred aphids during the two or three weeks they are growing and many more after they become an adult beetle.

Research one of the common predators of insect and mite pests and complete what you learn about them on the next page. The list on the side-bar to the right can help you get started.

Note: All spiders (Order Araneae) provide biological controls of other insects.

Common Predators of Insect and Mite Pests

Coleoptera

Lady beetles (Family Coccinellidae)
Ground beetles (Family Carabidae)
Tiger Beetles (Family Cincindelidae)
Checkered beetles (Family Cleridae)

Diptera

Syrphid/flower flies (Family Syrphidae)
Robber flies (Family Asilidae)
Tachinid Flies (Family Asilidae)

Neuroptera

Green lacewings (Family Chrysopidae)
Brown lacewings (Family Hemerobiidae)
Ant lions (Family Myrmeleontidae)

Thysanoptera

Bandedwinged thrips (Aleohipidae)

Odonata

Dragonflies and Damselflies (various families)

Mantodea

Mantids (Family Mantidae)

Hemiptera

Stink bugs (Family Pentatomidae)
Damsel bugs (Family Nabidae)
Assassin bugs (Family Reduviidae)
Minute pirate bugs (Family Anthocoridae)

Hymenoptera

Sphecid wasps (Family Sphecidae)
Spider wasps (Family Pompilidae)
Braconid flies (Family Braconidae)
Ichneumonid wasps (Family Ichneumonidae)
Chalcid wasps (Superfamily Chalcidoidea)



Teaming with Insects - Level 2 - Unit 4

Activity 3 Report

Insects as Biological Controls of Pests



Name of the insect you researched:

What other types of insects does the insect you researched eat or live off of as a parasite?

Is the insect you researched used by humans to control other insect pests? If so, did you learn how they are used?

During what stage(s) of life (egg, nymph, adult) does the insect you researched eat or feed off of another insect?

Is there anything else the insect you researched eats besides other insects?

Here are some helpful websites for your research:

[Natural Enemies of Pests](#), Colorado State University, College of Agricultural Sciences

[Natural Enemies Gallery](#), University of California Agriculture & Natural Resources

[Biological Control](#), Youth and Entomology, Purdue University

[Beneficial Biological Control Insects](#), Utah State University

Note: Using natural enemies to control pests on public lands is usually done by qualified scientists sometimes with government permits. Backyard gardeners can purchase helpful insects to release into their yard or garden.



Teaming with Insects - Level 2 - Unit 4

Activity 4

Add to or make an insect collection of at least 75 but not more than 125 insects. At least eight scientific orders should be represented. Pin and display insects in accordance with manual directions. Use purchased or homemade display boxes approximately the standard size indicated in the exhibit requirements. Regular insect pins are required. All new insects collected as part of Unit 4 must be labeled detailing when and where they were found.

Activity 5

Experiment around with which foods ants are most attracted to. Find an ant nest or ant trail and place different food sources nearby. Try a mix of sweet and savory foods. Take note of which foods had more ants on them. Record your observations here.

Type of Food Item: _____

Observation: _____

Type of Food Item: _____

Observation: _____

Type of Food Item: _____

Observation: _____

Type of Food Item: _____

Observation: _____

Activity 6

Report on at least three “Dig Deeper” special activities in the *Teaming with Insects* manual that you completed and include them in the e-Record before the story. You can type the report in a Word document, or you can handwrite your report on the next page.

This image shows a full page of blank, lined paper. It features approximately 20 evenly spaced, light gray horizontal lines running across the width of the page. The lines are thin and consistent in color and thickness throughout. There is no handwriting, printed text, or any other markings on the paper. The background between the lines is a clean, solid white.



Teaming with Insects - Level 3 - Unit 5

In this level (Unit 4), you will take insect identification to the family level. You will also be asked to map and observe where certain insects are found within your neighborhood and to gain experience with trapping insects for study. This unit also asks for you to reflect on what have been areas that you have found particularly valuable or interesting while studying insects. Do a minimum of eight activities of any combination from the Teaming with Insects manual and/or this section of the Entomology Workbook.

Project Outline for Completion of Level 3 - Unit 5

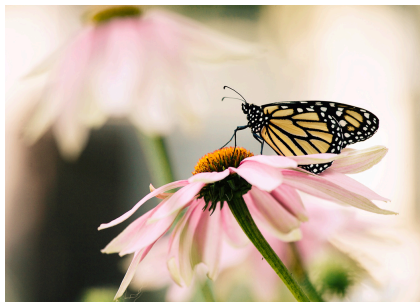
Make an insect collection of at least 100 but not more than 150 insects. At least ten scientific orders should be represented. Pin and display insects in accordance with manual directions. Use purchased or homemade display boxes approximately the standard size indicated in the exhibit requirements. Regular insect pins are required. All new insects collected as part of Unit 4 must have a label detailing when and where they were found.

