4H ENL 41

Forensic Entomology

UF UNIVERSITY of FLORIDA
IFAS Extension

Forensic Entomology

Grade Levels: 6ð8

Subjects Covered:
Science
Mathematics
Language Arts
History

Settings:
Indoor and Outdoor

Acknowledgements:
This work was partially funded by a grant from the USDA-CSREES Southern Region Pest Management Center to Russell Mizell, professor, and Erika Andersen, graduate student, Entomology and Nematology, University of Florida.

INTRODUCTION

It has been said that humans and insects are the two most successful creatures on Earth. Insects have been around much longer—they were here about 350 million years before humans entered the picture, which was only about 100,000 years ago!

Humans attempt to manage their environment, which allows us to manipulate our success as a species. Insects, on the other hand, do not have the powers of higher thought or the use of tools, as far as we know! What insects *do* have is the ability to adapt to a variety of habitats and lifestyles because of their small size, fast rate of reproduction, hard exoskeleton, and often the ability to fly. These traits have made insects the dominant group of animals on Earth (both on land and in fresh water).

Insects' unique abilities also make them a very useful tool in the world of forensics. Forensics is a hot topic, with many movies and popular television shows (such as "CSI") introducing youth to the tools, processes, and critical thinking skills needed to solve various crimes. Indeed, the growing presence of ***forensic entomology*** focuses on the information that insects provide investigators about the time, location, and criminal negligence within a wide variety of criminal cases—everything from food contamination to murder.

Using This Curriculum

This curriculum has been designed as a tool for teaching youth (grades 6–8) about the contributions that insects make to the world of forensics. This three-week series of lesson activities is designed for use in informal educational settings such as after-school programs, summer day camps, 4-H clubs. However, this package also includes the Next Generation Sunshine State Standards for teachers within formal classroom settings who may wish to incorporate these activities into their current lesson plans.

In order to capture the full content of this package, it is recommended that the nine lessons be followed in chronological order. Supplemental Lesson 1 and 2 can also be added for enrichment of the materials, but are not necessary to the forensic science content. Brief descriptions of each lesson are provided on the page 4.

The first page of each lesson provides several key pieces of information. In addition to the **MAIN IDEA** and **OBJECTIVES**, each lesson also contains a **SIDEBAR** which outlines the following:

- subject area emphasis
- time required
- science and life skills built
- materials needed for the Lesson
- applicable Sunshine State Standards

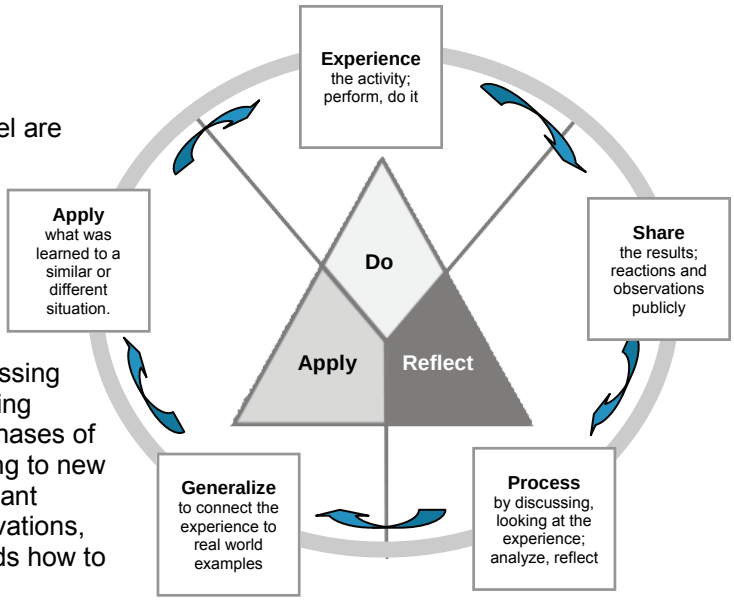
The first page of each lesson also contains **BACKGROUND INFORMATION** for the content within the Lesson. This is where key vocabulary for the lesson is identified and defined. Background topics include these items:

- What is forensic entomology?
- What is the history of forensic entomology?
- Forensically important insects
- Understanding metamorphosis
- Understanding the collection process
- Understanding sampling
- Understanding the connection between insects and forensic entomology

Directions for the corresponding lesson including advanced preparation needs, a materials list, any specific notes about the lesson, and suggested dialogue for use with the youth. The **Let's Begin** section contains the actual activity. This section is followed by **Let's Reflect** and **Let's Apply** with questions for use following completion of the activity. If you would like to continue the exploration of this subject matter, activity options have been included in the **Extension Activities** endnote.
Each lesson contains any handouts that may be needed for any given activity.

Experiential Learning

The five steps of the experiential learning model are used extensively in 4-H Youth Development to teach and reinforce life skills. The sequential steps of the model help youth identify what they have learned from an experience or activity and then how to apply that learning to other experiences or situations. Within this model, the "teacher/leader" must be very clear which skill or concept has been targeted, and then provide the experience and processing time which have been designed to support that learning goal. This learning process engages learners in all phases of the activity, resulting in the ability to apply this learning to new situations. Experiences lead to learning if the participant understands what happened, sees patterns of observations, generalizes from those observations, and understands how to use the generalization again in a new situation.



DO

We begin the process with an **Experience.** The experience should be concrete, and can be either an individual or group experience. The key here is that youth are "doing something." Within this project book, the "do" section is denoted by the heading **Let's Begin**.

REFLECT

Once the experience is completed, the youth then begin to reflect on what they learned within the activity. This includes sharing their experiences and processing themes, problems, or issues were brought out by the activity. Within this project book, this is found in the **Let's Reflect** section.

Share. Allow the participant(s) to discuss the experience. Some common sharing questions include:

- *What did you do?*
- *What happened?*
- *How did you feel?*
- *How did it feel to…?*
- *What was most difficult?*
- *What was easiest?*

Process. Discuss how recurring themes, problems, and issues are brought out by the exercise. Address specific problems and issues that the group discovers from the exercise or individual's recall from personal experiences. Some common processing questions include:

- *Did problems/issues seem to occur over and over? What were they?*
- *What similar experiences have you had?*

APPLY

Once youth have reflected on the activity, it is time to create links between that new knowledge and their lives. This includes generalizing principles that apply to "real life" and understanding how that knowledge can then be used in their daily lives. Within this project book, this is found in the **Let's Apply** section.

Generalize. Find general trends or common truths in the experience. Draw out and identify the principles that are important and that apply to "real life," not just the activity. Focus on the key messages. Some common generalizing questions include:

- *What did you learn about yourself through this activity?*
- *What did you learn about the life skill (i.e., making decisions)?*
- *How did you go about making your decision?*
- *How do the major themes or ideas relate to real life and not just the activity?*

Apply. Concentrate on how the new learning can be applied to everyday situations. Discuss how issues raised by the activity can be useful in the future. Describe how more effective behaviors can grow out of what is learned. Some common questions here may include:

- *How can you apply what you learned (making decisions) to a new situation?*
- *How can issues raised by this activity be used in the future?*
- *How will you act differently in the future as a result of this activity?*

Adapted from Kolb, D. A. (1984) *Experiential Learning*, Englewood Cliffs, NJ: Prentice Hall.

Table of Contents

Lessons

Supplemental Activities

Next Generation Education Standards

Please Note: Multiple grade levels are indicated in parentheses if standard is the same across grade levels.

	Lesson 1	*Lesson 2*	*Lesson 3*	*Lesson 4*	*Lesson 5*	*Lesson 6*	*Lesson 7*	*Lesson 8*	*Lesson 9*	*Supplement 1*	*Supplement 2*
LA.(6, 7, 8).3.1.1 The student will prewrite by generating ideas from multiple sources (e.g., prior knowledge, discussion with others, writers notebook, research materials, or other reliable sources), based upon teacher-directed topics and personal interests.				X					X		
LA.8.5.2.4 The student will research, organize, and effectively deliver speeches to entertain, inform, and persuade.				X					X		
LA.(5,6,7).4.2.1 The student will write in a variety of informational/expository forms (e.g., summaries, procedures, instructions, experiments, rubrics, how-to manuals, assembly instructions).				X					X	X	
MA.4.G.3.3 Select and use appropriate units, both customary and metric, strategies, and measuring tools to estimate and solve real-world area problems.						X	X				
MA.7.S.6.1 Evaluate the reasonableness of a sample to determine the appropriateness of generalizations made about the population.						X	X				
SC.4.N.1.6 Keep records that describe observations made, carefully distinguishing actual observations from ideas and inferences about the observations.		X									
SC.4.L.16.2 Explain that although characteristics of plants and animals are inherited, some characteristics can be affected by the environment.			X								
SC.4.L.16.4 Compare and contrast the major stages in the life cycles of Florida plants and animals, such as those that undergo incomplete and complete metamorphosis, and flowering and non-flowering seed-bearing plants.				X							
SC.(5,6,7).N.1.1 Define a problem from the sixth grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.	X	X			X	X	X	X			X
SC.5.N.2.1 Recognize and explain that science is grounded in empirical observations that are testable; explanation must always be linked with evidence.	X										
SC.6.N.1.4 Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.								X			
SC.7.N.1.6 Explain that empirical evidence is the cumulative body of observations of a natural phenomenon on which scientific explanations are based.	X										
SC.912.L.17.8 Recognize the consequences of the losses of biodiversity due to catastrophic events, climate changes, human activity, and the introduction of invasive, non-native species.										X	
SS.6.W.1.1 Use timelines to identify chronological order of historical events.	X		X							X	

*As of 01/01/10 Florida Department of Education

Introduction to Forensic Entomology

Lesson 1

Grade Levels: 6ð8
Subjects: Science
Setting: Indoor and Outdoor

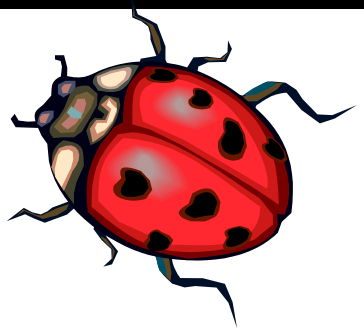
Time Needed:
2 weeks—Advanced Prep
30ð45 minutes for Activity

Science Skills:
Observation
Communication
Inference
Classification
Acquiring & Processing Data

Life Skills:
Teamwork
Problem solving
Communication

Materials Needed:
Activity 1
- Fresh chicken livers (1/2 pound should be plenty); can be purchased at most grocery stores in the meat department, though you may have to ask for them.
- Four large glass jars or plastic containers of similar size (with lids)
- Labels/Permanent marker
- Handout 1.2 (both sides copied double-sided)
- Pencils
- Four sheets of wax paper
- Collecting vials/film canisters
- Tweezers (forceps)

Sunshine State Standards:
SC.(5,6,7).N.1.1
SC.5.N.2.1
SC.7.N.1.6
SS.6.W.1.1



Main Idea

This lesson provides an introduction to the world of forensics through the introduction of basic vocabulary.

Objectives

Youth will be able to:

1. Practice observational skills by recording observations of a staged scene.
2. Communicate findings with group members.
3. Compare findings with other groups.
4. Use the skill of inference to solve a problem in a small group.

Background Information

What is Forensic Entomology*?*

Forensics is a hot topic, and many youth have seen forensic entomology practiced in movies and on popular television shows (such as "CSI") as a way to solve crimes such as murder cases. Even for those who are not aware of the current trend, a murder case is something that consistently piques the interest of youth.

Forensic entomology can be used in many areas to aid investigations. It is commonly broken down into three general areas:

1. ***Medicolegal*** - deals with necrophagous (or carrion) feeding insects that typically infest human (and other animal) remains. This may involve murder victims—insects can be used to pinpoint exactly when the victim was killed, and therefore eliminate or accuse suspects.

2. ***Stored produce pests*** - insects are commonly found in food (prepared or stored). A forensic entomologist may serve as an expert witness during both criminal and civil proceedings involving food contamination.

Background Information (continued)

Vocabulary

Post-Mortem Interval (PMI) - time elapsed between death and the discovery of a body

Pupate - to turn into a pupa

Forensics - of, relating to, or used in courts of law or public debate or argument

Forensic Entomology - using insects to solve crimes

3. Urban - deals with insects that affect man and his immediate environment. The damage caused by insects feeding on flesh can cause marks and wounds on the skin that may be mistaken as abuse. Insects can also show signs of neglect and abuse, particularly in children and the elderly. There are published cases documenting parents intentionally using wasps and bees to sting their children as a form of punishment,and entomological evidence has been used to prove neglect and lack of proper care for wounds existing on the elderly. Insects are also known to cause car and aircraft accidents. Stings of bees and wasps may be responsible for a large number of single-occupancy car accidents that lack a definitive cause. Insects also have been responsible for causing aircraft crashes through obstructed equipment, such as fuel lines, causing engine failure. Urban pests are of great economic importance and a forensic entomologist may become involved in civil proceedings over monetary damages.

Understanding the* CONNECTION *between insects and forensic entomology

Chronology is the science of locating historical events in time. Events that happened in the past occurred in a sequence over time. To fully understand what happened in the past, people in the present attempt to reconstruct how the events unfolded by developing a time line of the sequence of the events. Understanding the chronology of a crime is very important to an investigator trying to uncover what really happened and when.

The Post-Mortem Interval (PMI) is the time elapsed "chronology" between death and discovery and medical examination of a body. The knowledge of forensic entomology can help determine the PMI, if the evidence is properly collected, preserved, and analyzed. After 48–72 hours, forensic entomology is often the *only* method for determining the PMI. Blowflies are the first visitors to a corpse, followed by beetles and other insects. Knowing which insects are present, and which life stage they are in (maggot vs. adult, for example), can determine how long ago a death took place.

If a body is soft, it is likely that the death occurred less than three or more than 36 hours ago (>3 or <36 hours PMI). If it is stiff, the PMI is most likely between 3–36 hours PMI. If there are flies around the body, the PMI is 3 or more hours. If there are maggots (fly larvae) on the body, the PMI is between 3–5 days. Body stiffness and presence of insects can be greatly affected by the time of year (day length, temperature, humidity, presence of certain insects), location (sun vs. shade, body placed in bag or freezer), or other factors.

Defining the PMI Stages

The "Fresh" stage: The process of decay begins with blow flies (family: Calliphoridae) and flesh flies (family: Sarcophagidae) finding the body. They can arrive within 10 minutes of death! They lay their eggs, from which maggots hatch, and begin to feed on the tissues. (Flesh flies actually lay newly hatched maggots and not eggs). Beetles and predatory wasps may arrive to feed on the maggots (not on the corpse). Depending on weather conditions, it represents days 1–3 PMI.

The "Bloating" stage: Next, house flies (family: Muscidae) join the other flies and their maggots form feeding masses that help liquefy the tissue. At this point, there are a lot of maggots feeding on the body and the competition (as well as number of predators that come to eat on the maggots) increases. Depending on weather conditions, it represents days 2–6 PMI.

The "Decay" stage: This is when the decay of a body really starts to smell bad. By the end of this stage, most maggots have finished development and begin to leave the body to find a place to pupate in the soil. The corpse becomes devoid of all flesh, except cartilage, bone, and skin. Depending on weather conditions, it represents days 5–11 PMI.

"Post-decay" stage: Beetles come to feed on the remains. Depending on weather conditions, it represents days 10–25 or more PMI.

Recommended Resources

- Forensic Insect Identification Cards (By Castner and Byrd) - Available from Feline Press, P.O. Box 357219, Gainesville, FL 32635; 352-371-6439; or **http://www.FelinePress.com**.
- Carloye, Lisa. Of Maggots and Murder: Forensic Entomology in the Classroom. The American Biology Teacher, Volume 65, No.5, May 2003 (pp. 360–366).
  This article contains scenarios of 4 Murder investigations. Youth solve with the materials provided in (and indicated by) the article. Helpful background information and tables are provided. An adaptation of this article and activity can be found at ***http://ipm.ncsu.edu/4-H/CSIfinal.pdf****.*

Activity 1

Advanced Preparation—You will need to prepare the insect jars for this activity over the course of the two weeks immediately prior to performing this activity. Every four days (Day 1, 5, 9, and 13), place approximately 1/2 pound of chicken livers inside a new container. Place these open containers outside (in the same general location) for 30 minutes in order to attract insects to the meat. Be sure to place the containers in a location where raccoons and other animals cannot access the meat.

Materials for Creating Insect Jars

- Fresh chicken livers (1/2 pound should be plenty - Can be purchased at most grocery stores in the meat department, though you may have to ask for them).
- Four large glass jars or plastic containers of similar size (with lids)
- Labels/Permanent marker

Materials for Activity

For Each Youth

- Handout 1.1 (both sides, copy double-sided)
- Handout 1.2
- Pencils

For Each Jar

- Four sheets of wax paper
- Insect collecting vials or film canisters
- Tweezers (forceps)

After 30 minutes, return the container to the indoors and cover. The cover should allow for some ventilation, but not access by other insects. At the conclusion of the two weeks, you will have four distinct containers with different stages of insect attraction, growth, and decomposition of meat. In no particular order, label each numerically.

Note to the Leader

As a contingency plan for problems that may arise with time of year, weather, or other issues, the forensic experiment can be conducted outdoors prior to the lesson date and then labeled and frozen until use. This approach might also be taken to supplement the conduction of the experiment by the students, or to add other special scientific or "diabolical" treatments to the experiment. Then, relate the changes to how a criminal might try to counteract the normal forensic data and mislead an investigator. Discuss how an investigator might use his knowledge and the data to discover and interpret these diabolical schemes.

Some ideas for special treatments:

- Add ethyl alcohol (or other preservative) to the jar and compare what happens to this treatment versus the untreated jars.
- Subject a jar to higher or lower temperatures for a day or so indoors before freezing to compare the effects on insect growth and survival.

During the Activity:

Outside: If you gained permission from school administration regarding setting up the crime scene on school grounds, take the four jars and hang them from a tree somewhere on school property. Be sure this place is in a location where other youth in the school would not normally travel, and where wild animals will not bother the scene.

Inside: If permission was not granted, simply bring the four jars to the classroom or meeting area where youth will be able to observe the differences between the jars.

Do not discard these four jars— you will need them for later activities.

Let's Begin

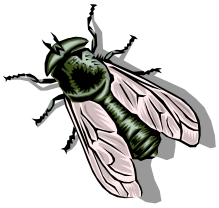
Begin today's activity by taking youth to the location of the jars (either **outside** or **inside**). Divide youth into four groups (hopefully between 3–5 youth per group). Each group should start at a different jar. Ask them to use their senses (what they see, smell, hear) to describe what is going on in the jar. However, do not allow them to touch the jar. Have youth record their observations in the appropriate place on their handout.

