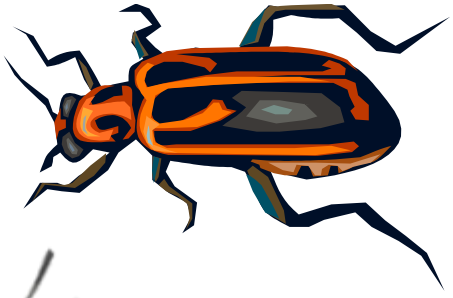
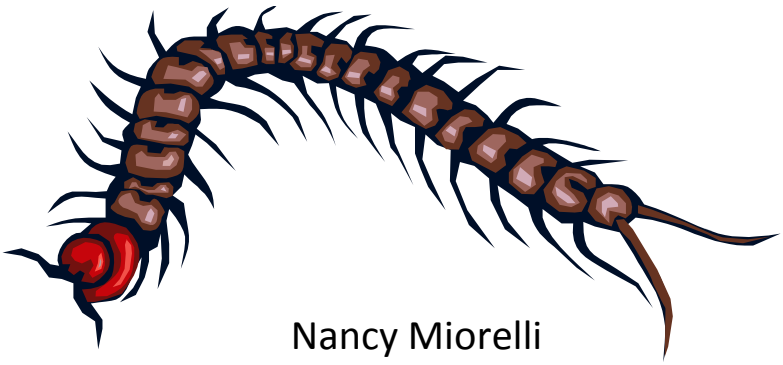


UNIVERSITY OF GEORGIA

High School integrated Pest Management Lesson Plan

The Department of Entomology



Nancy Miorelli

Standards

Georgia Standards 9-12			Next Generation Science Standards 9-12
Biology Standards	Ecology	Entomology	
Habits of Mind ° SCSh1 ° SCSh3 ° SCSh4 ° SCSh6	Habits of Mind ° SCSh1 ° SCSh3 ° SCSh4 ° SCSh6	Habits of Mind ° SCSh1 ° SCSh3 ° SCSh4 ° SCSh6	Natural Selection and Evolution: ° HS-LS4-5
The Nature of Science ° SCSh7 °SCSh8	The Nature of Science ° SCSh7 °SCSh8	The Nature of Science ° SCSh7 °SCSh8	Interdependent Relationships in Ecosystems ° HS-LS2-1 ° HS-LS2-6 ° HS-LS4-7 ° HS-LS2-8 ° HS-LS4-6
Co-Requisite Content ° SB2 ° SB3 ° SB4 ° SB5	Co-Requisite Content ° SEC1 ° SEC2 °SEC5	Co-Requisite Content ° SEN1 ° SEN2 ° SEN3 ° SEN4 ° SEN5	

Common Core 9-10	Common Core 11-12
° CCSS.ELA-LITERACY.RST.9-10.2 ° CCSS.ELA-LITERACY.RST.9-10.3 ° CCSS.ELA-LITERACY.RST.9-10.4 ° CCSS.ELA-LITERACY.RST.9-10.7 ° CCSS.ELA-LITERACY.RST.9-10.9	CCSS.ELA-LITERACY.RST.11-12.2 CCSS.ELA-LITERACY.RST.11-12.3 CCSS.ELA-LITERACY.RST.11-12.4 CCSS.ELA-LITERACY.RST.11-12.5 CCSS.ELA-LITERACY.RST.11-12.7 CCSS.ELA-LITERACY.RST.11-12.8 CCSS.ELA-LITERACY.RST.11-12.9

Overview:

- What are some of the adaptations that arthropods have to survive in their respective environments?
- How do arthropod organ systems compare to mammalian organ systems?
- How do genetics and play a role in resistance?
- How can we modify our practices for effective pest management control?