For Activity 1, select four insect orders and list the names of four families that occur within each order. Give a common name of an insect which is an example of each family listed. Record this information on the record sheets.

In Activity 2, take a survey of your neighborhood to see if you can locate any areas where flies or mosquitoes may breed. Make a map of the area and describe the situation in your record.

For Activity 3, set up some type of insect trap and record daily what you catch over the course of several days. You may use any type of trap-light trap, pitfall trap, sticky trap, pheromone trap, etc. Discuss how weather affected the number of insects you caught.

Activity 4 is working on your collection. Lastly, report on at least three “Dig Deeper” special activities in the Teaming with Insects Level 3 manual that you completed and include them in the e-Record before the story.





Suggested Additional Level 3 - Unit 5 Activities

1. Participate in a team or individual demonstration on entomology to your 4-H group or a local school.
2. Make a mini-insect zoo of insects you found. Observe the insects and use them to show other things that insects do. Report your activities.
3. Make a collection of samples that show injury by insects to plants or other materials. Try to find out what insect caused the injury.
4. Collect some immature insects. Try to identify the insect's scientific order.
5. Make a special report on one insect after studying it in several references.
6. Attend meetings on insects held in your area that are sponsored by local Colorado State University Extension offices, libraries, and schools. Report on these in your record book. If possible, visit museums and other displays of insects outside your county.

Teaming with Insects - Level 3 - Unit 5

Please complete your choice of the following activities for this unit and include them with your e-Record.

Activity 1

On the next page, select four scientific insect orders and list the names of four families that occur within each scientific order. Give a common name of an insect which is an example of each family listed.

Family Name	Common Name of One Insect

Family Name	Common Name of One Insect

Family Name	Common Name of One Insect

Family Name	Common Name of One Insect



Teaming with Insects - Level 3 - Unit 5

Activity 2

Survey your neighborhood to locate any areas where flies or mosquitoes may breed. Make a map of the area in the space below and describe the situation in the record sheets.



Teaming with Insects - Level 3 - Unit 5

Activity 3

Set up some type of insect trap and record daily what you catch over the course of several days. You may use any type of trap: light trap, pitfall trap, sticky trap, pheromone trap, etc. Record your catches and discuss how weather affected the number of insects caught.

Activity 4

Make an insect collection of at least 100 but not more than 150 insects. At least ten scientific orders should be represented. Pin and display insects in accordance with directions given in the manual. Use purchased or homemade display boxes approximately the standard size as outlined in the exhibit requirements. Regular insect pins are required. All new insects collected as part of Unit 4 must have a label detailing when and where the insects were found.

Activity 5

Report on at least three “Dig Deeper” special activities in the Teaming with Insects Level 3 manual that you completed and include them in the e-Record before the story. You can type the report in a Word document, or you can handwrite your report on the next page.

[illegible]



Teaming with Insects - Level 3: Immature Insects and Life Stages - Unit 6

In this level (Unit 6), further specialization of your insect studies is important. Also, considerable effort should be made to learn to identify the immature stages of insects. Based on your understanding of integrated pest management, you will be asked to develop some sort of insect management program. Do a minimum of eight activities of any combination from the *Teaming with Insects* manual and/or this section of the *Entomology Workbook*.

Learn how to store larvae in your collection. If you pin larva, secure a few pins at an angle to form a little “tent” to keep them from rolling around. Transport collections with larvae carefully so the vials containing larvae do not fall out and harm the rest of the collection. If you store them in vials, hand sanitizer is recommended. If the hand sanitizer changes color, you can just change it out for fresh sanitizer. It is not necessary to boil or microwave your larvae.

Project Outline for Completion of Teaming with Insects - Level 3: Immature Insects and Life Stages - Unit 6

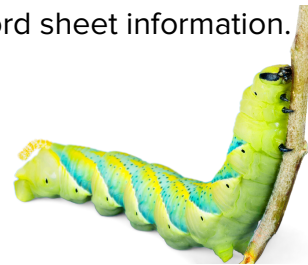
In Activity 1, learn the scientific family name of at least 25 insects in your collection. Give the scientific name of at least five insects.

In Activity 2, make a special collection that is different from one you made in previous units. Include at least ten insects in this collection.

For Activity 3, try to rear an insect through at least two life stages. Record observations on the record sheet.

Activity 4 is working on your collection. Make a collection of at least 10 larvae or immature insects and display it with your regular insect collection. These should be kept in vials with rubbing alcohol, hand sanitizer, or a similar preservative. Identify their scientific order.