After five minutes, have them rotate to the next jar. Have them observe what is going on in the second jar (just as they did in the first). Repeat the process until they have observed each of the four jars.

Once youth have made their observation at the final jar, have them gently pour the contents out onto a sheet of wax paper. Youth will now have the opportunity to inspect the insects that are in the sample. Using the tweezers and insect collecting vials, have youth collect and count the insects from that jar. Ask them to be as descriptive as possible as they collect and count these insects. Encourage them to figure out at least one way to categorize or sort the insects as they are collecting them.

***NOTE**: Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their "files."*

Let's Reflect



- After you observed the first jar, what did you expect to see in the other jars?
- Which jar would you say had the most insect activity? The least?
- Describe the differences between the four jars.
- Describe anything that surprised you while you were doing this activity.
- What would you say was the most difficult part of this activity?
- How did you and your group decide how to collect, categorize, and count the insects from your final jar?

Let's Apply

These jars were all placed outside in order to attract insects. Each one was placed in the same location, but at different times. One was put outside on Day 1, another was put out on Day 3, another on Day 5, and the last on Day 7.

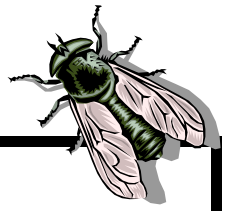
- Based on your observations, which jar do you think was from Day 1? Why do you think that is?
- Which one do you think was from Day 5? How do you know this is not from Day 3?
- How do you think these jars might be different if they had all been placed in different locations?
- There are many occasions where you have to work in teams or groups. Sometimes groups have problems. Did your group have any problems working as a team? How did you work through those problems to finish the task?

EXTENSION ACTIVITIES

Youth may want to try this same activity at home over a longer period to see more distinct differences between the jars. They can elect to change other variables (location, time of day, wrapping the meat in cloth, etc). Have them record their findings and report back to the group. Be sure they include what variable they chose to change, what they observed, and what they might conclude from those observations.

Handout 1.1

Insect Investigation...



What I Saw:

What I Smelled:

What I Heard:

What I Saw:

What I Smelled:

What I Heard:

What I Saw:

What I Smelled:

What I Heard:

What I Saw:

What I Smelled:

What I Heard:

Now, for A Closer Look...

Which was your final jar?

What I Saw:

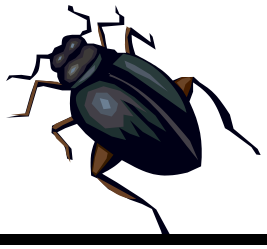
What I Smelled:

What I Heard:

Possible Categories:

Insect Count from this Jar:

What "PMI Stage" would you guess for the meat from this Jar? (Use Handout 1.2)



How did you reach your conclusion?

Handout 1.2

Did You Know…

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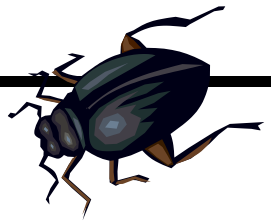

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The "Decay" stage: This is when the decay of a body really starts to smell bad. By the end of this stage, most maggots have finished development and begin to leave the body to find a place to pupate in the soil. The corpse becomes devoid of all flesh, except cartilage, bone, and skin. Depending on weather conditions, it represents days 5–11 PMI.

"Post-decay" stage: Beetles come to feed on the remains. Depending on weather conditions, it represents days 10–25 or more PMI.

First Use of Forensic Entomology

LESSON 2

Grade Levels: 6–8
Subjects: Science
Setting: Indoor

Time Needed:
20–30 minutes

Science Skills:
Communication
Inference

Life Skills:
Teamwork
Problem solving
Communication

Materials Needed:
Activity 2
- Paper
- Pencils
- Handout 2.1

Vocabulary

Forensic Entomology—using insects to solve crimes

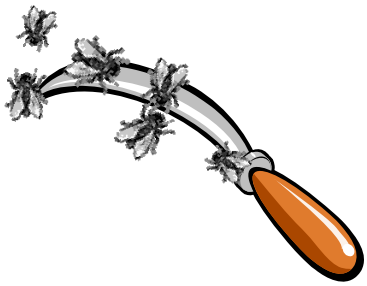
Sickle—a rounded tool made of wood and metal; used for harvesting rice

Inference —explanation or interpretation of an observation

Sunshine State Standards:
SC.(5,6,7).1.1
SC.4.N.1.6

Main Idea

This lesson provides the story of the very first recorded use of insects as a forensic tool.



Objectives

Youth will be able to:

1. Use the skill of inference to solve a problem in a small group.
2. Communicate with groups members to solve a murder case.
3. Cooperate in a small group to solve a problem.
4. Practice accurate note-taking from a case read aloud.
5. Demonstrate that a change in one or more variables can alter the outcome of an investigation.

Background Information

What is the HISTORY *of forensic entomology?*

Forensic entomology was first documented in China in 1235 A.D. in the book entitled *The Washing Away of Wrongs: Forensic Medicine in Thirteenth Century China* (University of Michigan, Ann Arbor, MI). See the case covered in this lesson for more information.

In 1668, Francesco L. Redi (1668) studied rotting meat that was either exposed to or protected from flies. From his analysis of blow fly infestations, he refuted the hypothesis of the "spontaneous generation" of life. Up to that time, it was generally believed that maggots were produced from rotten meat (in reality, they are hatched from eggs which are laid on a rotting carcass by flies).

French scientists Bergeret, Brouadel, Yovanovitch, and Megnin introduced forensic entomology into Europe during the 19th century. Forensic entomology did not reach the United States until 1898, when Dr. Murray Motter examined the stages of decomposition and insect succession on buried human remains. Not until 1963 was forensic entomology revisited in the United States. Dr. Jerry Payne conducted decomposition research with pig carcasses, and his work is still highly regarded today. During the 1980's, forensic entomology "exploded" in the U.S., as more and more scientists have examined insects that colonize carrion. The University of Tennessee has a long-term research program focusing on the factors affecting the decomposition of the

Activity 2

Materials for Activity
For Each Youth
- Paper
- Pencils

Following the Activity, provide youth with Handout 2.1

Instructor Reads:

Many of the skills that you just practiced in this activity (making observations, taking notes, working as a team, even counting insects) all are very important skills in the science of Forensic Entomology. Can anyone tell me what forensic entomology means? *You can give the youth hints such as "What does "forensic" mean?"; "What is entomology?"; "Have you seen the TV show CSI before?" It may be helpful to make a concept map or a list of the responses on a board or overhead projector.*

Let's Begin

Divide youth into groups of 2–4. These will be their brainstorming groups for the case. Each youth will need a piece of paper and a pencil/pen. Then read the following:

I am going to tell you the story of the first forensic entomology case ever recorded. Your groups will be groups of investigators that determine the best plan of action based on the evidence provided. When I ask you to stop and discuss or brainstorm the case, I expect each group member to participate in the discussion. As I am reading the case, please write down anything that stands out as important information to you, and share this information with members of your group.

"In 1235, a crime occurred in a village in China. The crime? Murder. *The weapon?* A sickle*, a rounded tool made of wood and metal, used for harvesting rice. The villagers called on the local death investigator to solve the crime.*"

Brainstorm with your group how you think the death investigator could solve this crime. *Give youth 5ç10 minutes to complete their group's response. Allow each group to share.*

"After some fruitless questioning, the investigator had all the villagers bring their sickles and lay them out next to each other on the ground before a crowd."

How do you think this helped the death investigator solve the crime? *Give youth 5 minutes to come up with a new theory.*

"There are probably many ways to solve this case, but the way it really happened was this—at first, it looked to the observers like none of the sickles had incriminating evidence. However, after a moment, flies were attracted to one of the sickles."

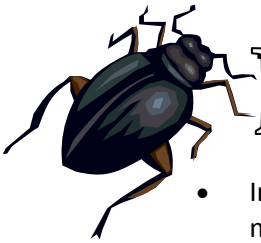
Why do you think this happened? *Allow 5 minutes of small group discussion time, then have small groups share answers with larger group.*

After the youth have shared their answers, tell them that the flies were probably attracted to the sickle because of the odors coming from the invisible remains of tissue and blood still adhering to it, even though the sickle had been wiped clean. Confronted with such evidence, the sickle's owner broke down and confessed to the murder. *This case is documented in The Washing Away of Wrongs, a book written in 1235 A.D. by Sung Tzu, a Chinese "death investigator."*

Handout 2.1 provides a copy of the story for each youth to keep.

Let's Reflect

- Did other people in your group come up with the same ideas as you, or did they bring new ideas to the group? In other words, how did you use cooperation to come up with ways to solve the case?
- Why was communication important in your group's efforts to solve this case? Would you have been able to share what you were thinking without successful communication? If you had been able to speak with the murder suspects or witnesses in this case, how would good communication skills have helped you?
- What does it mean to *infer* something? How is an inference different than an observation?
- What is an inference you made in the case today? *(What a youth would have done if they were an investigator based on the evidence provided.)*



Let's Apply

- In a murder case today, do you think experts are all called in from the same area of expertise, or are many different people with different talents chosen? For example, would you need a team of five fingerprint experts for this case, or would you require a diverse group of experts?
- In a murder case today, why would communication be so important?
- Describe a time when you have to make an inference about something.
- Describe a time when you had to solve a problem or mystery. What types of skills did you need to solve that problem or mystery?
- What do you think are some of the skills a forensic entomologist needs in order to solve mysteries?

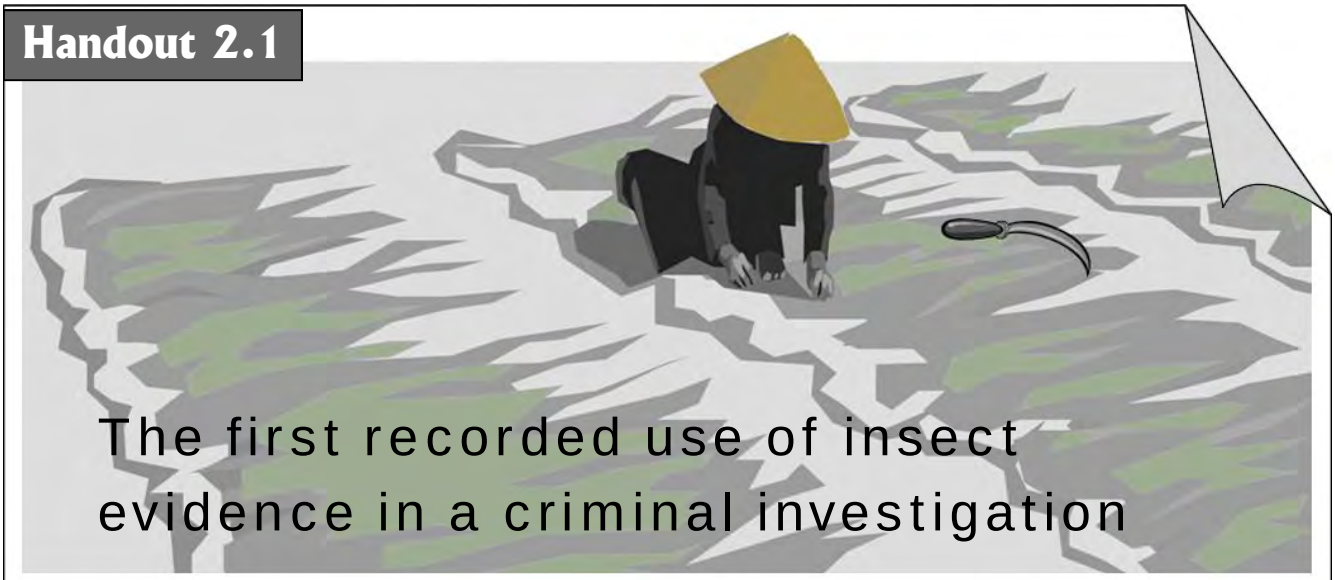
EXTENSION ACTIVITIES

Have youth act out this entomology case (not the murder, but the proceedings after the murder).

Possible Roles: *investigator, judge, suspects with sickles, flies, and villagers.*
Props: *magnifying glasses, plastic swords (sickles), gavel, rice picker hats, fly costumes.*

Reenact the scene by smearing several identical utensils (forks or spoons) with a bloody piece of meat. Then clean the utensils and place on a piece of cardboard. Ask youth to identify which one they think is the "guilty" utensil. Place the utensils outside and allow nature to tell which utensil committed the crime.

Handout 2.1



The first recorded use of insect evidence in a criminal investigation

Setting: Rice Field in China

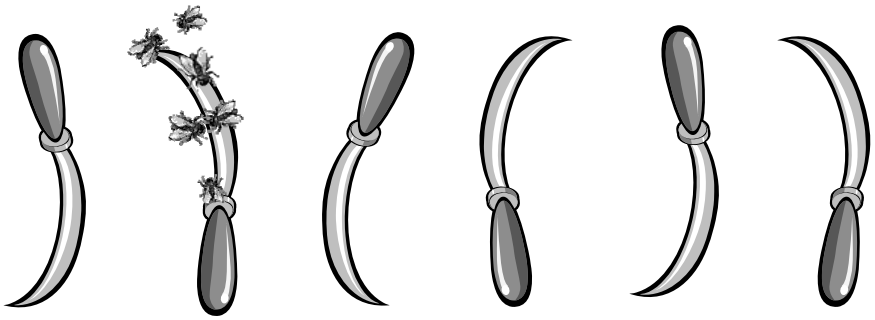
Year: 1235

The crime: Murder (stabbing) of a farmer

The weapon: Sickle - a rounded tool made of wood and metal, used for harvesting rice

Investigator: Sung Tzu documented in 'The Washing Away of Wrongs'

The case: The local magistrate (judge) suspected that a sickle had been used, but no one confessed to the crime. The day after the murder, the investigator told all workers to lay down their working tools (sickles) on the floor in front of them. Invisible traces of blood drew blow flies to a single sickle, even though its owner had wiped it clean. Confronted with such evidence, the sickle's owner confessed to the murder.



Tools of the Trade: INSECTS

LESSON 3

Grade Levels: 6–8
Subjects: Science
Setting: Indoor

Time Needed:
50 minutes

Science Skills:
Communication
Classification

Life Skills:
Problem solving
Communication

Materials Needed:
Carcass Crazy
For each small group…

- Game board (available on the project web site, copied on 11x17 paper)
- One dice
- Card set (Red Cards)
- Card set (Yellow Cards)
- Game pieces (pennies, dried beans, etc)

Sunshine State Standards:
SC.4.L.16.2
SS.6.W.1.1

Main Idea

This lesson provides an overview of the most important tool of the trade for forensic entomologists - INSECTS. Topics include a discussion of important insects to the field of forensics.

Objectives

Youth will be able to:

1. Identify insects that are important to the field of forensics.
2. Determine the stage of PMI based on the insects present.

Background Information

Forensically Important INSECTS

Flies: Often the first insect to arrive to the scene. Some of the more forensically-important members of this group include **blow flies** (can smell death up to ten miles away), **flesh flies** (often lays eggs in open wounds of mammals), **cheese flies** (do not take up residence in a corpse until three to six months after death) as well as others.

Beetles: Generally found on the scene when decomposition is more advanced. Some of the more forensically-important members of this group include **rove beetles** (common only during later stages of decomposition), **hister beetles** (among the first beetles to arrive at a corpse), **skin/hide beetles** (important in the final stages of decomposition because they are the only beetle with the enzymes necessary for breaking down dried skin, hair, tendons, and keratin), as well as others.

Moths: Closely related to butterflies, moths are important in the final stages of decomposition.

Mites, Wasps, Ants, and Bees: Found at the scene, but often because they are feeding on fly eggs and larva. This can lead to incorrect PMI estimates.

Activity 3

Advanced Preparation - You will need to make game boards and card sets for each small group. You may want to make multiple copies of the card sets (red and yellow) for each group so that they have plenty of cards doe continued play. The 11x17 game board and card sets are available at http://florida4h.org/projects/forensics.shtml.

Carcass Crazy
For each small group...
- Game board (available on the project web site, copied on 11x17 paper)
- One dice
- Card set (Red Cards)
- Card set (Yellow Cards)
- Game pieces (pennies, dried beans, etc)

Read the following:

You have now heard the story of the first forensic entomology case ever recorded. In that story it was the flies that gave the observer the answer he was looking for. However, many other insects can also help investigators solve mysteries of their own.

Today, in order to solve a mystery using forensic entomology, it is important to have several pieces of evidence. What do you think some important pieces of evidence might be? *Answers may include type of insect, stage of life, location.* **Forensic entomologists do need to know the type of insect, what stage of life it is in, where the insect is usually found, and a lot more. But let's begin with the basics: what is an insect ,and what are some of the insects that help out in forensics?**

Let's Begin

Carcass Crazy Board Game

The object of the game is for youth to learn about some of the important insects in forensics as they travel around the board. To win the game, youth must travel around the board and reach the carcass at the end.

Read the following instructions to youth:

Separate into small groups (between 4–5 youth per group*). Each group receives one game board, one dice, game pieces, and a set of cards. *You can double these numbers for larger groups (or if you have limited resources). Simply have youth pair up and work as a team.

The first youth rolls the dice. The youth moves that number of spaces and then draws a card from the corresponding pile.

If you land on a red square, draw a red card and then reads your card aloud.

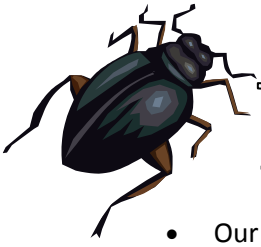
If you land on a yellow square, the person to your LEFT will draw a card for you from the yellow card set. That person then asks you the question on the card. If you get it right, you can roll again. If not, you have to wait until your next turn.

Be sure to remind youth to pay attention as everyone reads red cards since they contain the answers needed to complete the questions on the yellow cards. **The person to the right of the first person then repeats this process. Whoever gets to the carcass at the end of the board first is the winner!**

***NOTE**: Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their "files."*

Let's Reflect

- What are some of the insects that are important to the field of forensics?
- You have learned that certain insects arrive at different times over the course of decomposition. Construct a timeline or chronology of insect arrivals.
- Which are the first to arrive on the scene?
- Which arrive towards the end of decomposition?
- Why is it important to be able to identify which insects are found on a corpse?
- How can the counts of insects at a crime scene be affected by the environment?