Objectives:

- Students learn about arthropod anatomy and organ systems.
- Students learn how the arthropods are adapted to live in their respective environments.
- Students hone observation skills.
- Students learn to identify arthropod groups.
- Students learn about pesticide use throughout history and their associated effects.
- Students use their knowledge to analyze and provide solutions for case studies.

Game Plan:

The parts can be done all at once, or broken up over several days or weeks.

- Optional Overview – Arthropod General Introduction
- Part 1 – Arthropod Sketches
- Part 2 – The Inside of Arthropods
- Part 3 – Model an Arthropod
- Part 4 – Genetic Variability and Insecticide Resistance
- Part 5 – Arthropod Control through Varying Methods and Integrated Pest Management
- Part 6 – Case Studies

Optional Overview – Arthropod General Overview

The instructor should determine if this is necessary based on the level of the class

Objectives:

- Students review different types of arthropods
- Misconceptions about basic understanding and identification of groups are addressed

Plan:

Setup:

1. The instructor should create an activity either with insect cutouts (http://www.scibugs.com/#!lesson-plans/c1g8k) or a PowerPoint with pictures (www.bugguide.net).The goal should be for students to adequately place the arthropods into one of the following groups: Insects, Arachnids, or Myriapods.

Class Discussion:

2. After (or during depending on the preference of the instructor) the students should be led in a class discussion.
   - **Where are the arthropods are typically found?** Do the students even recognize some of the arthropods provided? What types of habitats do the students think the arthropods dwell in? What do they think the arthropods need in their different habitats?
   - If the instructor wants more in depth activity, the "Determining Habitats or Arthropods" as part of the Elementary School Lesson Plan can be used. (http://www.scibugs.com/#!lesson-plans/c1g8k)

2. Perception:
   - Do students like these animals? Are their friends or families afraid of them? Were there bad experiences?

Vocabulary:

Taxonomy: is the science of classifying, grouping, and naming biological organisms.

Insect: A class of animals that includes arthropods with six legs and antennae.

Arachnid: A class of animals that includes arthropods with 8 legs and no antennae.