In Activity 5, you will assume the responsibility for insect control in your home, garden or farm. Report in detail how you set up the program. Complete the record sheet information.





Suggested Additional Level 3 - Unit 6 Activities

1. Participate in a team or individual demonstration on some phase of entomology.
2. Prepare a poster display on the life cycle of an interesting or important insect, showing all stages.
3. Make a special display on the beneficial or pest insects found in your area.
4. Keep a record of newspaper and magazine articles, and television reports that include insects.

Teaming with Insects - Level 3: Immature Insects and Life Stages - Unit 6

Activity 1

Learn the scientific family name of at least 25 insects in your collection. Give the scientific name of at least five insects.

Family Name	Scientific Name





Teaming with Insects - Level 3: Immature Insects and Life Stages - Unit 6

Activity 2

What kind of special collection did you make?

What did you learn from it?

Activity 3

Try to rear an insect through at least two life stages. Record observations. What insect did you try to rear? _____

What did you have a chance to observe while rearing this insect?

Activity 4

Make a collection of at least 10 larvae or immature insects and display it with your regular insect collection. These should be kept in vials with rubbing alcohol, hand sanitizer, or a similar preservative. Identify their scientific order. All new insects collected as part of Unit 6 must have labels detailing when and where the insects were found.





Teaming with Insects - Level 3: Immature Insects and Life Stages - Unit 6

Activity 5

Assume the responsibility for insect control in your home, garden or farm. Many pantry items have properties that repel insects, such as cinnamon, mint, lemon, baby powder, etc. Find some of these items and experiment with what works best. See page 7 for a link to more specific instructions.

What insect did you attempt to control? _____

How did you go about the control program?

How successful do you think it was and why?

Safety Note: We recommend not using commercial pesticides for this activity. Pesticides can kill beneficial as well as harmful insects, so care should be taken when using pesticide products. Pesticides can also be harmful to humans if not applied correctly.





Exploring with Insects Advanced - Unit 7

Unit 7 is when you get to take all you have learned from your previous units and have fun exploring additional topics that interest you about the field of Entomology. You can learn about careers in Entomology by job shadowing an entomologist, doing a research report, or looking for an internship at a museum, lab or veterinary clinic. You could also build special equipment or something useful to your project area. Your imagination can run free in this unit!

Project Outline for Completion of Exploring with Insects Advanced - Unit 7

You have two options for your exhibit in Unit 7:

Display a special collection of beetles, flies, grasshoppers, butterflies or some other order. In your display, you should have at least 50 insects with no more than two of the same species. Give information on your special collection in your story.

OR

Create a display board or stand-alone item representing some phase of your advanced project work. This could include a chart or information on an area you have researched, or special equipment used or developed. The standard display board size of 4 ft. x 3 ft. is to be used with 4-H projects.

In Activity 1, learn how to determine the best scent attractant for fruit flies. Activity 2 covers internal insect anatomy. In Activity 3, you can learn how plant richness in an environment affects arthropod abundance.

Lastly, you will want to update your regular insect collection. Your collection should include no more than 250 insects.

Suggested Additional Unit 7 Activities

You may complete “Suggested Additional Activities” from previous units that you have not yet completed.

1. Create special collections for aquatic insects, urban pests, or medical/veterinary relevant insects. Go to a local veterinarian’s office to ask for their ticks, fleas, or other parasitic insects.
2. Investigate the inside of a beetle through X-rays by watching the video on this link from Arizona State University <https://askabiologist.asu.edu/micro-ct-beetle-navigator>. Additional games and simulations are available at <https://askabiologist.asu.edu/games>.

Exploring with Insects Advanced - Unit 7

Activity 1

The Best Scent Attractant for *Drosophila melanogaster* (Fruit Flies)

Activity by Hannah McKenrick, University of Florida, Department of Entomology

Introduction

Invading fruit flies are a big threat to today's produce growers and are pests to fruit-lovers (ucdavis.edu). "The key to stopping and controlling fly populations is early detection (alameda.ca)," and the most effective and least harmful way of getting rid of fruit flies is to lure and then trap them in either commercial or home-made traps (bhg.com). Many field experiments have tested baits and traps for fruit flies with surprising findings. For example, pineapple juice and brown sugar was found to attract papaya fruit flies (Casana-Giner, 2005). With this in mind, further studies can be conducted using other combinations of fruits as attractants for fruit flies. This research will help determine what types of fruit small fruit flies, *Drosophila melanogaster*, are attracted to the most.

Question

Will the fruits tested have differing levels of attractiveness to fruit flies?