Let's Apply

- Our insect timeline provides a way to know what to look for. What are some other ways that a scientist might use a timeline to discover what is going on?
- Forensic science uses lots of critical thinking and problem solving skills to solve a case. In what areas of your life are you able to use critical thinking and problem solving skills?
- How do you think scientists are able to look at something critically and objectively, and avoid emotional bias?
- Why would avoiding emotional or other types of bias be important when trying to solve a case?

EXTENSION ACTIVITIES

Have youth create their own game to educate others about some aspect of forensic entomology.

Have youth research additional insects or other environmental factors that are important to practitioners in the field of forensics.

RED CARDS

Blowflies are often the first insects at a crime scene because they can smell death up to ten miles away.	**Skin/hide beetles** are important in the final stages of decomposition because they are the only beetle with the enzymes necessary for breaking down dried skin, hair, tendons, and keratin.
Flesh flies arrive early at a crime scene and often lay their eggs in open wounds on mammals.	**Hister beetles** are among the first beetles to arrive at a corpse.
Cheese flies tell a lot about the timing of an old crime scene because they do not take up residence in a corpse until 3 to 6 months after death.	**Moths** are closely related to butterflies and are important in the final stages of decomposition.
Rove beetles are common only during the later stages of decomposition.	**Mites** can be found at any time on the scene. Some are feeding on the corpse, while others are feeding on fly eggs and larva. This can lead to incorrect PMI estimates.

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Wasps and bees can be found at any time on the scene. Some are feeding on the corpse, while others are feeding on fly eggs and larva. This can lead to incorrect PMI estimates.	**Wild or domesticated animals** can interfere with the crime scene by moving the corpse or consuming parts of it.
Temperature and climate can affect the amount of insect activity at a crime scene. Production of blow fly eggs will be lower at lower temperatures.	
Limited access to the corpse affects which insects are able to be found. If the corpse is submerged, then evidence of terrestrial (land) insects should be minimal.	
Clothing or coverings affects how quickly a corpse decomposes, thereby changing how many insects may be found at a given time. A tightly wrapped corpse will decompose at a slower rate and have less evidence of insect activity.	

YELLOW CARDS

Which insects are often the first insects at a crime scene because they can smell death up to ten miles away? **Answer: Blowflies**	Which beetles are important in the final stages of decomposition because they have enzymes necessary for breaking down dried skin, hair, tendons, and keratin? **Answer: Skin/hide beetles**
Which insects arrive early at a crime scene and often lay their eggs in open wounds on mammals? **Answer: Flesh flies**	Which beetles are among the first insects to arrive at a corpse? **Answer: Hister beetles**
Which insects tell a lot about the chronology of crime scene because they do not take up residence in a corpse until 3 to 6 months after death? **Answer: Cheese flies**	Which insects are closely related to the butterfly and are important in the final stages of decomposition? **Answer: Moths**
Which beetle is common only during later stages of decomposition? **Answer: Rove beetles**	Name one insect that can be found at any time on the scene with some feeding on the corpse, while others are feeding on fly eggs and larva. **Answer: Mites, wasps, or bees**

Name three insects that can cause forensic entomologists to determine incorrect PMI estimates. **Answer: Mites, wasps, and bees**	Why is constructing a timeline or a chronology of crime scene events important and useful? **Answer: To better understand how the events of a crime unfolded.**
Explain how temperature and climate can affect the amount of insect activity at a crime scene. **Answer: Low temperatures often reduce the production of blow fly eggs.**	
Explain how limited access to the corpse affects the ability of insects to find a corpse. **Answer: If the corpse is submerged, then evidence of terrestrial (land) insects should be minimal.**	
Explain how clothing or coverings affects how quickly a corpse decomposes. **Answer: A tightly wrapped corpse will decompose at a slower rate and have less evidence of insect activity.**	

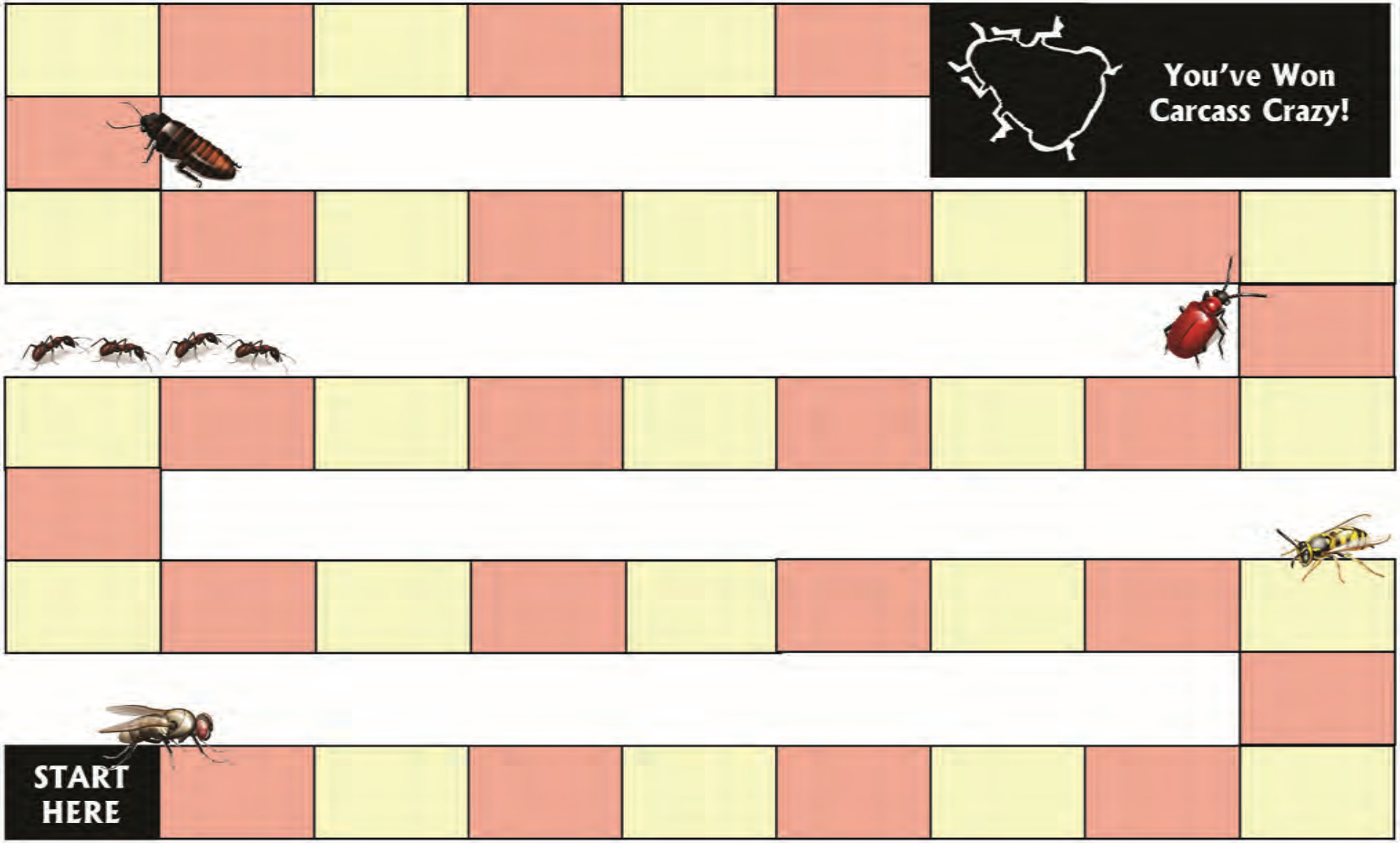

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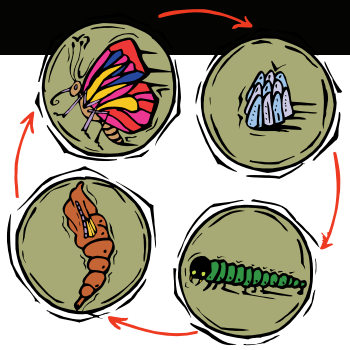
Image of Carcass Crazy Game Board

Available at the project website: www.florida4h.org/projects/forensics.shtml

Tools of the Trade: METAMORPHOSIS

LESSON 4



Grade Levels: 6–8
Subjects: Science
Setting: Indoor/Outdoor

Time Needed:
50 minutes

Science Skills:
Communication
Classification

Life Skills:
Problem solving
Communication

Materials Needed:
Foldables
For each youth…
- Handout 4.1 (both sides copied double sided)
- Books about insects or internet access for researching insect metamorphosis
- Miscellaneous materials for creating an educational activity
- Scissors
- Pencils
- Crayons or colored pencils

Just For Fun
For each youth…
- Handout 4.2 (double-sided)

Sunshine State Standards:
LA.(5,6,7).4.2.1
LA.6.3.1.1
LA.8.5.2.4
SC.4.L.16.4

Main Idea

This lesson continues the insect overview with a discussion of the processes they go through as they grow from egg to adult.

Objectives

Youth Will be Able to:

1. Differentiate between incomplete and complete insect development.
2. Illustrate the life stages of each type of development.
3. Give an insect example for each type of development.

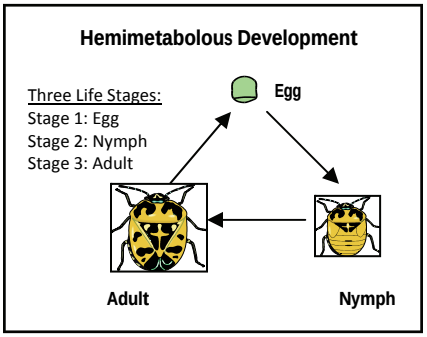
Background Information

Understanding METAMORPHOSIS

Metamorphosis

The term "metamorphosis" literally means "change" and refers to the way that most insects grow, develop, and change forms. There are two types of metamorphosis, incomplete and complete, although some insects do not have a metamorphosis at all.

In **incomplete metamorphosis**, the insect goes through three life stages: the egg, the juvenile stage, and the adult stage. Juvenile insects with this type of metamorphosis are called **nymphs**. Nymphs are typically small versions of the adult but lack wings. They often eat the same food as the adult. As they grow, they molt, or shed, their exoskeletons and replace them with larger ones. Grasshoppers, true bugs, and dragonflies are all examples of insects with an incomplete metamorphosis. These types of insects are called **hemimetabolous** (hemi =partial, metabolous = changing) insects because they only go through a "partial change."



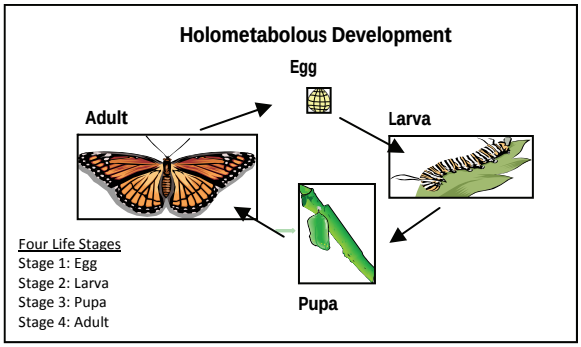
Background Information (continued)

Vocabulary

Complete Development - also called holometabolism or complete metamorphosis; the act of undergoing complete change within a life cycle; characteristic stages: egg-larva-pupa-adult

Incomplete Development - also called hemimetabolism or incomplete metamorphosis; the act of undergoing a partial change within a lifecycle; characteristic stages: egg-nymph-adult

Almost 90 percent of insect species have **complete metamorphosis**, or four life stages: the egg, the juvenile stage (called the **larva**, plural larvae), an intermediate stage (called the **pupa**, plural pupae), and the adult stage. Most larvae are somewhat worm-like and tend to look very different from the adults. Caterpillars, grubs, and maggots are all larval insects. As the larva grows, it sheds its exoskeleton and grows slightly larger. In the pupal stage, insects do not eat as their bodies develop into an adult shape with wings, legs, internal organs, etc. This change takes anywhere from 4 days to many months. After that time, the adult insect emerges from its pupal case. Examples include beetles, flies, bees, ants, and butterflies. These insects are called **holometabolous** (holo = complete, metabolous = changing) insects because they go through a complete change.



Why complete metamorphosis?

One common question that people ask when the topic of insect growth and development comes up is "Why do so many insects have such complicated life cycles?" There is no easy answer to this question, but a major reason probably has to do with competition. In hemimetabolous insects, the nymphs are basically just miniature adults, living in the same area as the adults and filling the same ecological niche. They must therefore compete for the same resources, including food and space. In contrast, during holometabolous development, juvenile insects are so different from the adults that they do not compete with each other. Often they live in different areas and eat different food. For example, caterpillars generally eat plant foliage, while adult butterflies drink nectar.

In addition, there is a division of labor of sorts for holometabolous insects. The juvenile insects are specialized to be eating machines. Their "job" is to eat a lot so that they can grow quickly. Adults need to find a mate and reproduce. They are specialized for reproduction, and some do not even have mouthparts. Although only adult hemimetabolous insects reproduce, their body plan is not as highly specialized as it is in holometabolous insects. This division of labor gives holometabolous insects a selective advantage.

Another advantage is that in colder regions, insects are better prepared to survive the winter if they have a pupal stage. Unlike juveniles and most adults, pupae do not have to find food. The pupae often burrow in the ground over winter and emerge in the spring as adults. Some insects actually must experience a freeze as a pupa before they are able to emerge.

These Background Basics are excerpts from *ABCs of Entomology*, Florida 4-H. For more information on this in-depth entomology curriculum, visit the project website at http://florida4h.org/projects/entomology_group.shtml.

Activity 4

Read the following:

You now know which insects forensic entomologists find most helpful. But while you were playing the Carcass Crazy game you learned some facts about eggs and larvae. You also heard about some of these stages when looking at the PMI.

Insects go through particular life stages often over a definite time period. So, let's take a closer look at these stages of life for some of the different insects we have studied so far.

Materials for Activity

Let's Get Living

For each youth...

- Handout 4.1a (both sides copied, double-sided)
- Books about insects or internet access for researching insect metamorphosis
- Miscellaneous materials for creating an educational activity
- Scissors
- Pencils
- Crayons or colored pencils

Just For Fun

For each youth...

- Handout 4.2 (double-sided)

Let's Begin

Let's Get Living

To reinforce knowledge of both development processes, youth will create educational tools for use in teaching others about the details of metamorphosis and the importance of insect life stages in forensic entomology.

Have youth begin this activity by getting into pairs. Have each pair choose three forensically important insects to research (from the ones studied in the previous lesson or others they have discovered through their own research).

Just for Fun: Which Insect Are You? Self-Quiz

Have youth take quiz (Handout 4.2) as a warm-up or short class activity. Take an informal poll to see which insect "personality" type was most common.

Once they research their three insects, have youth think about the type of educational tool they are going to create. This could be a skill-a-thon, an electronic game board, an illustrated poster or brochure, or some other game that teaches the concepts they have chosen to share with others. After youth have made their decisions, have the pairs use books or the Internet to research the information they will need. Be sure to encourage youth to research the stages of life for each of their insects, as well as the importance of those insects to the world of forensic entomology and any other facts they may want to include within their project.

Have youth use the sections on the front of Handout 4.1 to guide their thoughts when creating their project. They can then use the rubric questions on the back of Handout 4.1 to help them determine if their project will accomplish all the necessary goals.

***NOTE**: Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their "files."*

Let's Reflect

- What is the difference between complete metamorphosis and incomplete metamorphosis?
- What is one example of an insect that goes through complete metamorphosis? Incomplete?
- Have you ever been able to actually see an insect in each of the stages of life? Tell us what you saw or experienced.
- What educational tool did you choose to create? Why did you choose that one?
- What did you think was the hardest part of the project? How did you overcome those difficulties?
- What changes would you make now that the project is complete and you've seen what others have created?

Let's Apply

- This activity asked you to be part of a team. Why do you think it is important to know how to be part of a team?
- What skills do you think are important for you to use when you are on a team?
- Think about your life. If you had been an insect, what type of metamorphosis would you have gone through? Why did you choose that one?

EXTENSION ACTIVITIES

Allow youth to experience first hand the stages of metamorphosis. You can either have youth capture caterpillars or you may choose to order a butterfly kit (which often comes with butterflies in the larval stage). Have them keep a record of their observations. An easy method to obtain insect eggs is to use the porch light or a blacklight to attract insects at night. Female moths that come to the lights can be captured and placed in a brown paper bag. If they have eggs they will lay them inside the bag. Make sure to identify the moth collected so that the host plant they feed on can be determined and also used to raise the larvae.

Have youth create a skill station using either the information from the Life Stages Activity or from the Insect or Non-Insect Activity.

Handout 4.1

My Insect Information

Which educational tool are you planning to create?_____

Insect #1:_____

Type of Metamorphosis: ☐ Complete ☐ Incomplete

How are the stages of metamorphosis for this insect important to forensic entomology?

Other interesting details/facts about this insect:

Insect #2:_____

Type of Metamorphosis: ☐ Complete ☐ Incomplete

How are the stages of metamorphosis for this insect important to forensic entomology?

Other interesting details/facts about this insect:

Insect #3:_____

Type of Metamorphosis: ☐ Complete ☐ Incomplete

How are the stages of metamorphosis for this insect important to forensic entomology?