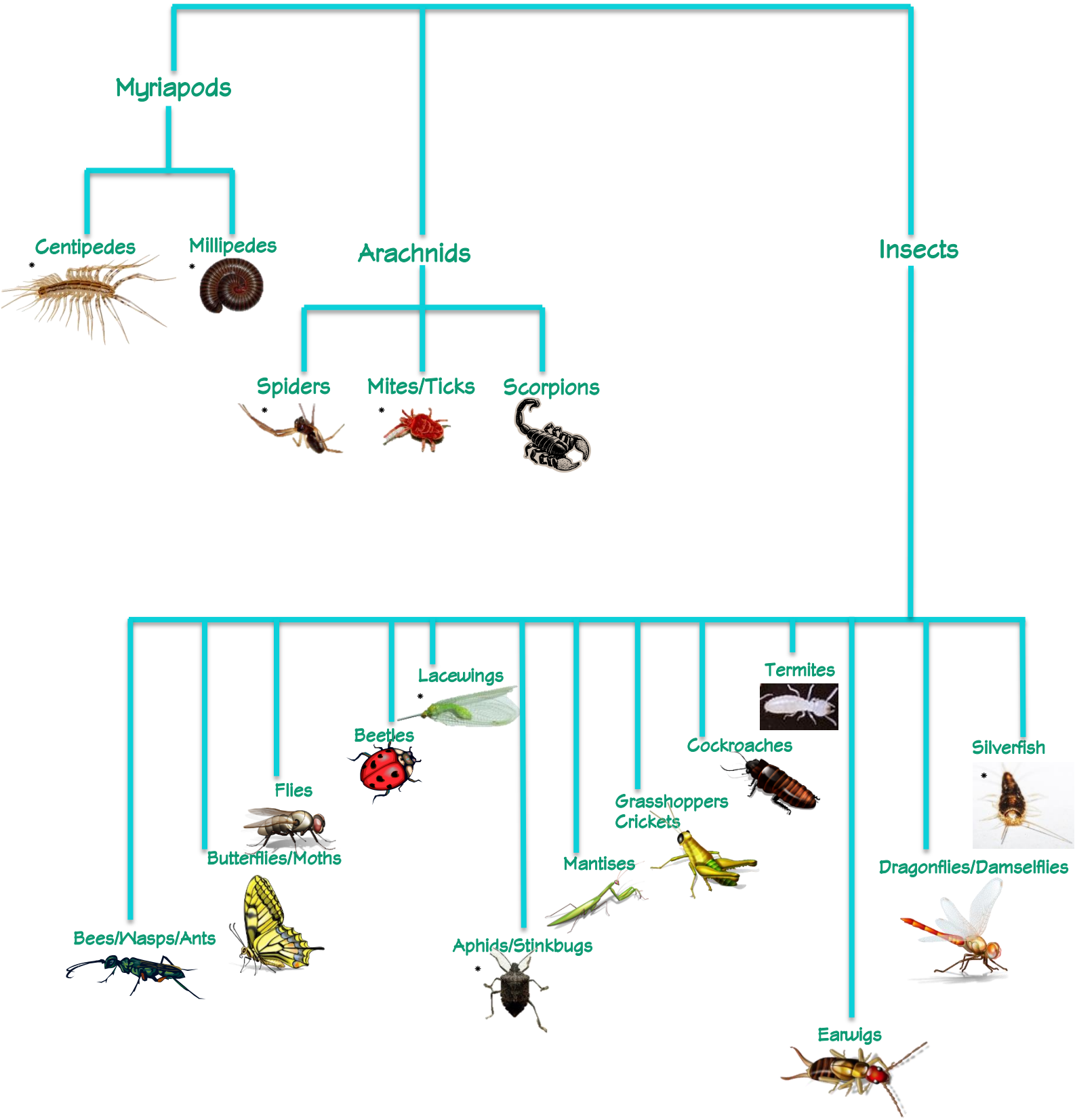
Myriapod: A subphylum of animals that have long bodies, many legs, and antennae.

This **wasp** is an **insect**. It has six legs and a pair of antennae.

This **spider** is an **arachnid**. It has eight legs and no antennae.

This **millipede** is a **myriapod.** It has many legs and a pair of antennae.

Arthropod Relatedness



* **Photo Credit:** Bruce Marlin, Jud McCranie, Nancy Miorelli, Olei, Nancy Miorelli, Lildobe, Nancy Miorelli

Part 1– Arthropod Sketches

Objectives:

- Students observe arthropods in their natural environment
- Students note behavior and external adaptions that aid the animal in their environment.
- Students strengthen their observation and critical reasoning skills.

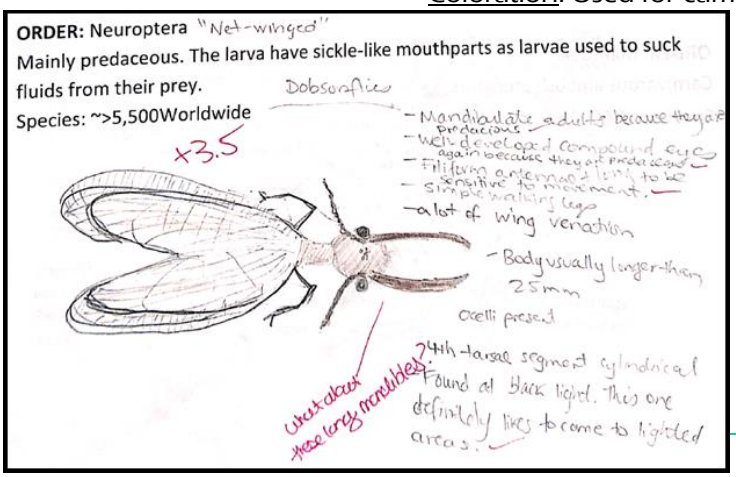
Plan:

Setup:

1. The instructor either decides or leads a group discussion where the students decide where they will observe their arthropods. This arthropod observation can either be done in class, or be assigned for homework.