Materials

- Cutting board
- Knife
- Aluminum foil
- Masking tape
- Three bait systems (see directions on next page)
- Refrigerator
- Freezer
- Funnel
- Approximately 300 *Drosophila melanogaster* (these can be obtained at pet stores, by ordering cultures online, or by simply placing fruit outside and collecting the small flies off it hours later).



An example of *Drosophila melanogaster*

Materials for Bait System

- 12 water bottles
- Plastic tubing
- Power drill and bits (use with adult supervision)
- Ruler with centimeters



Activity 1 Continued

Directions

Obtain 12 spring water bottles. Remove all labels and pour out the water. With a power drill put one hole in nine bottles and three holes in three bottles. Holes are 2.5 cm down the side of bottle and are 1 cm in diameter. Holes are made with consecutive use of 13/64, 7/16, and 1/2 drill bits. Then, the bottoms of all bottles are cut off 6 cm from the bottom of the bottle. Nine pipes that are 1 cm in diameter and 13 cm in length are cut to length. Pipes are washed with hot soapy water and allowed to dry. The pipes will connect three bottles with one hole to one bottle with three holes.



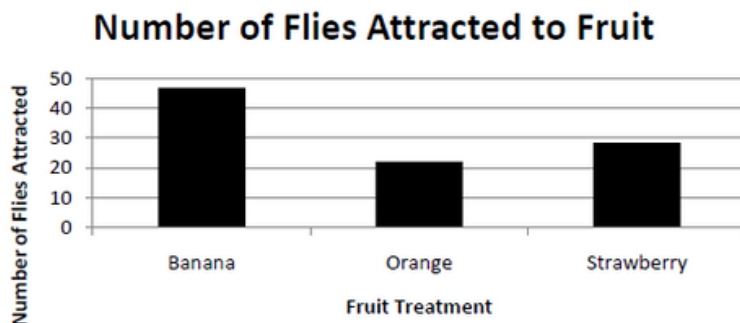
Example of a Bait System

Experiment

Set up the bait systems in one room. Cut the fruit into about the same-sized chunks and place them into the bottoms of the bait system water bottles. Each bait system should contain one of each fruit and an empty water bottle for control. Reconnect the bottoms to the bait system and tape to prevent any accidental spilling. Wrap all bottles in the bait system with aluminum foil; secure the foil with masking tape. Open top on all bottles to circulate air. Refrigerate approximately one hundred *Drosophila* fruit flies for 3 minutes. After five minutes, funnel the temporarily slowed flies to the center bottle and close all tops. Observe fly behavior and allow the flies to wander for a period of 1-2 hours. Record all behavior. When the period is done, disconnect pipes from the center bottle. Tape up all holes and place the disassembled bait system in a freezer. Once all flies are dead, take the system out of the freezer. Record the number of flies in each bottle.

Complete this experiment at least three times. The results of all trials can be averaged for easy depiction with a graph.

Example of Recorded Data:





Activity 1 Continued

Conclusion

Very few flies are found within the control bottle. The greatest fly attractant tested is banana, because it attracts an average of forty-seven flies. Strawberry is the next greatest attractant with twenty-nine flies attracted. Orange is the least attractive of the three fruits, attracting only twenty-one flies. Some of the variation in this project could be due to several factors. The size of the fruit probably influences how attractive it is to the fruit flies. Flies might also be confused when traveling within the bait system, causing them to not select a fruit.

Future Research

This research could be continued in many different ways. Different types of fruit can be used in the future as well as different stages of ripeness of those fruits. As mentioned in the introduction, combinations of ingredients may also be attractive to fruit flies. So, combinations of fruit with other fruits or sugar could also be explored. The differences between male and female fly preferences could also be researched to see if there is a gender difference in fruit preference. Finally, these baits could be tested outside to see if flies outside prefer the same fruit as the flies that are tested indoors.