Other interesting details/facts about this insect:

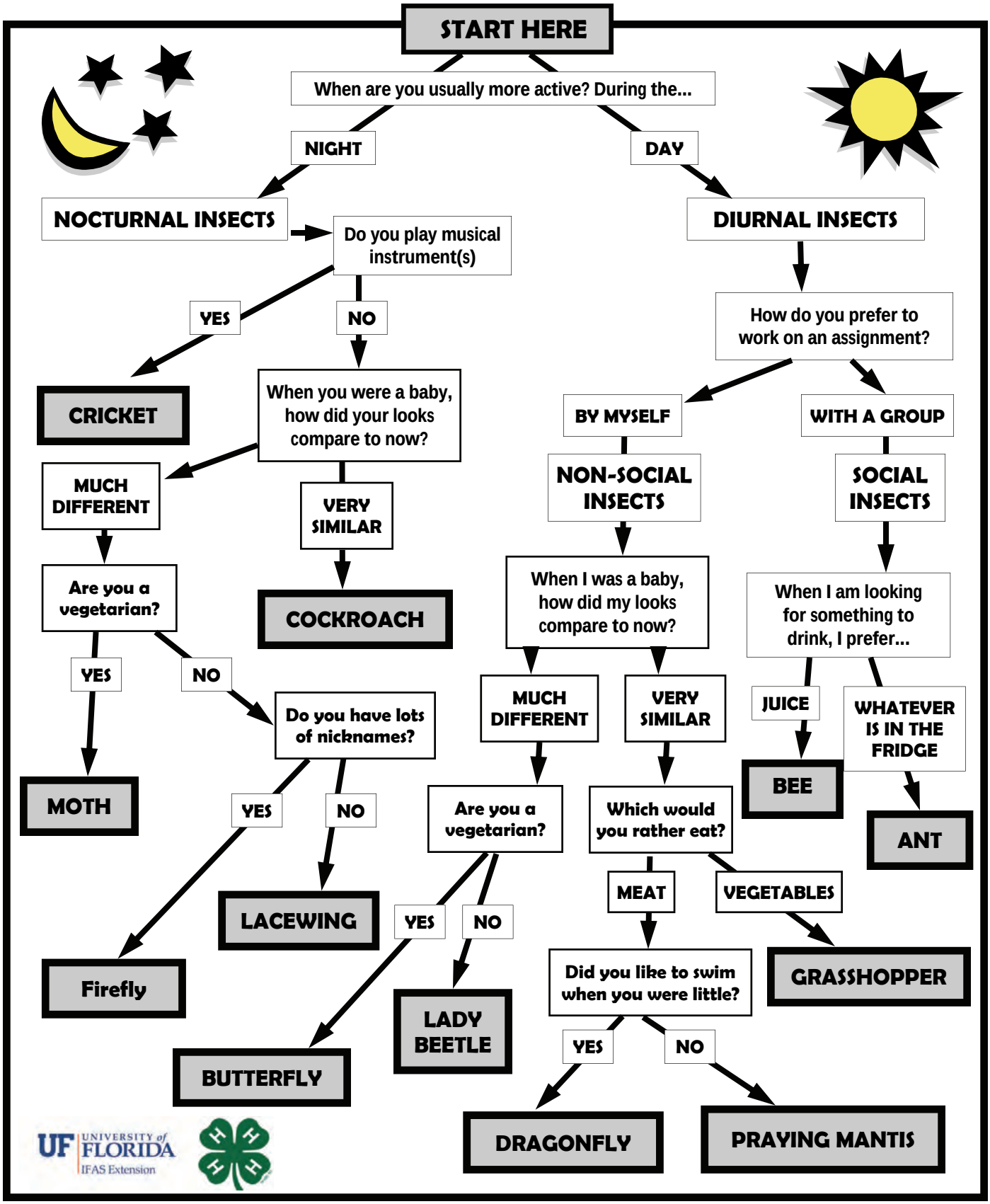
Rubric Questions

Determine whether your project is ready to use by asking these questions. Place a check mark (✓) next to any question you can answer yes to!

- ☐ **Did we include information about ALL THREE insects?**
- ☐ **Does our project help others learn about the stages of metamorphosis AND how these insects are important to forensic entomology?**
- ☐ **Is our project fun and interactive? Would we enjoy using this to learn about metamorphosis and the importance of these insects to the world of forensic entomology?**
- ☐ **Is our project educational? Did we use resources that were reliable and were they accurate sources of information?**

Handout 4.2

IF I WERE AN INSECT, I WOULD BE ...



SO, WHICH INSECT WERE YOU?

ANT- Most active during the day (diurnal), works with other members of community to achieve a common goal (social), will eat most anything

BEE- Most active during day (diurnal), works with other members of community to achieve a common goal (social), eats pollen and nectar

BUTTERFLY- Most active during day (diurnal), vegetarian (drinks nectar), young looks completely different than adult (holometabolous: think caterpillar vs. butterfly)

CRICKET- Most active during night (nocturnal), makes "music" by rubbing hind leg against wing

COCKROACH- Most active during night (nocturnal), young looks similar to adult (hemimetabolous)

DRAGONFLY- Most active during day (diurnal), aquatic nymph (baby), young looks similar to adult (hemimetabolous)

FIREFLY- Most active during night (nocturnal), eats other insects, snails, etc. (carnivorous), young looks very different from adult (holometabolous). Fireflies have many nicknames: they are actually beetles and not flies at all, and are called lightning beetles, lightning bugs, blinkie-wallies.

GRASSHOPPER - Most active during day (diurnal), vegetarian (mostly eats...you guessed it—grass!), young looks similar to adult (hemimetabolous)

LACEWING - Most active during night (nocturnal), carnivorous, young looks very different from adult (holometabolous)

LADY BEETLE- Most active during day (diurnal), carnivorous, young looks very different from adult (holometabolous)

MOTH - Most active during night (nocturnal), vegetarian, young looks very different from adult (holometabolous)

PRAYING MANTIS - Most active during day (diurnal), land nymph, young looks similar to adult (hemimetabolous)

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Tools of the Trade: INSECT COLLECTION

LESSON 5

Grade Levels: 6–8
Subjects: Science
Setting: Indoor/Outdoor

Time Needed:
1 or 2 50-minute blocks depending on activity chosen

Science Skills:
Observation
Communication
Classification
Acquiring Data

Life Skills:
Teamwork
Problem solving
Communication

Materials Needed:
Collect as many of the following items for display...

- Net
- Sticky Traps
- Vials/Kill Jars
- Preservation Chemicals: Ethyl Alcohol and Acetone
- Latex Gloves
- Forceps
- Live Specimen Containers
- Sifting Screens
- Death Scene Form

Materials needed for each activity are listed next to the activity instructions.

Sunshine State Standards:
SC.(5,6,7).N.1.1

Main Idea

This lesson introduces youth to the ten basic rules for insect collection as well as the basic tools of the forensic entomologist.

Objectives

Youth will be able to:

1. Discuss the Ten Basic Rules of insect collection.
2. Explain the use for each of the basic tools used by entomologists in the collection of insects.

Background Information

Understanding the COLLECTION PROCESS

Insect Collections

At a crime scene, forensic entomologists begin their processing of the scene by collecting adult insects in the area. The most common method uses nets, although sticky traps placed near the corpse can be used as well. By collecting adult insects, forensic entomologists are able to determine what species may be on the corpse in larval form.

The next step is to collect larvae in order to determine PMI. Orifices on the body (eyes, ears, nose, anus, and mouth) as well as any open wounds are good places to look for eggs and larvae. Larvae species each have unique migration patterns when they migrate away from their original food source in order to pupate. So it is important for the forensic entomologist to not only collect larvae from around the body itself, but also underneath.

Overall, a forensic entomologist collects two samples from around the corpse. The first set of insects are used for immediate observation. These are preserved using boiling water and "kill jars," or ethyl acetate. The second set are allowed to remain alive in order to grow for larval or pupal identification. Both of these methods help provide a positive identification for the insect genus and species. With all these details, it is easy to see why one of the most important parts of a forensic entomologist's job is documentation.

Background Information (continued)

The Ten Basic Rules of Insect Collection

Mark Benecke, a forensic biologist, developed the following basic guidelines for arthropod collection:

1. Take very good close-up photographs of all locations from where animals are collected. The state of insect-aided decomposition can severely change within days, even under cool conditions, and even when the body is stored in a cooling apparatus. Also, bites of mites should be documented on living persons (e.g., possible offenders).

2. Photograph without a flash. Maggots will "flash out," which means they become "just white nothings," especially on digital photographs.

3. A metric *and* an inch scale should always be used on every picture. (This helps investigators indicate the relative size or scale of the contents. A coin may suffice if a ruler is not available.)

4. Collect one spoonful of insects from at least three different sites on the corpse and around the crime scene in three different, clearly labeled jars.

5. Put half of the insects in 98% ethanol. Cheap ethanol (i.e., methylated spirit for camping purposes) can be used without any problems. Neither isopropyl alcohol ("hand cleaning alcohol") nor formalin should be used! Killed insects can be stored frozen with or without ethanol.

6. Attempts should be made to kill the animals with hot water ("tea water") before placing them in ethanol.

7. If possible, put half of the insects alive in a refrigerator (not a freezer). Put fabric on top of their open-lid containers so the insects can breathe. Maturing might become an issue, so forward the animals to a biologist within 1 or 2 days. Keep white larvae separate from brownish larvae and separate larvae from adults if possible.

8. Label excessively: location, exact time, date, initials.

9. If questions arise during collection, a forensic entomologist should be called.

10. Determination (i.e., identification of the arthropod species) *must* be performed by an experienced entomologist using keys that can be applied to the local fauna. However, for many regions of the world, appropriate keys are not yet available. Some forensic entomologists determine third instar larvae of known maggot species by the characteristics of the maggot's mouth parts.

Tools of the Trade

Forensic entomologists use a variety of tools to determine post-mortem interval:

* Net
* Sticky traps
* Vials/kill jars
* Preservation chemicals such as Ethyl alcohol and acetone
* Latex gloves
* Forceps
* Live specimen containers
* Shovel
* Thermometers
* Labels (adhesive)
* Small paint brushes
* Foil
* Vermiculite and food
* Graphite pencil
* Hand towel
* Camera
* Ruler
* Paper towels
* Sifting screens
* Death scene form

Activity 5

Read the following:

You have learned about which insects forensic entomologists find most helpful as well as the stages the insects go through as they change from eggs to adults.

Now, when forensic entomologists arrive at a crime scene, they are able to put all that knowledge to work as they collect the specimens that will help them solve the PMI mystery. This lesson is going to take us through the Ten Basic Rules for Insect Collection while also examining some of the other common tools forensic entomologists use in this process.

Materials for Activity
It's A Snap
Time: Two 50-minute blocks if youth are allowed to create digital presentations of their findings on site

For each youth...
- Handout 5.1

For each group...
- 1 of the four jars from Activity 1
- Digital camera
- Metric and inch scale
- Time in the computer lab to download pictures onto a CD or thumb drive
- Access to computers with presentation software

Let's Begin

There are three projects you can allow youth to complete for this activity depending on the resources and time available to you. If resources and time are not a problem, you could also allow youth to complete both ***It's a Snap*** and ***Caught Ya!***

It's a Snap

This activity teaches youth to capture insect evidence using an important tool in forensics— the camera. The camera captures that precise moment in time in order to allow forensic scientists the opportunity to examine those specific details at a later time.

Have youth read over Handout 5.1, focusing in on items 1–3.

1. *Take very good close-up photographs of all locations from where animals are collected. The state of insect-aided decomposition can severely change within days, even under cool conditions, and even when the body is stored in a cooling apparatus. Also, bites of mites should be documented on living persons (e.g., possible offenders).*
2. *Photograph without a flash. Maggots will "flash out," which means they become "just white nothings," especially on digital photographs.*
3. *A metric and an inch scale should always be used on every picture.*

Now, separate youth into four groups. Then, using the directions within Handout 5.1 (items 1–3), have youth capture the insect evidence for their assigned jar. Be sure to encourage youth to share photo-taking responsibilities.

Once each group has completed taking their pictures, allow them to download the images to a CD or thumb drive in order to create a digital presentation (either at home or during another meeting time). Provide each group with time at the end of the activity to share their presentations.

***NOTE**: Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their "files."*

Caught Ya!

This activity teaches youth to capture insect evidence using other forensic tools. These tools have been used by entomologists for many years to collect insects they wish to study.

Materials for Activity:
Caught Ya!
Time: Two 50-minute blocks

For each youth...
- Handout 5.1

For each group...
- Access to Internet for visiting Florida 4-H Bug Club (with instructions on *Collecting 101*)

Also for each group, have a variety of tools including...
- Net
- Sticky traps
- Vials/kill jars
- Preservation chemicals such as ethyl alcohol and acetone
- Latex gloves
- Forceps
- Live specimen containers
- Shovel
- Thermometers
- Labels (adhesive)
- Small paint brushes
- Foil
- Hand towel
- Paper towels
- Sifting screens

Day 1

Have youth read over Handout 5.1, focusing in on items 4–8.

4. *Collect one spoon full of insects from at least three different sites of the corpse and the crime scene in three different, clearly labeled jars.*
5. *Put half of the insects in 98% ethanol. Cheap ethanol (i.e., methylated spirit for camping purposes) can be used without any problems. Neither isopropyl alcohol ("hand cleaning alcohol") nor formalin should be used! Killed insects can be stored frozen with or without ethanol.*
6. *Attempts should be made to kill the animals with hot water ("tea water") before placing them in ethanol.*
7. *If possible, put half of the insects alive in a refrigerator (not a freezer). Put fabric on top of their open-lid containers so the insects can breathe. Maturing might become an issue, so forward the animals to a biologist within 1 or 2 days. Keep white larvae separate from brownish larvae and separate larvae from adults if possible.*
8. *Label excessively: location, exact time, date, initials.*

Items 4-8 only capture a small part of what goes into doing a proper insect collection. In order to learn what it takes, ask youth to separate into small groups of three or four youth and then visit the website at www.entnemdept.ufl.edu/bug_club/ent-events/collecting101.shtml. Once at the website, ask each group to research one of the following sections:

Where to Collect	How to Collect
How to Kill Your Insects	How to Preserve/Pin Insects
How to Label Insects	

Have each group share their findings before the end of the meeting.

Day 2

With their new knowledge about creating an insect collection, have youth begin their own hunt for insects using any of the tools you have provided for them. Remind them to use the practices that they learned from Handout 5.1 and the Florida 4-H Bug Club when collecting and preserving their insects. Have youth share their findings at the end of the meeting.

***NOTE**: Leader may want to use a camera (Polaroid or digital) to record evidence and require youth to make a collage or add to their "files."*

Let's Reflect

- What types of insects did you find on your hunt?
- What was the hardest one to capture? Why do you think it was the hardest?
- Which insect was the easiest to capture?
- What tools were you using? Would it have made a difference if you had been using a different tool?
- What would you say is the most important rule in creating an insect collection?
- What would you do differently next time?

Let's Apply

- Often we are asked to follow a particular set of directions in order to "do" something. In this case, collecting and preserving insects has a very particular process. Why is it important to follow those directions?
- How would choosing to not follow directions change a scientist's ability to do his or her job?
- How can choosing to not follow directions limit your ability to do what someone has suggested you do?

EXTENSION ACTIVITIES

Youth who are interested in doing more insect collections can participate in the Florida 4-H Insect Collection Contest. Use the link below to find out more information about this annual event.

http://www.entnemdept.ufl.edu/bug_club/ent-events/collection-contest.shtml

Handout 5 The Ten Basic Rules of Insect Collection

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6. Attempts should be made to kill the animals with hot water ("tea water") before placing them in ethanol.

7. If possible, put half of the insects alive in a refrigerator (not a freezer). Put fabric on top of their open-lid containers so the insects can breathe. Maturing might become an issue, so forward the animals to a biologist within 1 or 2 days. Keep white larvae separate from brownish larvae and separate larvae from adults if possible.

8. Label excessively: location, exact time, date, initials.

9. If questions arise during collection, a forensic entomologist should be called.

10. Determination (i.e., identification of the arthropod species) *must* be performed by an experienced entomologist using keys that can be applied to the local fauna. However, for many regions of the world, appropriate keys are not yet available. Some forensic entomologists determine third instar larvae of known maggot species by the characteristics of the maggot's mouth parts.

Tools of the Trade

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* Small paint brushes
* Foil
* Vermiculite and food
* Graphite pencil
* Hand towel
* Camera
* Ruler
* Paper towels
* Sifting screens
* Death scene form

These Background Basics were taken from *Forensic Entomology: Arthropods and Corpses* by Mark Benecke, available in its entirety in PDF form on the project website.

Taking an Insect Census: QUADRANTS

LESSON 6

Grade Levels: 6–8
Subjects: Science, Mathematics
Setting: Indoor

Time Needed:
50 minutes

Science Skills:
Population sampling
Measuring using metrics
Prediction

Life Skills:
Keeping records

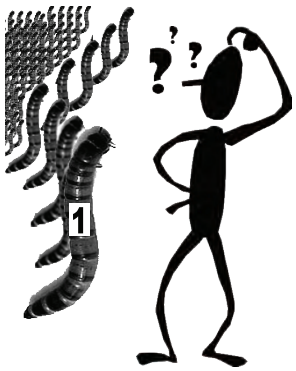
Materials Needed:
Quadrant
For each small group…
- Metric Ruler
- Pair of scissors
- Pencil
- Index card

For each youth…
- Handouts 6.1, 6.2

Sunshine State Standards:
SC.(5,6,7).N.1.1
MA.4.G.3.3
MA.7.S.6.1

Main Idea

This lesson provides an introduction on estimating population sizes using the quadrant sampling method.



Objectives

Youth will be able to:

1. Estimate the number of caterpillars on the page.
2. Measure a 5 cm x 5 cm square using a ruler.
3. Measure the length and width to find area of a rectangle.
4. Find the difference between his/her estimate and the class average, before and after sampling.
5. Describe two reasons why population estimates may have differed among youth.
6. Explain two scenarios where scientists might use quadrant sampling.

Background Information

Understanding SAMPLING

What is sampling?

Organisms and "things" occur differently in time and space. Often we would like to know how many there are of something and what their pattern of occurrence might be. For example, we might like to know what the difference is in the average height between boys and girls. Usually a scientist or any other experimenter does not have the time or the resources necessary to count every member of a population of interest. Therefore, a sample of some type and number, usually greater than one sample is taken. The sample(s) serve as a representative estimate of the true population number. From these sample counts, then such things as the average value and the variation in the values are calculated. These new values are termed statistics and statisticians analyze and interpret numerical data. Sampling theory is strongly rooted in the mathematical principles underlying statistics. One special type of sampling called "sequential sampling" was invented during World War II to reduce the number of manufacturing errors in the making of weapons and ammunition.

Often, the purpose of sampling a population of organisms is to determine their numbers in time and space. Basically we want to estimate certain values about the population, termed parameters such as the average value or "mean" and the variation or "variance" among the samples. The variance actually is an estimate of how much the sample values differ among themselves. This is known as their "distribution" and we can think of the distribution as the value of the mean surrounded by the values that are less and greater than the mean which make up all the sample values. Since there will be sample values that are repeated, the distribution actually represents the frequency of each of the sample values. In a "normal" distribution the mean is always less than the variance and the values closest to the mean will occur with the greatest frequency. Other distributions of counts also occur and have different relationships between the mean and variance. One such distribution is known as the Poisson (mean and variance are equal) and another is the negative binomial (variance is less than the mean). If the distribution of the sample frequencies is known than it is easier to chose the appropriate statistical analyses. For advanced study, you might search the Web for these distributions to find out how they are graphically depicted.

By sampling a population, hypotheses about the population can be tested. There are many sampling methods available, and the method used depends on the question being asked. In this exercise you will be introduced to several methods of sampling and asked to apply them to different types of populations. In other words, you will use your sample data to pose hypotheses about the populations you are studying, and then make inferences about your results.

Two types of sampling

The first method is referred to as quadrant sampling. *Quadrant sampling* uses a small plot to sample a population in a larger area.