Activity:

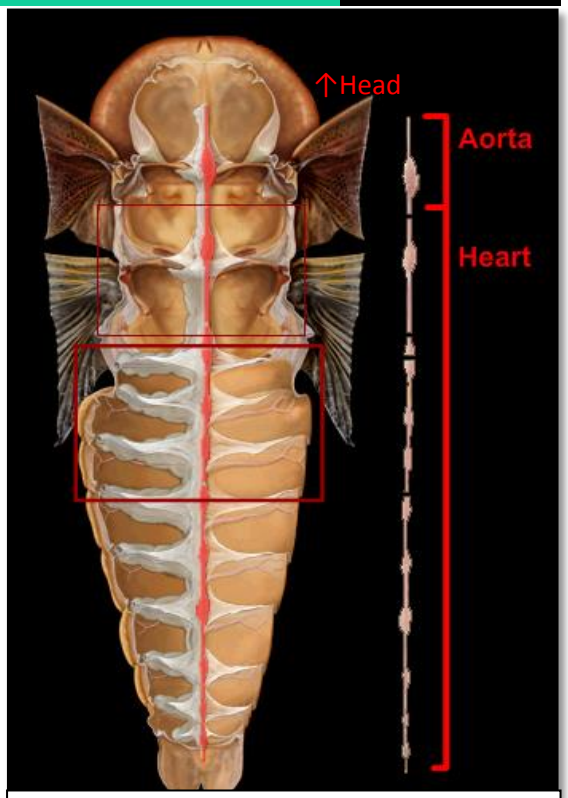
2. Students pick at least two environments in which to observe arthropods.
3. Students provide detailed annotated sketches of **three** arthropods of choice. These sketches should include
   a. The location (habitat type in which the arthropod was found). These locations can include inside buildings, ponds, fields, gardens, leaf litter, forests etc…
   b. An identification of their arthropod as an **Insect**, **Arachnid**, or **Myriapod**. Students should identify their arthropod to order. (www.bugguide.net) (http://keys.lucidcentral.org/key-server/player.jsp;jsessionid=BF6550703B3E21E68ED018FF90B22251?keyId=1).
   c. Students should label adaptations the arthropod has to aid it in its habitat including anatomical and behavioral.
   d. In addition to labeling the adaptions, students should reason as to why this helps the organism.
      - Students are encouraged to look at the shapes of certain features. For instance, many insects have wings but they are different shapes and colors. Students should reason as to why those features evolved in this way.
      - **Example Adaptations**:
        - Exoskeleton – water balance/protection
        - Antennae – sensing the environment. Generally long antennae gather more sensory information than short antennae
        - Eyes – Visual sensory information. Most insects can see orange to ultraviolet light. Large eyes with more lenses detect more information than little eyes.
        - Legs – Insect legs have been modified for many different purposes including jumping, catching prey, swimming, and digging.
        - Wings – Allow for dispersal. Dragonflies with narrow wings are built for speed whereas butterfly wings are used to signal potential mates.
        - Mouthparts: Arthropods eat a wide variety of material. Spiders have fangs which inject venom into the prey. Beetles tend to have strong mouthparts to chew through wood. Butterflies have proboscises to drink nectar.
        - Coloration: Used for camouflage, mimicry, or to warn of toxicity.



Example student work for a similar assignment

Praying Mantises are insects that have forelegs for capturing prey. They have four wings; the outer most are slightly hardened for protection. The praying mantis's large eyes indicate that it is a visual predator.

Part 2– The inside of Arthropods



The circulatory system of the cockroach. Alary muscles are connected to the heart and the aorta. Hemolymph (the blood) bathes the internal organs and the heart is responsible for circulating the blood.