References

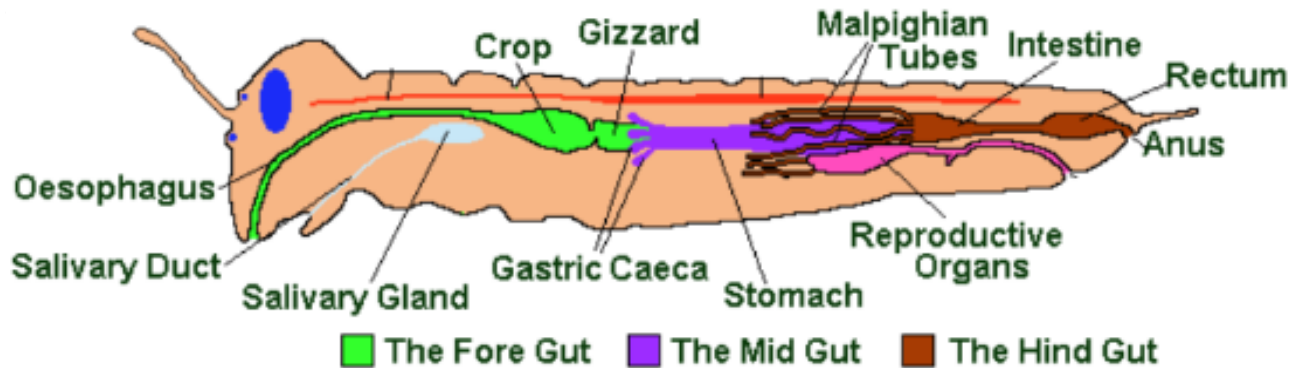
Casana-Giner, Victor, et al. "Attractiveness of 79 Compounds and Mixtures to Wild *Ceratitis capitata* (Diptera: Tephritidae) in Field Trials." *Journal of Economic Entomology* 94 (2001): 898-904. Feb. 2005
<<http://www.entsoc.org>>.
http://www.bhg.com/au/gardening.nsf/Content/Article_BHG_apr01_flytrap 1994. Feb. 2005.
<http://www.co.alameda.ca.us/cda/awm/agprograms/pestdetection/melonfruitfly.htm> 1994. Feb. 2005.
<http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74112.html> 23 Feb. 2005.



Exploring with Insects Advanced - Unit 7

Activity 2

Insect Digestive System



When food is first chewed with the help of saliva from the salivary gland, it enters the foregut by traveling through the oesophagus and down into the crop. Here, food is stored until the insect is ready to pass it along deeper into their body. Food will then enter the gizzard, which has hard teeth-like structures that grind the food into smaller pieces. It then enters the midgut where absorption of the nutrients occurs. The stomach has additional folds called gastric caeca which provide additional surface area for even more cells to absorb nutrients.

At this point, the food has been rendered to waste and will enter the hindgut. The waste will be packed down in the intestine, then passed through the rectum and finally out of the anus. Additionally, there are long, thin tubes stretched throughout the abdomen called malpighian tubes which draw waste from the hemolymph into the hindgut to be excreted as well. Hemolymph is the “blood” of an insect, a liquid that delivers nutrients and hormones to tissues throughout the body.

Now apply what you’ve learned! Label this simplified digestive system below with every part of the digestive system described above. (Ignore the reproductive organs.)

References

The Insect Abdomen, Earth Life, <https://earthlife.net/insect-abdomen-digestive-reproductive-systems/>



Activity 2 Continued

Insect Digestive System

Now apply what you've learned! Label this simplified digestive system below with every part of the digestive system described above. (Ignore the reproductive organs.) Hint: The foregut is green, the midgut is pink, and the hindgut is yellow. Label the diagram with parts from the word bank.

Word Bank

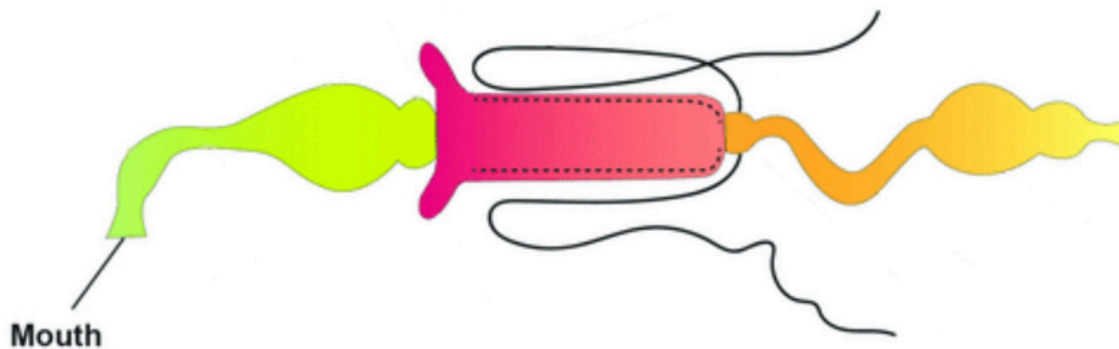
anus
gizzard

crop
malpighian tubule

esophagus
rectum

intestine
stomach

gastric caeca



References

The Insect Abdomen, Earth Life, <https://earthlife.net/insect-abdomen-digestive-reproductive-systems/>
Diagram: https://www.researchgate.net/figure/Basic-structure-and-divisions-of-the-insect-digestive-system_fig1_360358089



Exploring with Insects Advanced - Unit 7

Activity 3

How Does Plant Richness Influence Arthropod Richness and Abundance?