The second, which is often used for estimating animal populations, is known as *mark-recapture sampling* (or *capture-recapture sampling)*. For example, a biologist might set live traps for a certain kind of beetle. Once collected, each beetle could be marked with a dab of fingernail polish and then be released back into the wild. After a certain amount of time, say a week, the traps are reset and another sample of beetles is caught. Some of the beetles in this second group will be new ones, never seen before, but some of them may be marked individuals from the first trapping.

Activity 6

Advanced Preparation

- This activity fits well with the themes of population density and population sampling methods. It may be helpful for youth to be introduced to the idea of population sampling (and purposes behind sampling) before completing this activity.
- Make copies of the three related handouts for each student (or pair of youth). Make sure to place the caterpillar field on a separate sheet of paper, rather than on the back of a sheet.
- Be sure there are scissors, index cards, and metric rulers for each group.

Materials for Activity:
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For each small group...
- Metric Ruler
- Pair of scissors
- Pencil
- Index card

For each youth...
- Handouts 6.1, 6.2

***NOTE**: Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their "files."*

Read the following:

So far, you have seen many tools of the trade forensic entomologists use when trying to solve a case. Now, think back to our first activity where you observed the various insects that had collected on the chicken livers. One of the tasks that you were asked to do was to count the number of insects that you saw on your "corpse" chicken. How easy or difficult was that to do? Now imagine if that was an entire animal or human corpse. That would be a lot of counting.

Sometimes it is good enough to estimate the number rather than counting each and every one. Remember, some of those insects can lay over 500 eggs each! In order to get an estimate as accurate as possible, scientists often take samples.

Let's Begin

Read the following:

Here are some terms you will need to know as we talk about samples.

Population - the total number of individuals occupying an area or making up a whole

Population Density - usually expressed in terms of items or organisms per unit area. An example of this would be 2300 dogs per 1 square mile.

Population Sampling - selecting a number of study subjects from a defined population in order to approximate a picture that represents the whole

Now, distribute Handout 6.1 and Handout 6.2, rulers, index cards. Have youth work individually or in pairs. Have youth complete all steps on worksheet to estimate the number of caterpillars in Farmer Melanie's field.

After youth complete steps 1–10 on the worksheet, compile all the student data on an overhead projector or on the blackboard. Find the mean of all youth' estimates to get one class estimate.

Finally, youth should next complete the Population Questions 1–4.

Answer Key:
for Caterpillar Chaos!

Measurements below were made from the inside of the **BOLD BLACK LINE**.
Width = **18.1 cm** & Length = **18.7 cm**
There are **280** caterpillars in the field.

***NOTE**: Leader may want to use a camera (Polaroid or digital) to record evidence and require youth to make a collage or add to their "files."*

Let's Reflect

- Did every group come up with the same average? Give two reasons why you think this is the case.
- How far off was the class estimate from your estimate before sampling? (Hint: subtract to find answer) After sampling?
- Why do you think a scientist would use quadrant studies to measure populations of organisms? *Too difficult to count each organism, convenient if animals or plants are spread evenly over an area.*
- Can there be too many of a certain type of plant or animal in a certain area? Give two reasons (or examples) to support your answer.
- Would you have been to complete this sampling activity if you had not been able to measure using the metric system? Justify your answer.
- Why would record-keeping be important to a farmer who was trying to manage pests in her/his crop? *(Think of farming on a year-to-year basis, for example).*

Let's Apply

- Give two or more scenarios where using a quadrant would help to estimate a population. Your examples can be for sampling insects as well as other animals or plants.
- When do you use the skill of (metric) measurement in your life?
- When do you use the skill of prediction (estimation) in your life?
- When is keeping records important in your life?

EXTENSION ACTIVITIES

Have youth research other methods scientists and other researchers use to sample the population that they are interested in studying.

Handout 6.1

Too Many Caterpillars!

Instructions: Please follow each step carefully and in order.

1. Measure the length and width of Farmer Melanie's field (Handout 6.2) in centimeters.

_____ cm × __ cm = _____ cm^2 (total area; record as **G** below)

2. Estimate the number of caterpillars in the field. Your estimate: _____

3. Cut out a 5 cm by 5 cm square from an index card. This is your quadrant.

4. Lay your copy of Farmer Melanie's field on a flat surface.

5. Drop your paper quadrant onto the field and trace around it with a pencil or pen. If your quadrant lands off the field, try again until it lands fully on the field.

6. Count the number of caterpillars in your square (this is **A**). If there is a part of a caterpillar within the square, round up to "1" if it is more than ½ and down to "0" if it is less than ½.

7. Repeat steps 4 and 5 four more times Record your data in the table below. (**B through E**)

8. Find the mean (average) of your five samples by adding them together and dividing the sum by 5 (# of trials). (**F**)

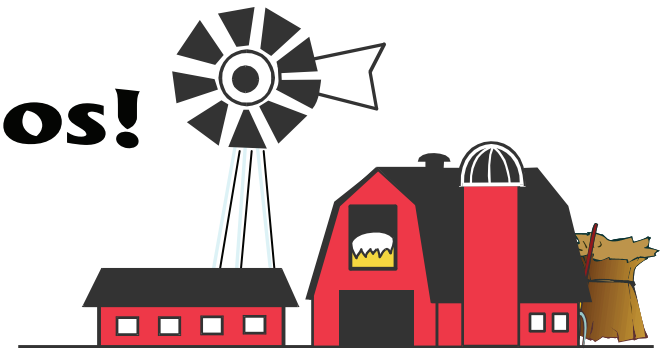
9. Multiply the average of the five trials by the area of the field (**F × G**). This is your total number of caterpillars in the field.

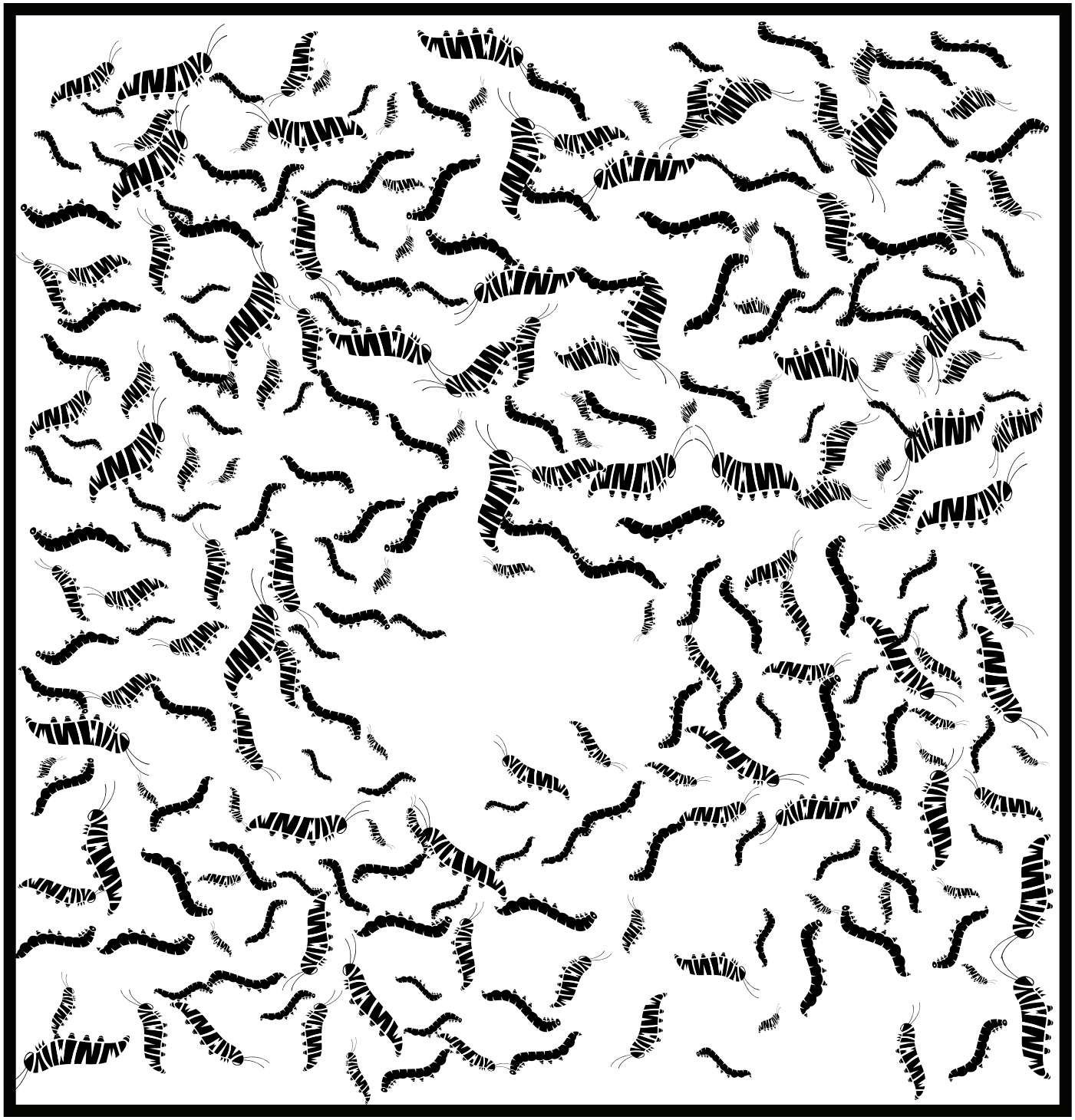
	Caterpillars per quadrant
Trial 1	A.
Trial 2	B.
Trial 3	C.
Trial 4	D.
Trial 5	E.
Average of 5 trials $\frac{(A+B+C+D+E)}{5}$	F.
Area of field	G.
Total # caterpillars in field (F × G)	H.
Average of class data (to be worked on board)	I.

Handout 6.2

Caterpillar Chaos!

Follow the directions found on your "Too Many Caterpillars" worksheet.





UF UNIVERSITY of FLORIDA IFAS Extension

Taking an Insect Census: MARK-RECAPTURE

LESSON 7

Grade Levels: 6–8
Subjects: Science, Mathematics
Setting: Indoor

Time Needed:
50 minutes

Science Skills:
Population sampling
Prediction

Life Skills:
Critical thinking
Keeping records

Materials Needed:
Mark-Recapture
For each small group…

- Approximately 4 dozen mealworms*
- Permanent marker (black, blue or purple)
- 2 plastic boxes
- Wheat flour or germ

*Missing the mealworms? You can use approximately 1/2 pound of dried beans (pinto, kidney, etc.) instead of the 4 dozen mealworms.

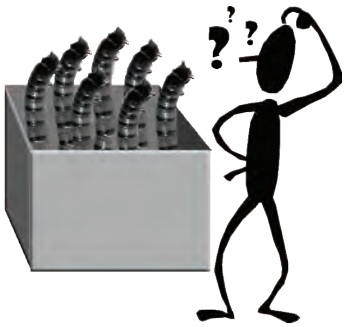
For each youth…

- Handout 7

Sunshine State Standards:
SC.(5,6,7).N.1.1
MA.4.G.3.3
MA.7.S.6.1

Main Idea

This lesson provides an introduction on estimating population sizes using the mark-recapture sampling method.



Objectives

Youth will be able to:

1. Estimate the number of mealworms or beans in a box.
2. Use an algebraic expression to calculate a population estimate.
3. Calculate which of two estimates deviates less from an actual population.
4. Modify a sampling method in two ways in order to increase accuracy.
5. Identify one reason why a scientist would use the mark-recapture method.
6. Contrast one animal mark-recapture would work well for with another animal it may not work well for.

Background Information

Understanding SAMPLING

What is sampling?

Organisms and "things" occur differently in time and space. Often, we would like to know how many there are of something and what their pattern of occurrence might be. For example, we might like to know what the difference is in the average height between boys and girls. Usually a scientist or any other experimenter does not have the time or the resources necessary to count every member of a population of interest. Therefore, a sample of some type and number, usually greater than one sample is taken. The sample(s) will serve as a representative estimate of the true population number. From these sample counts, then such things as the average value and the variation in the values are calculated. These new values are termed statistics, and statisticians analyze and interpret the numerical data.

Sampling theory is strongly rooted in the mathematical principles underlying statistics. One special type of sampling called "sequential sampling" was invented during World War II to reduce the number of manufacturing errors in the making of weapons and ammunition.

Often, the purpose of sampling a population of organisms is to determine their numbers in time and space. Basically, we want to estimate certain values about the population, termed parameters such as the average value or "mean" and the variation or "variance" among the samples. The variance is actually an estimate of how much the sample values differ among themselves. This is known as their "distribution," and we can think of the distribution as the value of the mean surrounded by the values that are less and greater than the mean, which make up all the sample values. Since there will be sample values that are repeated, the distribution actually represents the frequency of each of the sample values. In a "normal" distribution the mean is always less than the variance, and the values closest to the mean will occur with the greatest frequency. Other distributions of counts also occur that have different relationships between the mean and variance. One such distribution is known as the Poisson (mean and variance are equal), and another is the negative binomial (variance is less than the mean). If the distribution of the sample frequencies is known, then it is easier to choose the appropriate statistical analyses. For advanced study, you might search the Web for these distributions to find out how they are graphically depicted.

By sampling a population, hypotheses about the population can be tested. There are many sampling methods available and the method used depends on the question being asked. In this exercise you will be introduced to several methods of sampling and asked to apply them to different types of populations. In other words, you will use your sample data to pose hypotheses about the populations you are studying, and then make inferences about your results.

Two types of sampling

The first method is referred to as quadrant sampling. *Quadrant sampling* uses a small plot to sample a population in a larger area.

The second, which is often used for estimating animal populations, is known as *mark-recapture sampling* (or *capture-recapture sampling)*. For example, a biologist might set live traps for a certain kind of beetle. Once collected, each beetle could be marked with a dab of fingernail polish and then be released back to the wild. After a certain amount of time, say a week, the traps are reset and another sample of beetles is caught. Some of the beetles in this second group will be new ones, never seen before, but some of them may be marked individuals from the first trapping.

Activity 7

Advanced Preparation

- Set up a plastic box with lid containing approximately 4 dozen mealworms and wheat flour or wheat germ for **each group** of students.
- Divide students into groups of 3 or 4.
- Make sure each group has a permanent marker, an extra plastic box, and a copy of Handout 7 for each student in the group.
- Place equation on the board *(shown below)*.

Materials for Activity:

For each small group...

- Approximately 4 dozen mealworms*
- Permanent marker (black, blue or purple)
- 2 plastic boxes
- Wheat flour or germ

*Missing the mealworms?
You can use approximately 1/2 pound of dried beans (pinto, kidney, etc.) instead of the 4 dozen mealworms.

For each youth...

- Handout 7

***NOTE**: Leader may want to use a camera (instant or digital) to record evidence and require students to make a collage or add to their "files."*

Read the following:

We just learned about sampling a population by using a Quadrant method. Someone explain how we determined an estimate from Farmer Melanie's Farm. Now, there is another way that scientists find an estimate for a population. It is called the Mark-Recapture (or Capture-Recapture) method. For example, a biologist might set live traps for a certain kind of beetle. Once collected, each beetle could be marked with a dab of fingernail polish and then be released back to the wild. After a specified amount of time—(let's say, a week) —the traps are reset and another sample of beetles is caught. Some of the beetles in this second group will be new ones, never seen before, but some of them may be marked individuals from the first trapping. Let's take a closer look at this sampling

Let's Begin

These instructions apply to either specimen choice (mealworms or beans). The worksheet (Handout 7) is also applicable to either choice.

N = Population estimate

M = Number of "animals" captured and marked in first sample

$$\frac{N}{M} = \frac{n}{m}$$

n = Number of "animals" captured in second sample

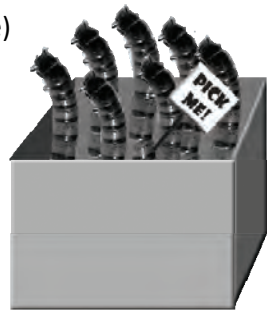
m = Number of "n" that were already marked

1. Have students follow instructions on worksheet. Each student should make an *estimate* of how many "animals" (*mealworms or beans)* they think are in their group's box. NO COUNTING!

2. Each student can be given a different job, such as 'Handler', 'Marker,' 'Recorder.'

3. The **Handler** begins by picking up a handful of the "animals" from the box. The **Marker** will then color the specimens with a marker and then release them back into the population by gently placing them back into the container and stirring them around. The **Recorder** should write down the number of specimens from that handful once they are marked (**M**).

4. Next, the **Handler** (the same student who picked up the handful the first time) picks up another handful of the "animals". The **Recorder** should write down this number as (**n**).



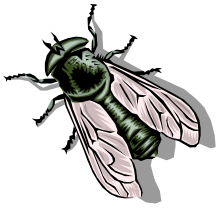
5. Within (n), there should be some specimens that are marked. The **Recorder** counts the previously-marked "animals" and records this number as (**m**).

6. Simply knowing these three numbers (M, n, and m) is enough to make a calculated estimate of the total number of "animals" in the box (N). Multiply n by M and divide by m.

7. Finally, remove the specimens and count them. Place them into the other box to help keep track.

8. Students should answer questions 8–11 on their worksheet individually.

Let's Reflect



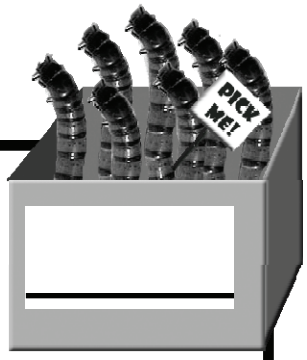
- Was your estimate closer when you predicted the number of specimens at the beginning, or after marking and recapturing (#8 on worksheet)? Why do you think this was the case?
- Could you have gotten your estimate closer to the actual number of specimens in the box? What are some ways you could have increased your accuracy (#9)?
- Why would a scientist use the mark-recapture method instead of counting all the individuals in a population (#10)?
- Compare one insect type (or other animal) that mark-recapture would work well for with another type(or other animal) it may not work well for (#11)? Why is this?
- Why is record-keeping important to make mark-recapture sampling as accurate as possible?
- Why might a scientist have to think critically in order to plan exactly how to sample a population?
- What are some similarities between the quadrant and the mark/recapture methods? Some differences?

Let's Apply

- When have you had to use the skill of prediction before?
- What could you do to predict the examples you gave above more accurately?
- Why is keeping records important in your life? Think of a sports match or grades in school.
- Have you ever had to guess the number of something? How did you go about doing it? Would the mark-recapture method have helped you make that guess?
- Scientists have to think critically (solve a problem by looking at it from many angles). Think of a time when someone you know had to think critically to help them solve a problem.