Objectives:

- Students learn about how the insides of arthropods work
- Students compare and contrast human organ systems to arthropod organ systems
- Students present scientific information to their peers.

Plan:

Setup:

1. This part of the lesson plan starts with the physiology of insects. If the instructor wishes to know more about the basic physiology of the insects, he or she may want to watch the following YouTube video.
   http://youtu.be/Dh5uAOAwKJw
   [www.youtube.com/scibugs Physiology]
2. The instructor should access "The Virtual Roach" (http://www.orkin.com/cockroaches/virtual-roach/)
3. Alternatively, the instructor can lead a dissection lab using lubbers for the dissection.
   a. To buy lubbers: http://www.hometrainingtools.com/grasshopper-lubber-large/p/PM-GRASHOP/#review-sec
   b. Lubber Anatomy and Dissection: http://www.hometrainingtools.com/grasshopper-dissection-guide/p/DE-GDGRASS/

Activity

4. The instructor should outline a class discussion including the following
   a. Do the students think insects have hearts, nerves, brains, lungs, and veins like we do? Why or why not?
   b. Have students heard of the notion that "Cockroaches can live for a week with their head cut off?" How do students think this could be possible? What do students think the cockroaches die from? (Answer, starvation).
5. The instructor either leads the lubber dissection or the virtual roach demonstration.
   a. The instructor should cover the following systems: **Digestive, Excretory, Circulatory, Respiratory, and Nervous.** Optional: (**Reproductive**)
   b. The important things to note are
      i. Insects have open respiratory and circulatory systems. Meaning blood and oxygen are not transported through the body like in people. The insects blood (**Hemolymph**) bathes the organs and the heart is responsible for moving blood around the body. Likewise, air enters small holes on the sides of the insect's body (**Spiracles**). Oxygen travels through several series of tubes and diffuses into the cells.
   c. After viewing the respective systems, the instructor should break the students into groups. Each group will get an organ system to research and give a 10 minute presentation including the following:
      i. What the organ system's main responsibility is
      ii. How the organ system works
      iii. A comparable organ system in mammal (Ex. The circulatory system in Insects vs. the circulatory system in humans)
      iv. A brief explanation as to how the organ systems are different in humans and arthropods.

Part 3– Arthropod Models

Objectives:

- Students build a model arthropod.
- Students present their model to their peers in a presentation.

Possible Sample Mediums

- Legos
- Minecraft (or similar)
- 3D Printing
- Puppets/Dolls
- Clay
- Paper

Students should not feel limited by the kinds of materials or medium that they wish to use when creating this model.

A paper model of a cockroach with labeled parts

Model by Jim Kay and Richard Ferguson
George McGavin. 2013. *Bugs*. Somerville Massachusetts: Candlewick

Homework Assignment

1. This model should be done for homework.
2. The students create a model insect based on one of the three arthropod drawings they did.
3. This model should represent that external anatomical features that were annotated in the sketch and the organ systems mentioned in class.
    a. The instructor may provide a list of internal structures that the students can include, but the students do not have to include all of them.

Activity:

4. The models should be put on display so all the students can see them
5. Each student should talk about their model to the class including
    a. The order of the arthropod and if it's an Insect, Arachnid, or Myriapod
    b. Where they found the arthropod and what it's behavior was at the time
    c. The anatomical adaptations they noted and how the student thinks these adaptations would be helpful for the arthropod.
    d. The internal anatomy they included
    e. What materials they used to construct their arthropod and some of the challenges that were posed making it.