Activity by Matthew L Richardson, USDA-ARS, Subtropical Insects Research Unit

Grades: Middle and High School

Many arthropods (invertebrate animals with an exoskeleton, such as insects, spiders, mites, centipedes, etc.) use plants for food and shelter. Areas that have a greater number of species of plants, such as natural areas (Fig. 1) and gardens seem to have more arthropods than areas that have few species of plants, such as agricultural fields (Fig. 2) and grass lawns.

Figure 1

A natural area with a high species richness of plants.



Figure 2

An agricultural area with a low species richness of plants (soybeans in foreground, corn in background).

Does the number of plant species in an area influence the number of arthropod species and their abundance?

Hints to Form the Hypothesis

Herbivorous arthropods may eat one plant species (specialists) or eat a variety of plant species (generalists). Areas that have a diversity of plants may provide more food for specialist and generalist herbivores. Arthropod predators often prey on insect herbivores, so predators may be more abundant where there are many herbivores. Arthropods also find shelter in a variety of plant parts.



Activity 3 Continued

How Does Plant Richness Influence Arthropod Richness and Abundance?

Hypothesis

Arthropod richness (the number of species) and abundance (number of individuals of each species) will be higher in diverse plant communities because of the availability of a greater variety of food and shelter.

Materials

- At least three plastic yellow bowls (Yellow is attractive to many types of insects and other arthropods and they are drawn to the bowls)
- A one meter long piece of string
- An instruction and plant data sheet (Table 1)
- At least three plastic containers with lids (use peanut butter jars or other containers from home)
- Water, table salt, dish detergent
- A hand lens or dissection microscope (Fig. 3 shows a sample packet of materials).

The Experiment

Student fills each plastic yellow bowl with one cup of water. Stir two teaspoons of salt and a couple drops of dish detergent into the water. Student places their bowls outside in areas with a low number of plant species, medium number of plant species, and a high number of plant species. With the help of a parent, measure how many plant species are within one string-length of the bowl. Parents hold one end of the string at the bowl and the student holds the other end. Holding the string taut, students walk in a circle around the bowl and count the number of plant species the string passes over.

Record data on the instruction and data sheet (Table 1). Leave bowl in place for 24 hours. After 24 hours, pour the contents of the bowl into a plastic container with a screw lid.

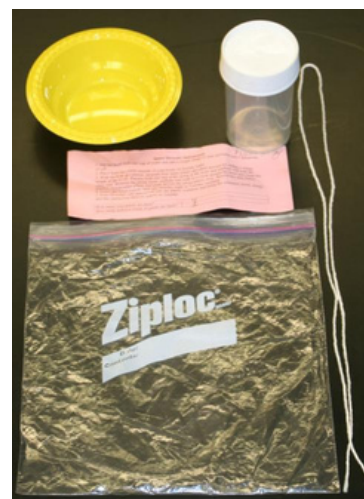


Figure 3

Packet of materials sent home with student to collect arthropods (yellow bowl, plastic container with lid, instruction and data sheet, a one meter long piece of string, and a plastic bag to carry the materials).



Activity 3 Continued

How Does Plant Richness Influence Arthropod Richness and Abundance?

Table 1

Instruction and Data Sheet

1. Fill each bowl with one cup of water and add a couple drops of dish detergent and 2 teaspoons of salt.
2. Place bowl(s) anywhere outside of your house.
3. With the help of a parent/adult, measure how many plant species are within a string-length of the bowl. Parents/adult hold one end of the string at the bowl and students will hold the other end. Holding the string taut, students will walk in a circle around the bowl and count the number of plant species the string passes over. Record data below.
4. Leave the bowl outside overnight.
5. Pour the water, salt and insects into the plastic container and bring the container, bowl, string, and this instruction sheet inside to do the evaluation.

How many different kinds of plants are there? _____

Once inside, student pours a small amount of sample back into their yellow bowl. Using a hand-lens or microscope, count the number of different kinds of arthropods (for older students, group arthropods by major categories, as in Table 2 on the next page) and the total abundance of arthropods (i.e., number of individuals of all species or taxa), empty the yellow bowl, and pour more sample into their bowl. Continue this process until the entire sample is sorted.

Enter all data into a computer program with graphing capabilities, or hand draw a figure showing the richness and total abundance of arthropods versus plant richness (see page 45 for more instructions). The data can be graphed as a bar chart showing the number of arthropods in each habitat, or if you sample a large number of habitats, use an xy scatter graph, as shown in Figure 4 (the regression line is not necessary, but does show the general trend in the data – Microsoft Excel provides an option in their graphing tools to insert this line).