Handout 7

MARK-RECAPTURE SAMPLING



1. **Estimate** the number of "animals" you think are in the box: _____

2. Now pick up a handful and count them. This is your first trapping sample, **M**.

   M =_____

3. Mark these specimens by placing a visible dot on their backs with your permanent marker. "Release" them back into the population after they have been marked.

4. Shake the box and (without looking) pick up another handful. This is your second trapping sample, **n**.

   n =_____

5. Some specimens in your second trapping sample were probably already marked. Count how many were already marked; this number equals **m**.

   m =_____

6. Use the mark-recapture equation to calculate your population estimate, **N**.

   Show your work here:

$$N = \frac{n\,(M)}{m}$$

N =_____
Population Estimate

7. Now, count up the actual number of "animals" in your box: _____

8. Which was closer to the actual number of "animals" in your box—the estimate using sampling, or your initial estimate?

9. What are two ways you could increase the accuracy of your estimate (when using the sampling method)?

10. What is one reason a scientist would use the mark-recapture method instead of counting all the individuals in a population?

11. Can you think of one type of animal that the mark-recapture method of sampling might work well for? One that it would not work well for? Why did you choose these animals?

The Black Bear Murder Mystery

LESSON 8

Grade Levels: 6–8
Subjects: Science, Mathematics
Setting: Indoor

Time Needed:
Four 50-minute blocks

Science Skills:
Observation
Communication
Inference
Classification
Acquiring and Processing Data

Life Skills:
Teamwork
Problem solving

Materials Needed:
See Activity for detailed list of materials needed as well as Advanced Prep requirements

Sunshine State Standards:
SC.6.N.1.4
SC.(5,6,7).N.1.1

Main Idea

This four-day lesson may stand alone or can be integrated into a unit on forensics, black bears, entomology, or science process skills. *Permission from school administration should be granted before setting up the crime scene on school grounds.*

Objectives

Youth will be able to:

1. Practice observation skills by recording observations of a mock crime scene.
2. Determine a Post Mortem Interval by making inferences about their observations.
3. Identify insects found at the crime scene.
4. Communicate findings with group members.
5. Compare identifications and findings with other groups.
6. Determine which suspect committed a crime by making an inference.
7. Determine what evidence is necessary to accuse a suspect of killing an animal.

Background Information

Understanding the CONNECTION *between insects and forensic entomology*

The Post-Mortem Interval (PMI) is the time elapsed between death and discovery and medical examination of a body. The knowledge of forensic entomology can help determine the PMI, if the evidence is properly collected, preserved, and analyzed. After 48–72 hours, forensic entomology is often the *only* method for determining the PMI. Blowflies are the first visitors to a corpse, followed by beetles and other insects. Knowing which insects are present, and which life stage they are in (maggot vs. adult, for example) can help determine how long ago a death took place.

If a body is soft, it is likely that the death occurred less than three or more than 36 hours ago (>3 or <36 hours PMI). If it is stiff, the PMI is most likely between three and 36 hours PMI. If there are flies around the body, the PMI is 3 or more hours. If there are maggots (fly larvae) on the body, the PMI is 3–5 days. Body stiffness and insect presence can be greatly affected by the time of year (day length, temperature, humidity, presence of certain insects), location (sun vs. shade, body placed in bag or freezer), or other factors.

Defining the PMI Stages

"Fresh" stage: The process of decay begins with blow flies (family: Calliphoridae) and flesh flies (family: Sarcophagidae) finding the body. They can arrive within 10 minutes of death! They lay their eggs, from which maggots hatch, and begin to feed on the tissues. (Flesh flies actually lay newly hatched maggots and not eggs). Beetles and predatory wasps may arrive to feed on the maggots (not on the corpse). Depending on weather conditions, it represents days 1–3 PMI.

The "Bloating" stage: Next, House flies (family: Musciade) join the other flies and their maggots form feeding masses that help liquefy the tissue. At this point, there are a lot of maggots feeding on the body and the competition (as well as number of predators that come to eat on the maggots) increases. Depending on weather conditions, it represents days 2–6 PMI.

The "Decay" stage: This is when the decay of a body really starts to smell bad. By the end of this stage, most maggots have finished development and begin to leave the body to find a place to pupate in the soil. The corpse becomes devoid of all flesh, except cartilage, bone, and skin. Depending on weather conditions, it represents days 5–11 PMI.

"Post-decay" stage: Beetles come to feed on the remains. Depending on weather conditions, it represents days 10–25 or more PMI.

Activity 8

Advanced Preparation:

- On day one, the leader (with the facility/ administrator permission) will set up the mock crime scene in the morning before school. Be sure to place the crime scene in a location where other youth in the school would not normally travel, where wild animals will not bother the scene, and **out of direct sunlight**. Four wooden posts are hammered in the ground approximately two feet apart in a square. The posts should be connected by crime scene tape. On the ground within the crime scene, place two yards faux black fur (fur side up) and dump the chicken livers on top of the fur. Spread the chicken livers with a shovel to make the scene look realistic. At the end of the school day, promptly shovel up the livers and fur into a heavy-duty trash bag and dispose of properly.
- Also, predetermine how you will form investigation groups of threes. Will youth choose their own groups or will you assign the groups? Each group member will each have a role (illustrator, scribe, crime scene manager), which you may also want to assign.

Materials for Activity

Black Bear Mystery

For each small group...

- Fresh chicken livers (5 pounds is plenty - Available at most grocery stores in the meat department if you ask)
- Faux black fur (2 yards is plenty, it can be purchased at most fabric or craft stores)
- Crime scene tape (Approximately 12 feet - Most police stations will gladly donate for educational use)
- 4 wooden posts (2 ft x 2 in x 1 in)
- Hammer to put posts in ground
- Shovel (for clean-up)
- Thick garbage bag (for cleanup)
- Camera to photograph scene and youth (or, if available, a camera for each group of 3 youth)
- Transparency of The Case & Suspects page
- Thermometer

For each youth:

- Copies of The Case & Suspects page, observations page, and questions page
- Pencil and set of colored pencils
- Clipboard
- Thin wooden stick/stake to test stiffness of chicken livers (can have 1 per group)

Let's Begin

Remember to set up the crime scene out of direct sunlight —as it will alter the results and level of decay of the specimen.

Schedule Overview	Day 1	Day 2	Day 3	Day 4
	In morning Teacher sets up crime scene *During class* Scripted crime story *For tomorrow* Notes/research	*During class* To schoolyard for observations Share findings with small group	*During class* To schoolyard for observations Follow-up identifications	*During class* Follow-up class discussion

***NOTE**: Leader may want to use a camera (instant or digital) to record evidence and require students to make a collage or add to their "files."*

Day 1

Read this script to youth: **Early this morning, I received a call from the director of the Florida Fish and Wildlife Conservation Commission (FWCC). She called me with an emergency situation: a Florida Black Bear was found in the Ocala National Forest, shot and abandoned with much of the fur missing. The FWCC is asking for your help in determining how long ago this bear was killed so that they can arrest the offender who illegally shot this bear. Remains of this bear are being brought to (your site) for your analysis (later today/tomorrow).**

Ask students: **What are some ways you can tell how long ago the bear was killed?**
(They may not have any ideas, but allow them to guess based on their prior knowledge).

Read suspects sheet *(via overhead transparency, if possible)* to students.

Have students get out piece of paper and a pencil for taking a short set of notes *(or provide them with the one included).* Students should write down the phrase "Post-Mortem Interval (PMI)." Ask them what they think it means—break down the words: Post (after), Mortem (death), Interval (elapsed time).

Review the important ways to tell how long ago something died:

⇒Is the body is soft or stiff?

Stiff=between three and 36 hours PMI
Soft=less than three or more than 36 hours PMI

⇒What types of insects were present around the body and are they adults?

1. Under specified environmental conditions, it is possible to predict (within hours) the exact order of insects that will appear at a carcass/corpse, when their larva will hatch, and how quickly the larva will turn into adults.
2. Flies and beetles are the most important "key witness" insects in forensic entomology—they are the first to arrive at a scene.
3. Depending on how much time you have and how detailed you'd like to make the notes, go through the stages (Fresh through Post-decay) with students.

Day 2

Yesterday morning, I received a phone call from the director of the Florida Fish and Wildlife Conservation Commission. The report that came was that a Florida Black Bear was found in the Ocala National Forest, shot and abandoned, with much of its fur missing. The FWCC is asking for our help in determining how long ago this bear was killed so that they can arrest the offender who illegally shot it. Remains of this bear were brought to (your site) to be analyzed by you today. There are three suspects in this case, which are profiled in a handout you will receive momentarily. Each of the suspects has demonstrated some suspicious behaviors, and it is up to you to end this illegal hunting by putting this (the correct suspect's) hunting to a halt.

***NOTE**: Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their "files."*

At this point, divide students into groups of three and assign team roles as Illustrator, Scribe, and Crime Scene Manager within each group. Pass out the observation form, a clipboard, and items listed for each role accordingly.

Illustrator: *Sketches all aspects of the crime scene with colored pencils. Include drawings of any insects (or other animals) that are at the crime scene. The drawing should be so descriptive such that someone who hadn't seen the crime scene could imagine it in detail.*

Scribe: *Maintains a written log of all observations. Include written, detailed descriptions of any insects (or other animals) that are at the crime scene. The writing should be so descriptive that someone who had not seen the crime scene could imagine it in detail.*

Crime Scene Manager: *Makes sure Scribe and Illustrator have all materials and are on-task and that no group member crosses crime scene tape or touches the evidence. Also should assist scribe or illustrator upon request. If camera is available, photograph scene and group members examining scene. Each group member must fill out an observation form.*

You will be observing the remains of this black bear. Just as in any crime scene, you may not touch the remains or cross the crime-scene tape except to test the stiffness of the bear's body with a wooden stake. When testing the remains by poking them with the wooden stake, you must take care to not move the remains, nor should you attempt to pick them up with the stick in any way. Just a warning—if the smell or sight of the remains is more than you can handle, please do not scream or run away. Instead, calmly ask another member of your group to take on your role for this portion of the exercise in exchange for you completing part of their role later in the assignment. If this event, you may walk quietly to (specified place in full view of teacher).

Once the students are fully aware of their roles and what they are looking for, the whole class should be escorted to the crime scene by the teacher. Allow each student to have an initial reaction to the scene before beginning their job. After the initial reaction, each group member should begin their assigned job (as described above).

Day 3

Students should go outside and fill out observation logs again. Any changes to the crime scene should be noted in the descriptions and drawings of scribe and illustrator. Crime Scene Manager should fulfill same roles as day before.

Students should identify any insects described/drawn by using one or both of the recommended references (Forensic Insect Identification Cards or **http://ipm.ncsu.edu/4-H/CSIfinal.pdf**). Students can also refer to other insect photo guides or websites at the instructor's discretion.

NOTE*: Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their "files."*

Day 4

Students should begin class in their small groups. If they did not finish insect identifications from Day 3, this may be an appropriate time to do so.

Pass out **Suspect Sheets** to each group. Allow groups to determine amongst themselves who they think the criminal offender is. Ask them to not shout out or share with class, but rather begin to answer the questions on the back of the **Suspect Sheet**.

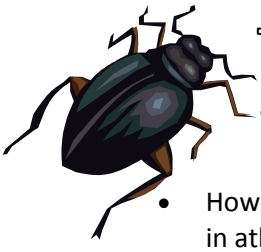
Collect groups' data and compile as a class: animals seen at the crime scene, other important observations, and what this tells you about how long age the bear was killed.

After compiling the data, ask each group to write down the name of who their group thinks is the suspected criminal on a piece of paper and turn in to you (or a designated student) as a "silent ballot."

Announce the results to the class, then follow-up with the reflect and apply questions *(out loud, or as part of a written assignment)*.

Let's Reflect

- How did you work as a team to complete this activity and solve the case (the problem)?
- Why was it important to be a careful observer when it came to recording or drawing details?
- How did your group communicate your findings to one another? To the class?
- Do you need any additional information to make an inference about which person is guilty? Why or why not?
- Which insects (or other animals) that you observed came to the corpse first?
- What methods did you use to classify these insects/other animals (in other words, how did you figure out what they were)?
- Once you had your data (based on your observations), how did you use this to make a conclusion about the identity guilty party?



Let's Apply

- How is the skill of working as a team important for working in groups on school projects or in athletics?
- When have you had to use problem solving skills in a situation with your family? How did you solve the problem?
- When does the skill of observation help you in your daily life?
- Think of five times you have used the skill of communication already today. *(You may want students to list these on paper)*. How can someone become a better communicator?
- Has someone ever made an inference about you? Are inferences always true/factual?
- When do you use the skill of classification in your every day life? *(Think of organizing closets or drawers at home!)*
- Imagine you are working on a science fair project. What would you do once you have gotten all your data? *(Make a conclusion by processing, or interpreting, your data).*

EXTENSION ACTIVITIES

If you would like to view more of the insects that come to a decaying corpse, allow the chicken livers to decay for several days (having them in jars works well because they are easy to transport and put lids on when needed) before setting up the crime scene. This would cause another suspect to be the correctly accused suspect. Have the students research what types of insects they would see on the bear at the different stages of PMI.

Have students collect insects around bear crime scene using tweezers and collecting nets. Students may identify insects to order or family level using pictures or a key.

The Black Bear Murder Mystery

Black bear identification photo

The Case:

In 1994, The Florida Fish and Wildlife Conservation Commission (FWCC) outlawed the shooting of a Florida Black Bear anywhere in Florida. However, a call came in to the Director of FWCC that a Florida Black Bear was found, shot and abandoned (with much of the fur missing), in the Ocala National Forest.

Your Task:

Examine the remains of the bear and determine when this bear was actually killed so that the FWCC can try and determine the person responsible for its death.

The Suspects:

Bayer "Taxi" Dermist

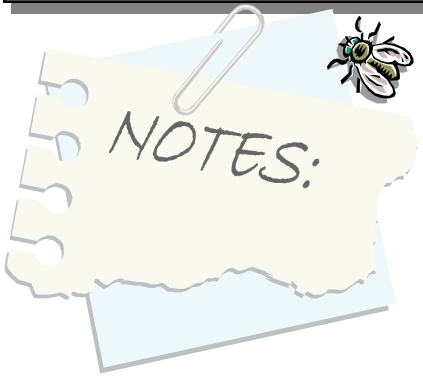
Selling black bear pelt in Jacksonville, Florida. Investigators collected pelt and say the fur is about one week old.

Hunter O'Bears

Was spotted, yesterday, illegally hunting out of season in Ocala National Forest, and brought in for questioning.

Ishoda Behr

Repeat Florida Black Bear hunter. Was seen in the Ocala National Forest two weeks ago, and has been out of the country since then.



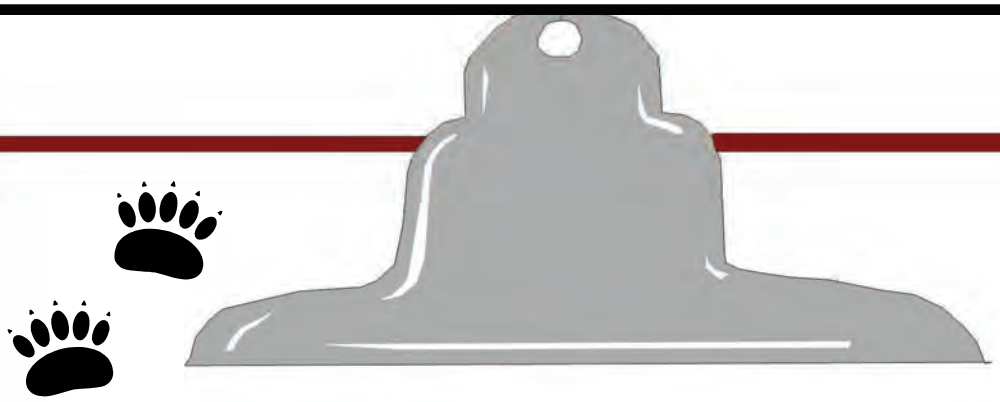
Investigator's Name: **Role: Crime Scene Manager**

Crime Scene Team

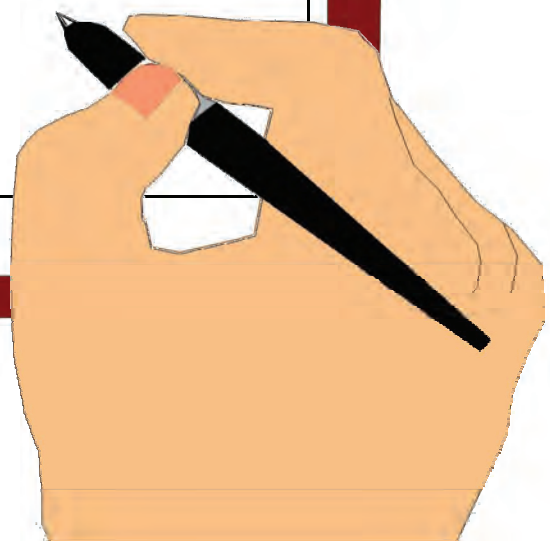
Scribe	
Illustrator	
Investigators	

	Describe the scene in detail.	What insects or other animals are present?
Date: **Time:** **Temperature:**		
Date: **Time:** **Temperature:**		

Investigator's Name: **Role: Scribe**



	Describe the crime scene in detail.	What insects or other animals are present?
Date: **Time:** **Temperature:**		
Date: **Time:** **Temperature:**		



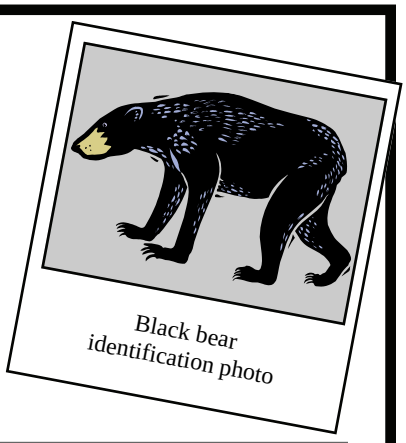
Investigator's Name: **Role: Illustrator**

SkEtChBoOk

	Illustrate the crime scene in detail.
Date: **Time:** **Temperature:**	

Date: **Time:** **Temperature:**	

The Black Bear Murder Mystery



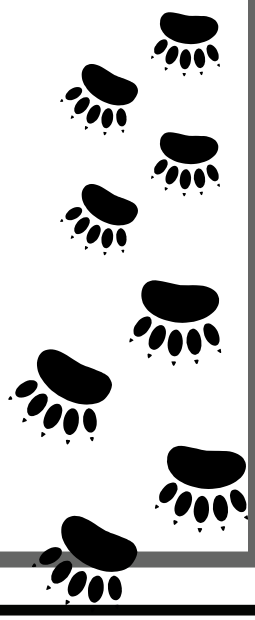
Black bear identification photo

1. Which insects came to the bear remains first?

2. What does this tell you about how long ago the bear was killed?

3. Which suspect most likely killed the bear? Why?

4. What kind of evidence do you think is still needed to find this person guilty?



UF UNIVERSITY of FLORIDA IFAS Extension

Exploring the Field of Forensic Entomology

LESSON 9

Grade Levels: 6–8
Subjects: Science, Language Arts
Setting: Indoor

Time Needed:
50 minutes

Life Skills:
Planning for the Future

Materials Needed:
Scavenger Hunt
For each small group…
- Access to the internet
- Handout 9

Sunshine State Standards:
LA.(5,6,7).4.2.1
LA.6.3.1.1
LA.8.5.2.4

Main Idea

This final lesson provides youth with an opportunity to explore what it would take to become a part of the field of forensic entomology.