Part 4– Genetic Variability and Insecticide Resistance

The Public Domain

Objectives:

- Students understand that insects have a short generation time and produce a lot of offspring
- This aspect of insect biology means that insect resistance can appear readily
- Insect resistance and pesticide use is looked at throughout history

Plan:

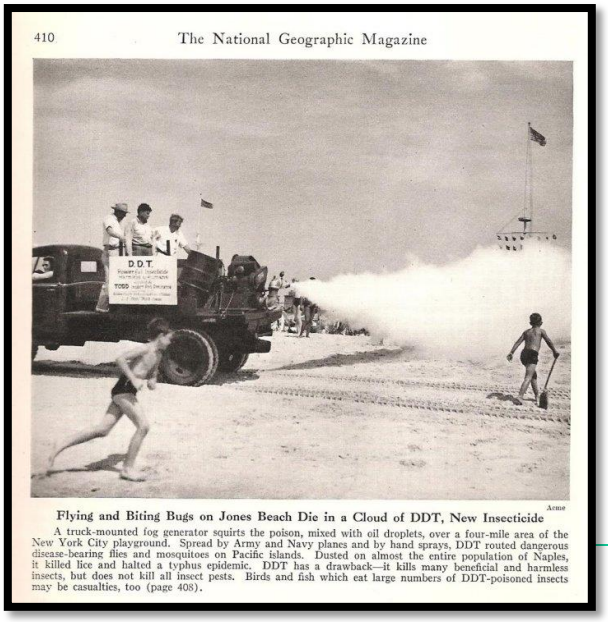
Setup:

1. The instructor should be familiar with the history of DDT and associated environmental impacts that it had.

Activity:

2. The instructor will present a brief history on the uses and environmental issues associated with DDT (dichlorodiphenyltrichloroethane).
    a. Synthesized in 1874 and its insecticidal properties were discovered in 1939. Paul Herman Müller was awarded a Nobel Prize in 1948 for this discovery.
    b. DDT was initially used in the military to control for mosquitos and typhus.
    c. It was subsequently used for agricultural use.
    d. Insect resistance.
    e. Rachel Carlson's book, *Silent Spring*, and its catalogue of environmental issues caused by DDT.
        i. Near extinction of raptors
        ii. Human health risks
    f. DDT's official ban in 1972.

3. The instructor should then start a class discussion including the following points
    a. How did we change the environment? How did populations change in response?
        i. How did these changes happen?
        ii. Why were insects able to cope with the environment faster than the apex predators?
            1. What adaptations do insects have to cope with the rapidly changing environment?
    b. What benefits did DDT have?
        i. It should be included that DDT eradicated malaria from the United States.
    c. What detrimental effects did DDT have?
    d. How could DDT have been used more responsibly?



Flying and Biting Bugs on Jones Beach Die in a Cloud of DDT, New Insecticide

A truck-mounted fog generator squirts the poison, mixed with oil droplets, over a four-mile area of the New York City playground. Spread by Army and Navy planes and by hand sprays, DDT routed dangerous disease-bearing flies and mosquitoes on Pacific islands. Dusted on almost the entire population of Naples, it killed lice and halted a typhus epidemic. DDT has a drawback—it kills many beneficial and harmless insects, but does not kill all insect pests. Birds and fish which eat large numbers of DDT-poisoned insects may be casualties, too (page 408).

The Public Domain

Part 5– Arthropod Control in Varying Methods and Integrated Pest Management.

Objectives:

- Students learn about different methods of pest control and the history
- Students discuss how they can promote

Plan:

Setup:

1. The instructor should be familiar with how insects grow and develop (http://youtu.be/NoMBSm8KkjI) [www.youtube.com/scibugs Growth and Development]
2. The instructor should be familiar with other methods of pest control (GMOs, Biocontrol, Targeted Insecticides)

Activity:

3. There were two take away messages from the use of DDT
   a. Regulated pesticide application
   b. A variety of methods need to be used to avoid pest resistance.