Activity 3 Continued

How Does Plant Richness Influence Arthropod Richness and Abundance?

Table 2

Common Arthropods Caught with Yellow Bowls

Common Name	Order	Description
Spiders	Araneae	Eight legs, no wings
Beetles	Coleoptera	Hard elytra
Springtails	Collembola	Minute & wingless
Earwigs	Dermaptera	“Pincer”-like cerci
Flies, gnats, mosquitoes	Diptera	Only order with 2 wings
Leafhoppers, planthoppers	Hemiptera	Wings half hard, half membranous
Aphids	Homoptera	Small, with cornicles
Wasps, bees, ants	Hymenoptera	Usually with a constricted “waist”
Moths, butterflies	Lepidoptera	Scale-covered wings
Lacewings	Neuroptera	Clear, vein-filled wings
Harvestmen	Opiliones	Like spiders, “daddy longlegs”
Crickets, grasshoppers, katydids	Orthoptera	Long hind legs for jumping

Results

Present the results in a chart on a separate piece of paper. See a sample in Figure 4 on the next page.

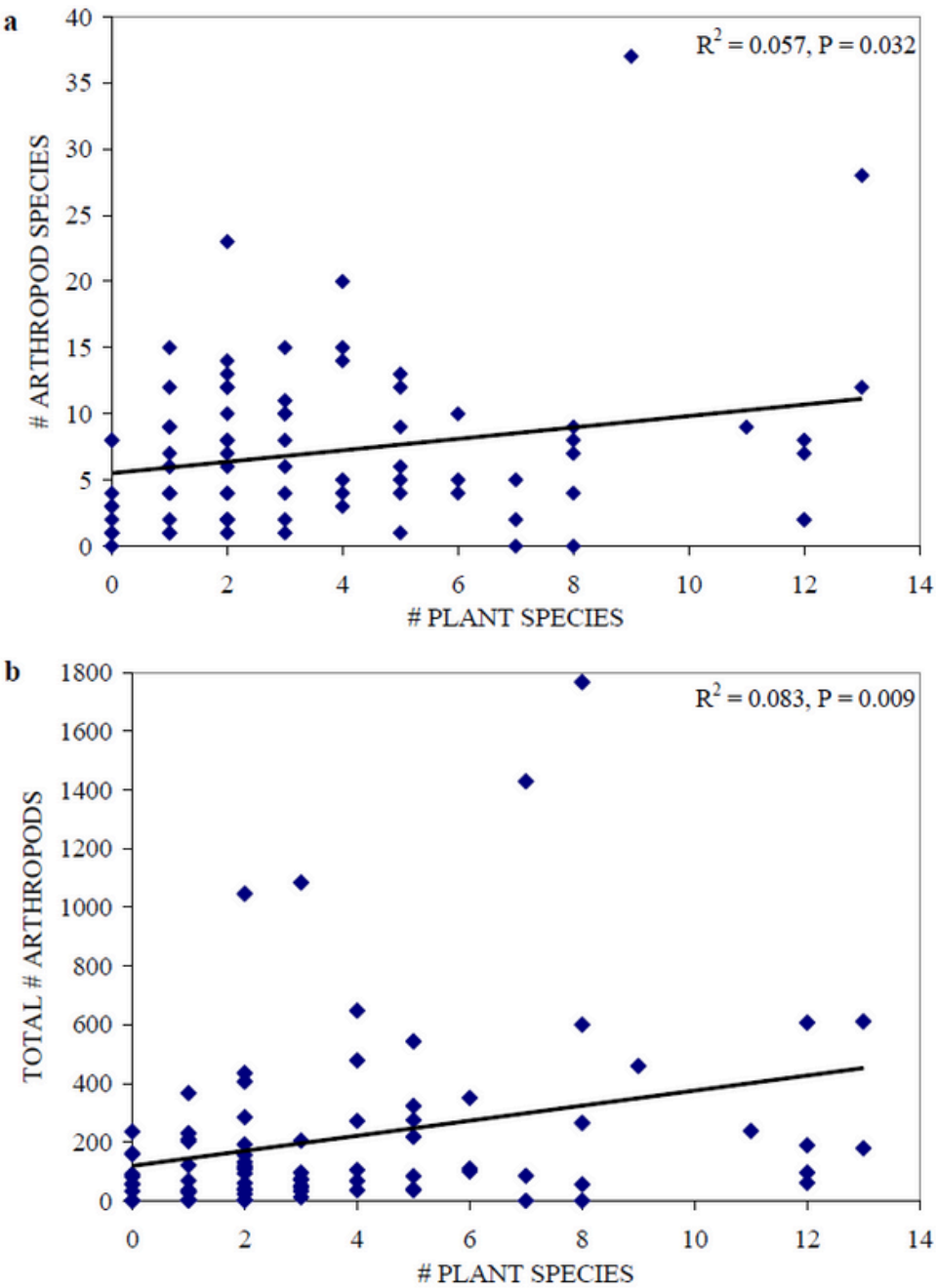
Discussion

Discuss whether the data do or do not support the hypothesis, focusing on whether species richness and abundance of arthropods increases or decreases with species richness of plants. Formulate follow-up questions and hypotheses if possible. For example, how do you think modifying habitat for human uses (agricultural and urban areas) influence arthropod richness and abundance? What can we do in human-modified areas to increase arthropod richness? Were there any specific types of arthropods most attracted to the yellow bowls? Are there certain kinds of arthropods that we may not catch with yellow bowls (such as those that live in leaf litter)? What methods can we use to sample a greater variety of arthropods?



Activity 3 Continued
How Does Plant Richness Influence Arthropod Richness and Abundance?

Figure 4
Sample Student Graphs
a. Arthropod richness versus plant richness; b. Arthropod abundance versus plant richness



Activity 3 Continued

How Does Plant Richness Influence Arthropod Richness and Abundance?

Graphing Instructions