Objectives

Youth will be able to:

Discuss the requirements for working in the field of forensics, entomology, or forensic entomology.

Activity 9

Read the following:

You have now completed the Black Bear Murder Mystery. What do you think of the field of forensic entomology? We have learned a lot of information about the way insects can aid forensic scientists, but what does it really take to become one of these scientists? This final activity gives you an opportunity to explore what it would take for you to be a part of this field.

Let's Begin

Provide youth with Handout 9 and access to the Internet (allow them to pair up to complete the activity if computer resources are limited). Give them the remainder of the time to research the answers to the questions presented on Handout 9.

Let's Reflect

- What was the most surprising fact you found about being a forensic entomologist?
- Which schools would you have to attend or what kind of degree would you need to have earned in order to work in this field?
- If you did want to work in any of these fields, what courses will you need to focus on in middle school and high school in order to be well prepared for college?
- Is there anyone who might want to go into this field? Explain why you feel that way. What interests you about it?

Let's Apply

- Why is it important to have an idea about what you would like to do once you graduate from high school?
- What are some steps that you would need to plan out now in order to be best prepared to enter college?
- Everyone has strengths and weaknesses, things they like and things they do not. That's what makes our world so wonderful. What are some of the strengths you have that would make you a good scientist? What skills would you have to improve to overcome any of your perceived weaknesses?
- How could you use the activity we did today to explore any other field you might be interested in? Are there any other questions you would ask?

Handout 9

SCAVENGER HUNT!

To begin, let's take a look at what it would take to become a FORENSIC ENTOMOLOGIST.

1. What is a forensic entomologist?
2. Which college/university would you have to attend in order to study forensic entomology?
3. What college majors do forensic entomologists often have?
4. What are some of the main courses you would have to take once you got into college?
5. Would you be able to work as a forensic entomologist after you completed your undergraduate degree or would you need to get a more advanced degree?
6. Other than investigating crime scenes, what are some of the jobs that a forensic entomologist might also do?
7. Would you be limited in where you might live, or does every city have a trained forensic entomologist?
8. What professional networks exist that you would be able to join as a professional forensic entomologist?

OK, so, what if you like the CRIME SCENE, but not the bugs? That might mean you would be interested in the broader field of FORENSIC SCIENCE. Use the American Academy of Forensic Science website below to answer questions 9–15. If you prefer the BUGS but not the crime scene, skip to question 16.

http://www.aafs.org/default.asp?section_id=resources&page_id=choosing_a_career

9. What skills do you need to be a forensic scientist?
10. What are the minimum requirements to become a forensic scientist?
11. What are some of the possible areas in which you could specialize? Which of these would you choose?
12. What major would you have in college if you chose that specialization?
13. What are some of the main courses you would have to take once you got into college?
14. Would you be able to work as a forensic scientist after you completed your undergraduate degree, or would you need to get a more advanced degree?
15. Other than investigating crime scenes, what are some other jobs that you might also be able to do with that degree?

So, you are more interested in the BUGS than in the crime scene. That might mean you would be interested in the broader field of ENTOMOLOGY. Use the Entomological Society of America website http://www.entsoc.org/resources/education/index.htm to answer questions 16–21. (If you answered questions 9–15, skip this section and go to question 22.)

16. Which college/university could you attend in order to study entomology?
17. What are some of the possible areas you could specialize in? Which one would you choose?
18. What major would you have in college if you chose that specialization?
19. What are some of the main courses you would have to take once you got into college?
20. Would you be able to work as a forensic scientist after you completed your undergraduate degree or would you need to get a more advanced degree?
21. Other than investigating crime scenes, what are some other jobs that you might also be able to do with that degree?

Now, based on everything you have researched, let's look at what you could do now TO PREPARE for one of these fields.

22. If you wanted to work in any of these three fields, what courses would you need to focus on throughout middle school and high school?
23. A great way to find out more information about what these scientists actually do is to contact them. Find someone in the field you are most interested in and ask them any questions you might have about their field of study. Explain that you have just completed this project and would like more information about what they do. Most scientists appreciate sharing their love for science with others.

Insects Throughout History

SUPPLEMENT 1

Grade Levels: 6-8
Subjects: Science, History, Language Arts
Setting: Indoor

Time Needed:
Two 50-minute blocks

Science Skills:
Communication
Classification
Constructing a Timeline
Inference

Life Skills:
Problem solving
Cooperation
Communication

Materials for this Lesson:
Timeline Activity

- Handout 1
- Handout 2 (both sides copied double sided)
- Crayons or colored pencils
- Scissors
- Glue

Malaria/Plague Activity

- Photographs of malaria and plague patients' symptoms
- Handout 3 (both sides) *personal accounts
- Handout 4 (both sides copied double sided)
- Access to books (or Internet) on insect-vectored diseases (**see procedure for suggestions)

Sunshine State Standards:
LA.(5,6,7).4.2.1
SC.912.L.17.8
SS.6.W.1.1

This lesson provides background on the role that insects have played throughout history including both the good and the bad impacts they have had on numerous societies.

Objectives

Youth will be able to:

1. Justify why (or why not) insects are the most important animals in the history of the world.
2. Describe one way Earth would be different without insects.
3. Compose a timeline including insect and non-insect related historical events.
4. Illustrate an event in his/her life that (positively or negatively) involved insects.
5. Define "vector" in terms of insects and disease transmission.
6. Compare symptoms of malaria and plague.
7. Compose an original vignette of a "day of the life" of another illness/ disease.

Vocabulary

- **Pollination**—transfer of pollen from male to female plant parts, assisted by insects such as bees and butterflies.
- **Earwigs**—elongated insects with pincer-like appendages protruding from the rear of the abdomen.

- **Springtails**—insects with two elastic caudal stylets that can be bent under the abdomen and then suddenly extended like a spring, enabling them to leap.

- **Vector**—an insect or other organism that transmits disease (via bacteria, virus, fungus, etc.).
- **Proboscis —an e**xtended, beak or straw-like mouthpart of an insect.

Let's Begin

Read the following:

In addition to knowing the type of insect and what stage of life it is in, it is also very important to be aware of the impact that insects can have on human life. Forensic archaeologists and entomologists often study the fossilized insects or insect-remains at an ancient site to better understand the role insects may have played during that time. Let's take a look at some of the more critical roles that insects have played throughout history.

1 *Break out youth into groups of 3ç4. GÌØŜ youth 10ç15 minutes to work in gr2ups: they should cut out insect answer boxes, and make their best guess as a group for the matching of the timeline.*

2 *After groups appear done with their best guesses, go through each answer as a class. Call on groups for their answers and their reasoning. If their answer is correct, let them know, and move onto the next item on the timeline. If incorrect, ask other groups' answers.*

3 *Once the timeline is complete and correct, pass out glue to each group and have them glue correct answers onto timeline. If time remains following the Let's Reflect and Let's Apply sections, pass out colored pencils/markers and allow youth to color their timelines and hang them up in the classroom.*

Answer Key

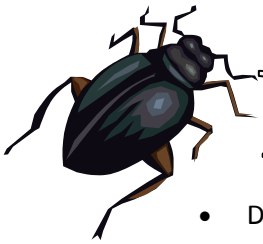
1. **DRAGONFLIES -** 285+ million years ago: Paleozoic Period; appeared prior to dinosaur existence
2. **EARWIGS -** 145–245 million years ago: Mesozoic Period; appeared during dinosaur existence
3. **BUTTERFLIES -** 25–40 million years ago: Cenozoic Period; appeared after dinosaur existence
4. **SCARAB BEETLE -** 2000 B.C.: Ancient Egyptians; symbol of life, hope, and regeneration
5. **BLOWFLIES -** 1235 A.D.: Chinese; first recorded use of insect evidence in a criminal investigation
6. **RAT FLEA -** 1347 A.D.: Europe; spread bubonic plague throughout Europe (wide-spread)
7. **BODY LOUSE -** 1812 A.D.: Russia & France; spread typhus fever, led to defeat of Napoleon
8. **MOSQUITO -** 1847 A.D.: Mexican/American Border; yellow fever caused 90% of the deaths, not battle
9. **HARLEQUIN BUG -** 1861 A.D.: America; first instance of alleged use of insects as a weapon of war
10. **BOLL WEEVIL -** 1919 A.D.: America; trouble with this pest led to growth in valuable crops like peanuts

***NOTE**: Leader may want to use a camera (instant or digital) to record evidence and require youth to make a collage or add to their "files."*

Let's Reflect

When groups have glued down their timelines, ask the class the following questions:

- What was the hardest part about this activity?
- What process did you use to figure out which insect went with a certain time period?
- What was the easiest insect to match with its time period. Why do you think that was the easiest to match?
- What other insects can you think of that were important in history that were not mentioned in this activity?



Let's Apply

- Do you think insects are the most important animals in our history? If so, why? If not, why not?
- What would be different about our world today without insects?

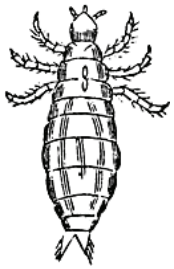
EXTENSION ACTIVITIES

Add to the timeline other historical events, such as the appearance of humans or various wars.

Have youth think of an event in their own life that involved insects. Have the youth describe and/or illustrate this event add this to the timeline by attaching a piece of paper to the bottom of the timeline. Options include a comic strip, diary entry, story, or picture.

Insects In History

EARWIGS

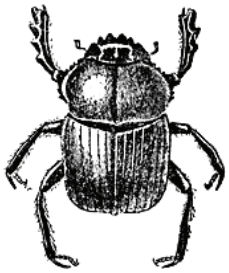


BODY LOUSE

HARLEQUIN BUG

BOLL WEEVIL

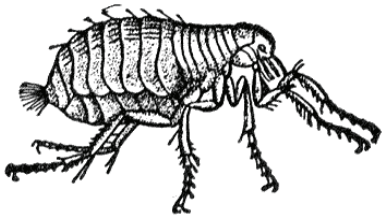
DRAGONFLY



SCARAB BEETLE

MOSQUITO

BUTTERFLY



RAT FLEA

BLOW FLY

**By this time, however, dinosaurs were extinct, which means dinosaurs could never really be recreated with DNA trapped IN AMBER AS IN THE MOVIE “Jurassic Park.” THE PREMISE OF THE MOVIE (AND BOOK) “JURASSIC PARK” IS THAT MOSQUITOES FED ON DINOSAURS AND WERE THEN TRAPPED IN TREE RESIN AS IT HARDENED (and turned into amber). IT WAS THIS BLOOD THAT WAS EXTRACTED IN THE MOVIE, AND THIS IS HOW THE DINOSAURS WERE CLONED. However, this scenario probably could never happen, because by the time insects were being preserved in amber, dinosaurs were already extinct!

Handout 2

Insects In History

285+ MILLION YEARS AGO
PALEOZOIC PERIOD

These insects, along with crickets and springtails, roamed the earth. Dinosaurs did not yet exist.

145-245 MILLION YEARS AGO
MESOZOIC PERIOD

This insect, along with beetles, flies, mammals, and dinosaurs roamed the earth.

25-40 MILLION YEARS AGO
CENOZOIC PERIOD

These insects came into being, and it is during this time that insects were trapped in amber.**

2000 B.C.

Ancient Egyptians considered this insect a powerful symbol of life, hope, and regeneration. Images of it can be seen on their jewelry and on their tombs.

1235 A.D.

These insects were used in the first recorded use of insect evidence in a criminal investigation. A murder case was solved because the insects were attracted to traces of blood on the killer's weapon.

1347 A.D.
This blood-sucking insect was responsible for transmitting bubonic plague. The disease wiped out much of the European population.

1812 A.D.
Typhus fever ended Napoleon's invasion of Russia.
It was spread by this insect.

1847 A.D.
Yellow fever was spread by this insect during the Mexican-American War. Ten times as many soldiers were killed from the disease than in battle!

1861 A.D.
The American Civil War marked the first instance of alleged use of an insect as a weapon of war. The Confederacy accused the Union of introducing this type of insect into the South. Tremendous crop damage resulted in the South because of this pest.

1919 A.D.

A monument was built to honor this insect. Bad luck with this pest eventually led cotton farmers to turn to other valuable crops like peanuts.

Handout 2

Background Information

Vector-borne DISEASES

In the study of human health and disease, a **vector** is any living carrier that transmits infections. That commonly includes insects. Two vector-borne diseases that you most probably have heard of are **malaria** and **the plague**. These diseases have been around for centuries and are still being fought today.

Malaria, a widespread disease in both tropical and subtropical regions, affects between 300-500 million people every year. Of the people affected by malaria each year, approximately 1.5—2.7 million people die from the disease or disease complications. The plague, on the other hand, affects 2,000—3,000 people (about 10—15 in the United States) per year. During the Middle Ages, the plague claimed the lives of nearly a third of the population of Europe.

Read Handout 4.3 for more information on malaria and the plague. Other good sources for reading about insect-vectored human diseases are listed below.

Books

Buzz: The Intimate Bond Between Humans and Insects by Glausiusz and Steger

Medical and Veterinary Entomology by Mullen and Durden

Medical Entomology for Youth by Mike Service

Most encyclopedias have good descriptions of many insect-vectored diseases like encephalitis and yellow fever.

Internet:

Centers for Disease Control
http://www.cdc.gov

World Health Organization
http://www.who.int

Let's Begin

15 min 1. Read all or part of the two vignettes (malaria and the plague) aloud to youth.

10 min 2. Read aloud "What really happened" at the end of each vignette.

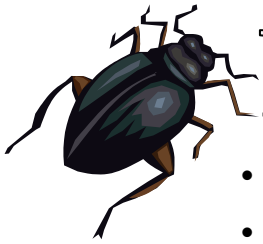
5 min 3. Define terms "Vector" and "Proboscis" to class. Explain that a vector is a "spreader" and does not cause a disease but spreads it from one organism to another. A proboscis is simply a long, extended mouthpart of an insect. Examples include the needle-like proboscis of a mosquito or a straw-like proboscis of a butterfly. This can be demonstrated as in the "Insects for Lunch" lesson.

3 min 4. Pass out copies of vignettes (Handout 3.3) and worksheet (Handout 3.4) to each youth.

20 min 5. Instruct youth that Handout 3.4 is a group assignment. Have them form groups of 2–3 to work on first three questions of worksheet. Question 4 should be answered individually as homework or class work (see sources above for information on insect-vectored human diseases).

Let's Reflect

- What is a vector? How does it relate to entomology?
- What are some of the symptoms of malaria? How does it spread? How can it be prevented?
- What are some of the symptoms of the bubonic plague? How does it spread? How can it be prevented?
- Which disease did you think sounded like it would be worse to have—malaria or the plague? Why? Give at least three reasons to justify your answer.
- Someone share what they found out about another vector-borne disease. Be sure to tell us what the vector is, how it spreads, symptoms, and any prevention methods you researched.



Let's Apply

- Why is it important to know the vectors for any disease?
- How could knowing how a disease is spread help scientists come up with ways to prevent the disease from spreading?

EXTENSION ACTIVITIES

Using the Internet or library resources, have youth explore additional personal accounts from these diseases. Have them share the stories they found during the next session.

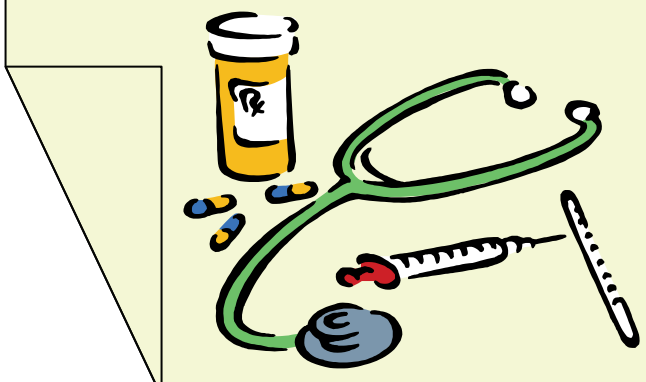
Have youth create informational boards about a vector-borne disease.

Malaria: A personal story

January 23, 2004
Kampala, Uganda

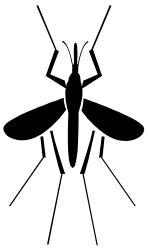
I woke up in the night with a bad headache and nausea. I shivered but I was sweating like I was hot. I have been waking up like this every night for two years now—ever since I was eleven years old. My whole family has malaria. My mom and dad both seem ok—they are able to work and sleep better than I can.

I am tired and only get out of bed when I have to use the toilet. Ugh, the toilet. That word brings back thoughts of standing over it, nauseated and throwing up. Sitting on it, days of diarrhea. My mom gave the disease to my baby sister when she was pregnant with her. My baby sister was born with malaria. She died the day before she turned two years old. Her body got too sick because she was so little.



Handout 3

What exactly is happening?



A single-celled parasite causes malaria. The transmitter (also called a vector) of this parasite to humans is a female mosquito. When a mosquito bites a person infected with malaria, it eats the parasite in the blood.

When the mosquito bites another human, it injects the parasite into that person. These parasites cause liver cells and blood cells to burst open.

Typically, symptoms begin 10 days to four weeks after the initial mosquito bite. The person can have an attack of chills, fever and sweating. Other symptoms include headaches, nausea, and diarrhea.

In many cases, medication or the immune system eventually help stop the infection. People who carry a genetic trait called sickle cell are less likely to get sick from the parasite which causes malaria. The sickle cell trait is common in areas where malaria often occurs and can be found in a higher percentage of African Americans. This trait is inherited when a parent has the sickle cell trait and passes it on to their children.