4. The instructor should have a short presentation that includes the following methods of pest control.
   a. **GMO**'s – Genetically Modified organisms come in all varieties from drought resistant wheat to corn that can produce a specialized, easily degradable insecticide called Bt.
   b. **BioControl** (Biological Control) – Many insects and arthropods have predators that either eat or parasitize them. These predators can be used to control pest populations. The first successful biological control effort was in Australia to control the Cottony Cushion Scale Insect.
   c. **Sanitation** – Many indoor pests can be dissuaded by just keeping the area clean and reducing habitat space for them. This includes throwing trash and food in the garbage cans, cleaning up spills, and reducing areas that could provide as shelter for the organisms.
   d. **Targeted Insecticides:** Many insecticides have come to market that degrade quickly in the environment, are targeted for specific insects and will not affect non target species. These can come in sprays, baits, and traps.

5. Integrated Pest Management
   a. IPM (Integrated Pest Management) does not condemn the use of pesticides. Instead it is a practice using all of the aforementioned techniques and using pesticides when there is a need for them.
   b. The instructor should lead a **Discussion** including the following topics
      i. What do the students think some of the biggest barriers to the IPM method is?
         1. Fear of pests
         2. People are uneducated about the options and control methods
            a. Not only that there are options, but people fear things like GMOs
      ii. How can we solve some of these problems?
      iii. How can we work together to promote IPM in our spaces?

Aphids can be an ornamental pest and an agricultural pest. The braconid wasp can be an effective biological control agent to reduce aphid numbers.

Part 6– Case Studies

Objectives:

- Students work though a case study using elements from this lesson plan.
- Students take previous knowledge and apply it to new situations

Plan:

Setup:

1. The instructor distributes the two case studies. The students can choose or the instructor can decide for the students.

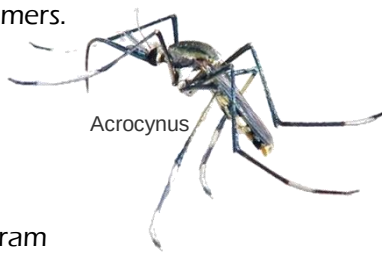
Cockroach Case Study

"Medio Italy" is a restaurant that opened last year. Despite producing wonderful Italian food and killer pizza, the management has come under scrutiny because of an alleged cockroach problem. You have been called in to help. You talk to the kitchen staff and they tell you that cockroaches scurry to their hiding spots when the staff enters the kitchen for the first time every morning. The staff tells you that they don't know of any current measures being used to treat the infestation. Looking around the kitchen for yourself, it does not look to be properly cleaned. The back door is usually propped ajar and a dumpster is only a few feet away with the lid opened. The owner of the restaurant asks you for help to save his restaurant.

Gary Alpert

Mosquito Case Study

"Windcrest Acers" is a farm that offers horseback riding lessons and boarding. They have an indoor and outdoor riding ring, four pastures for the horses, and three small ponds. The barn always had problems with flies, but this year they've had a particular problem with mosquitoes. You have been called to help investigate the situation. Upon your arrival you immediately notice the ponds are covered in a thick algae and investigation of the areas lead you to conclude that no fish or frogs are living in the ponds. Further investigation of the area several areas where stagnant water can build up particularly in some of the pastures where the large water buckets are only emptied and refilled every couple weeks. The grain room's door is usually kept shut but you find many flies in that room anyway. All mucked stalls remnants and waste is discarded in a compost pile at the edge of the property. The owner asks for your help for the safety of her animals and to keep her customers.



Acrocynus

Setup:

2. For each of the following cases the students must give:
    a. A brief background on their organism
        i. Basic adaptations it has to thrive in the given habitat
        ii. Basic growth and development of the insect including a life cycle diagram
        iii. Basic behaviors of the organism that apply to the given situation
        iv. Basic needs of the organism and how the current situation provides it to them
    b. A strategy for combating the current problem using various strategies.
        i. The instructor may want to encourage students to research particular pesticides or chemicals that are effective on these organisms and explain why those were decided upon.
    c. An educational system to help promote understanding of the pest's biology to both the owners and the staffs of these establishments.