Organize your data into two pairs of columns: # of plant species vs. # of arthropod species and # of plant species vs. total # of arthropods. Number of plant species goes on the x-axis (horizontal). Number of arthropod species or total number of arthropods goes on the y-axis (vertical). Create two graphs, one for number of arthropods and total number of arthropods, like in Figure 4. You can graph this data in any of the following ways:

1. Sketching

- Sketch a box, labeling your x- and y-axis, and your units.
- Draw vertical and horizontal lines to create a grid pattern in your box.
- Plot your data points, using the grid on the x- and y-axis to figure out where to draw each point.
- After plotting all the data points, draw a line that cross through or comes close to as many points as possible.

2. Online programs

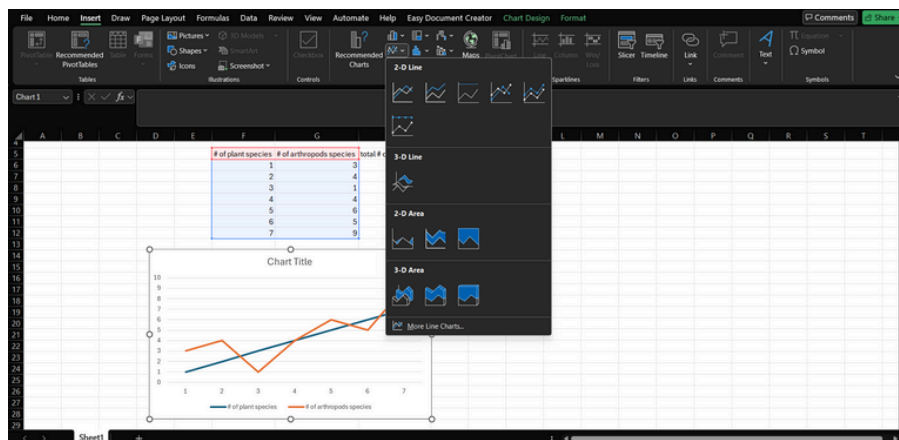
- Use either of the following links to enter your data points and label your graph:

- <https://www.mathsisfun.com/data/data-graph.html>

- https://nces.ed.gov/nceskids/graphing/classic/line_data.asp

3. Excel

- Enter your data in the columns. For each line graph, select the whole of both columns. This can be done by pressing and dragging the mouse.
- With your data set selected, click on the 'Insert' tab (top right corner, 3rd from the left).
- Move your mouse over the graphics of various graphs, clicking the one of a line graph (two overlapping blue and white lines).
- Pick one of the "2-D Line options."



Colorado 4-H Mission

4-H empowers youth to reach their full potential by working and learning in partnership with caring adults.

Colorado 4-H Vision

A world in which youth and adults learn, grow and work together

4-H Pledge

I pledge.....

My head to clearer thinking,
My heart to greater loyalty,
My hands to larger service,
My health to better living
for my club, my community,
my country and my world.

Promesa 4-H

Prometo usar mi mente para pensar con más claridad,
mi corazón para ser más leal,
mis manos para ser más servicial,
mi salud para cuidarme más,
por mi club, mi comunidad, mi país y mi mundo.

4-H Motto

“To Make the Best Better.”



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