But in other cases, particularly in children and elderly people, complications of the infection may lead to death. Malaria does not occur in the United States but it affects 300–500 million people worldwide and kills 1.5–2.7 million people each year. Currently, there is no proven cure for malaria.

The Plague: A personal story

November 15, 1347
Venice, Italy

I woke up screaming with a terrible headache. My body shook and I couldn't make it stop. I held on to the bedpost and tried to steady myself to stop the shaking. My stomach felt like it had been turned inside out and all of a sudden I realized I must have been vomiting in the night. In my bed. I tried to lift my arms to reach a glass of water. They wouldn't move. My legs felt like they were glued to the bed. My eyes were the one thing that could still move, blink, blink, around and around. The light was too bright, though. I had to close them. I fell back into sleep for another day. Or was it two? I noticed my door and windows were boarded shut. How long had I been inside, I wondered? No one else was inside—my family and dog had already died of this terrible plague and I was the next victim. The next time I woke, there were lumps on my neck, my underarms, my thighs. They burned like they were on fire. Later the lumps turned black and split open. I could see lumps inside my thighs the size of oranges. Now I lie in bed, and I am bleeding internally. There is blood in my urine, blood in my stools, and blood collecting in pools under my skin. It looks like bruises, like I was badly beaten.

Thoughts race through my head. The past few months were terrible for my town. No one knows what this sickness is, or where it came from. Some people say it can be warded off by incense to keep away the deadly vapors. The air smells terrible, the smell of decaying bodies. There are no longer proper funerals, only holes in the ground for mass graves. Towns next to us have resorted to using sound to scare the disease away—clanging church bells and firing cannons. My mother bought charms and spells from the local apothecary, but she died last week anyway.

Handout 3

What exactly is happening?

The plague or "Black Death" is spread by fleas, which people in the Middle Ages did not suspect. Fleas had always been around, but people did not even know insects could transmit disease.

The plague killed nearly one-third of the population of the European continent (20 million people!) between 1347–1351.

The actual cause of the disease is a bacteria. The bacteria usually infects rodents but can be accidentally transmitted to humans.

Symptoms of the disease include high fever, headache, convulsions, blood poisoning, extremely swollen lymph nodes and swollen 'buboes.'

Now, the plague affects 2,000–3,000 people per year (about 10–15 in the United States). There is currently treatment available that greatly increases the chances of surviving the disease.

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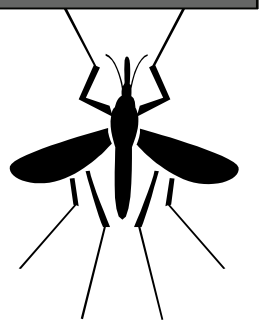
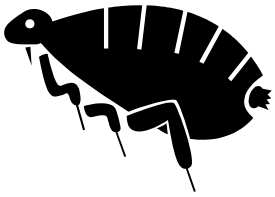
Handout 4



Name:_____

Insects & the Diseases they can spread to People



1. What is a vector?

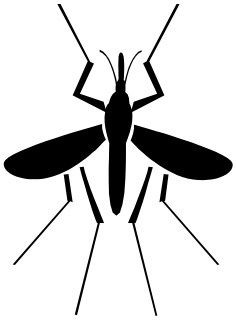
2. What is the vector for the plague? What is the vector for malaria?

3. Which sounds like it would be worse to have—malaria or the plague? Why? Give at least three reasons (symptoms, for example) to justify your answer.

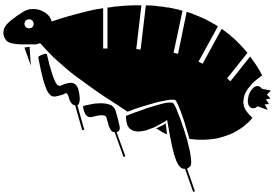
4. Search books or the internet to research an insect-vectored disease besides malaria or the plague. Some examples include West Nile virus, typhus, dengue, yellow fever, or encephalitis.

   a. First, list the cause of the disease (such as a bacteria or virus) and the vector for the disease (such as a mosquito or flea).

   b. On the back of this page or a separate sheet of paper, write a vignette, journal entry, or story about the life of a person infected with the disease. Be sure you use complete sentences and describe symptoms the person experiences. Your entry should be 2–3 paragraphs. Think about how the disease is spread, what the symptoms are, how long a person can be infected, and any prevention methods that might be implemented.



Insects & the Diseases they can spread to People



Biodiversity in the Food Court

SUPPLEMENT 2

Grade Levels: 6-8
Subjects: Science
Setting: Food court at shopping mall or other location.

Time Needed:
One 50-minute block plus travel time

Science Skills:
Observation
Communication
Classification
Prediction

Life Skills:
Problem solving
Cooperation
Communication

Materials for this Lesson:
Food Court Activity
- Handout 5.1 (both sides, copied double-sided)
- Clipboard
- Pen/pencil
- Lunch money

Additional Handout:
- Handout 5.2 (both sides, copied double-sided)

Vocabulary:
Diversity - variety or multi-uniformity

Biodiversity - the diversity of plant and animal life in a particular habitat (or in the world as a whole)

Sunshine State Standards:
SC.(5,6,7).N.1.1

This lesson provides background on the role of biodiversity within our world as well as the importance that it plays in our daily lives. It also introduces youth to ways they can play a part in preserving biodiversity.

Objectives Youth will be able to:

1. Define biodiversity.
2. List at least three types of plants (fruits/vegetables are good examples) sold in the mall food court.
3. List at least three animals (or animal products) sold as food in the mall food court.
4. Estimate the total number of species involved in creating lunch.
5. Give an example of how biodiversity is important in his/her life.

Background Information:

Understanding BIODIVERSITY

The word "biodiversity" was made up in 1985. It is a combination of the words “biological” + “diversity.” The amazing variety of life on Earth is called biodiversity. All the species of plants, animals, and microorganisms make up a biologically diverse earth. Plus, the diversity of genes *within* these species (your skin and eyes aren’t exactly the same as everyone else’s in the world, are they?) makes for even more diversity on earth. Almost all cultures have some way that they recognize the importance of nature, and the need to maintain biodiversity.

Overall, the major issue for biodiversity is how its conservation may be integrated with other needs of society. Why is Biodiversity important? Does it really matter if there aren't so many species? Biodiversity actually boosts ecosystem productivity. Each species, no matter how small, has an important role to play. It is this combination that enables the ecosystem to possess the ability to prevent and recover from a variety of disasters, such as hurricanes. This is obviously useful for mankind as a larger number of species of plants means more variety of crops and a larger number of species of animals ensure that the ecosystem is naturally sustained.

Let's Begin

Before leaving for the Food Court, read the following:

Now we've learned how to determine the general type of insect we are looking at, what stage of life it is in, and the important impact that insects can have on human life. All of these aspects of insect life play a part of the larger circle of life, known as biodiversity. Biodiversity refers to the diversity of plant and animal life in a particular habitat (or in the world as a whole). Plants and animals all have the ability to interact with one another, creating a unique habitat as they do.

Being able to identify the biodiversity in an area sometimes helps forensic entomologists to identify what belongs in a crime scene and what doesn't.

Be sure to review rules for behavior and the plan of action for the assignment (listed below). Pass out Handout 5.1 to youth, and then have them form groups of 2–3 for their time in the Food Court.

Biodiversity in the Food Court

Travel to Food Court	
20–35 minutes	Lunch time at Food Court, eat, and answer Part I of Handout 5.1
Travel back to school	
10–15 minutes	Allow students to complete part II of Handout 5.1 (or it may be completed at home for homework)

***NOTE**: Leader may want to use a camera (Polaroid or digital) to record evidence and require youth to make a collage or add to their "files."*

Let's Reflect

- Someone tell me three types of plants (or plant products) that were being sold in the Food Court.
- What are three animals (or animal products) that were being sold as food in the Food Court.
- Someone share with us what you chose to eat for lunch and what you think the total *number* of species involved in creating your lunch. Explain how you came up with that number.
- Someone define biodiversity in their own words.
- What was the hardest part of figuring out the biodiversity in your meal? How did you solve that problem?
- Did working in a group help you to accomplish this task? Why or why not?

Let's Apply

- Can someone give us an example of how biodiversity is important in your life?
- Why do you think it is important to preserve biodiversity? Give at least **TWO** reasons.
- It is often necessary to work on problems that may not have a perfect answer. Some of you may have guessed the right number of species, some may not. How do you work through a problem even when you might not get the right answer?

EXTENSION ACTIVITIES

Have youth keep a journal for 24 hours of all the foods that they eat. Once they have completed the journal, ask them to figure out how many contributors they had to their meals over the course of a day.

Products made by or with insects…

Bees

Honey

- candy
- cough drops
- honey butter
- Humans' earliest sweetener

Beeswax

- Humans' earliest form of wax
- Candles
- Crayons
- Soap
- Make-up
- Lotion
- Lip balm
- Waterproofing products
- Modeling clay
- Sealing putty
- Furniture polish
- Shoe polish
- Wax for braces
- Molds for crowns, bridges for teeth
- Waxes for golfing, fishing, skiing, sewing needles, floors

Silk moths: Produce silk—a strong, natural fiber

- Clothing
- Stitches (humans)
- Thread for musical instruments
- Carpets and rugs
- Sheets

Scale Insects: Used as source for red dyes for food coloring and cosmetics. About $9 million worth of shellac, made from scale insects, is used annually in the United States.

Insect Galls: Used for tannic acid (for tanning hides to make leather) as well as to make inks.

Blow Fly Larva (maggots): Used to treat battle wounds for centuries, and now also to treat bone infections. They feed on dead tissue and secrete a substance called allatonin.

Handout 1

Name: _____

Group Members: _____

_____

Biodiversity in the Food Court

Directions: In your small groups, complete questions 1–3 during lunch; complete questions 4–6 when you get back to school.

1. List three types of plants (or plant products) sold in the food court.

2. List three animals (or animal products) sold as food in the food court.

3. What did you eat for lunch? Estimate the total *number* of species that were involved in creating your lunch. List the animals and plants you think might have been a part of your lunch below:

4. Define biodiversity in *your own words.*

5. Give one example of how biodiversity is important in *your* life.

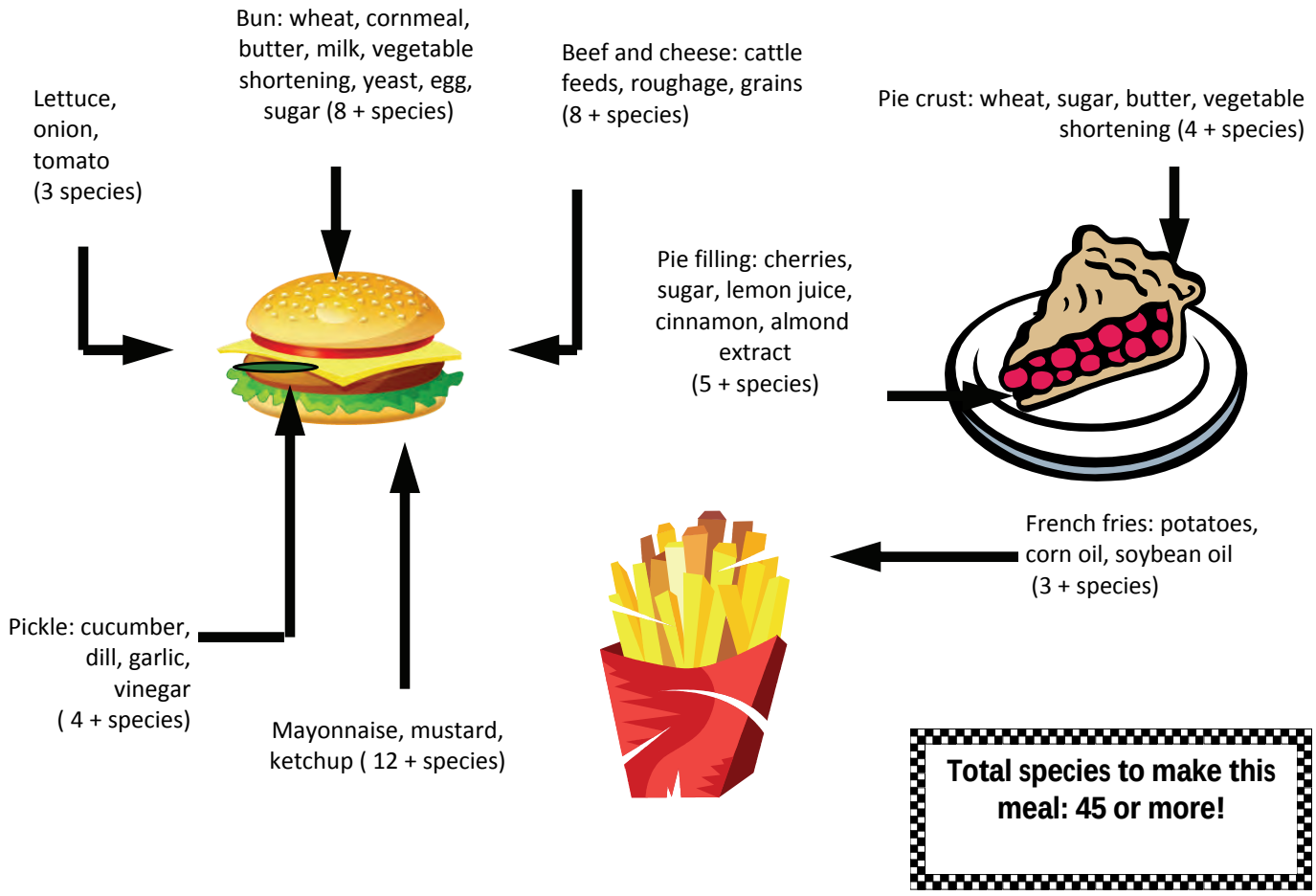
6. Why do you think it is important to preserve biodiversity? Give at least **TWO** reasons.

Biodiversity in the Food Court

The word "biodiversity" is a combination of the words “biological” and “diversity.” The amazing variety of life on Earth is called biodiversity.

All the species of plants, animals, and microorganisms make up a biologically diverse earth. Plus, the diversity of genes *within* these species (your skin and eyes aren’t exactly the same as everyone else’s in the world) makes for even more diversity on earth.

What’s a way that <u>your</u> life depends on biodiversity? How about sitting down to dinner—how many different species does it take to make a meal of a hamburger, French fries, and cherry pie? Take a guess before reading the “menu” below.



Total species to make this meal: 45 or more!

Diagram modified from Biodiversity-Our Living World: Your Life Depends on it!
A PennState Publication, 2001

Handout 2

How can I help preserve Biodiversity?

Stop junk mail from arriving at your home. If 1 million people did this, they could save 1.5 million trees and a lot of energy. Write to:

Mail Preference Service
Direct Marketing Association
P.O. Box 9008
Farmingdale, NY 11735-9008,

or visit www.the-dma.org/consumers or stopjunk.com.

Help protect tropical forests and birds by buying shade-grown coffee. Coffee plantations that grow coffee under a canopy of trees provide better habitat for biodiversity than plantations that strip away all vegetation but the coffee plants.

Instead of buying a new table or dresser, shop around at used furniture outlets, yard sales, and antique stores. Not only will you save money but you'll also save trees and wood.

Plant and nurture trees in your community and around your school. Trees not only produce oxygen but also guard against global warming by absorbing CO2. They even lower our air-conditioning needs in summer by shading our homes and offices. The National Arbor Foundation <www.arborday.org>, the National Tree Trust <www.nationaltreetrust.org>, and TreeLink <www.treelink.org> can provide information and resources and can help you find others in your community with similar interests.

At your dinner table, use cloth napkins rather than disposable paper ones. Paper accounts for the largest percentage of solid waste at landfills. By reusing cloth napkins, you can help cut down on solid waste and help protect forests.

When shopping, choose products in limited packaging, such as buying pasta and cereal in bags rather than boxes. This will not only help cut down on the amount of waste in landfills, but will also help reduce our need to harvest trees for paper packaging.

If you bring your lunch to school or work, pack it in a lunch box or reusable cloth bag rather than in disposable paper bags. Using reusable bags not only will help cut down on the amount of waste in landfills, but also will help reduce our need to produce throwaway paper products.

Look for ways to reduce your paper use. Try using both sides of every sheet of paper, cutting paper into smaller squares for memo paper, reusing envelopes, and other paper-saving techniques. On average, each American uses 730 pounds of paper per year. That's seven times as much as the world average.

Help start a paper recycling program at your school if there isn't one already. You can collect information about recycling services in your community, organize students to help in paper collection, and provide information about how many resources can be saved by recycling paper.

Buy recycled paper products for your home, including sheet paper, envelopes, paper towels, napkins, and toilet paper. Look for products that contain at least 50 percent post-consumer waste. This means that at least half of the material used in making the item comes from paper that people like you have recycled. If your store doesn't carry recycled paper products, tell the manager you would like it to do so. Encourage your school to also buy recycled paper products.

Consider taking a family vacation that will help biodiversity. Earthwatch (www.earthwatch.org) is an organization that allows citizens to assist with scientific research, and the group's website details a range of research expeditions that explore the biodiversity of the planet. You could spend your next vacation working with scientists studying anything from ospreys to orangutans.

Visit forests responsibly, remembering to bring out everything you take in, clean up litter left by others, stay on marked trails, and respect wildlife. To learn more, contact the Leave No Trace program for publications and educational materials at 1-800-332-4100 or on the Web at www.lnt.org.

Participate in National Trails Day and other events that highlight the need for parks, trails, and open spaces. The American Hiking Society (www.americanhiking.org) can help you find an event near you and can even help you plan an event.

Donate used books and magazines to hospitals, retirement homes, women's shelters, or libraries. The donations not only will help these organizations, but also will reduce the resources used to produce paper. Paper accounts for the largest percentage of the volume at solid waste landfills.

Recycle your old newspapers. Americans throw away the equivalent of more than 30 million trees in newsprint each year. Take them to a commercial or community recycling center if your town doesn't have curbside recycling. Recycling 1 ton of newsprint saves 17 to 20 trees, uses 30 to 70% less energy than does making paper from trees, and reduces related air pollution by 95 percent.

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(Modified from "Taking action for forests." From Biodiversity 911: Saving Life on Earth, a traveling exhibit by the World Wildlife Fund)

Certificate of Completion

I certify that _____

has successfully completed

the requirements of the

Forensic Entomology Achievement Program.

Leader: _____

Date: _____

The 4-H Motto

To make the best better.

The 4-H Pledge

I pledge

my head to clearer thinking,

my heart to greater loyalty,

my hands to larger service, and

my health to better living,

for my club, my community,

my country and my world.

Visit the 4-H website for more information:

http://www.florida4h.org/projects/forensics.shtml

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