

## Unit IV Insects

A major portion of the information for this unit was obtained from “The guide to the Common Aquatic Invertebrates of the Loxahatchee Basin” by Carlos L. de la Rosa, Ph.D. and Carlos A. de la Rosa

### On the cutting edge...

Scientists at Brooker Creek Preserve are on the cutting edge of science using biological indicators to survey the health of the ecosystem and its watershed area. In addition to using the latest electronic sensors to measure water quality, scientists can verify their results by studying the health of biological indicators. In this case, by looking at aquatic insects in the various preserve habitats, researchers can tell if the food webs are still intact.

## Aquatic Insects

**Lesson Objectives:** Students will be able to do the following:

- Categorize aquatic insects with regard to their habitat
- Describe the functional trophic groups of aquatic organisms
- Distinguish between complete and incomplete metamorphosis

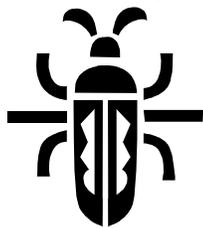
Key concepts: insect, macrohabitat, microhabitat, functional trophic group, complete metamorphosis, incomplete metamorphosis

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## Insects and their Habitats

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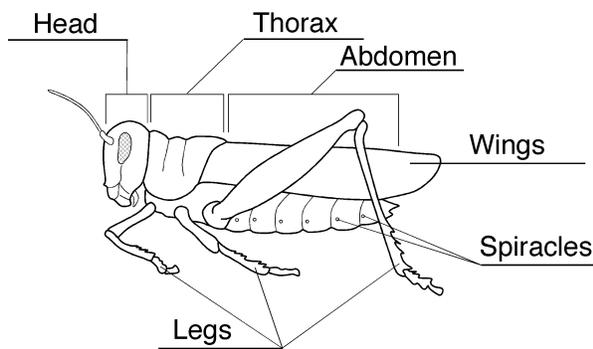
**Insects** are one of the largest groups of organisms on earth. Only about one million species have been identified of the one billion estimated to exist. Their three distinct body regions, six legs, and sometimes wings identify insects. The three body regions include: the head, the **thorax**, and **abdomen**. The head contains the mouthparts and most of the sensory organs. The thorax provides the attachment area for the three sets of legs and if present the wings. The



abdomen mainly functions in digestion, respiration, and reproduction. Insects also have a tough exoskeleton that protects them from natural enemies and extreme changes in environmental conditions.

Insects have interesting internal **adaptations** designed to suit their lifestyles. For instance, insects have open circulatory systems that allow the blood to move around inside the body cavity without being enclosed in blood vessels. This helps to more efficiently distribute oxygen and nutrients to all body parts. Insects breathe using openings on the body

called **spiracles**. Air enters the body through these holes and is distributed throughout the insect's body. Insects that eat have digestive systems that are long tubes divided into parts for different functions. The insect nervous system transports information from the sense organs such as the antennae and eyes to the brain for processing. Other information is processed at nerve centers throughout the body.



Insects can also be categorized and classified in other ways. Scientists classify organisms by studying similarities and differences in their appearance (including shape, size, color, etc.) They also study behaviors, **life cycles**, and other characteristics. For instance, insects can be divided into two large groups: those found in aquatic environments and those found in terrestrial environments. These large categories can continue to be divided until we have insects that are similar in many ways. In this program, we will focus on the aquatic insects and learn about some of their distinguishing characteristics and behaviors.



Aquatic insects make their homes near or in water. The places where these organisms live are called **habitats**. Aquatic habitats can be divided into two categories based on size. Aquatic



**macrohabitats** are large, complex areas such as oceans, lakes, and ponds. Aquatic **microhabitats** are much smaller environments such as the single blade of a submerged plant. Microhabitats are the specific places where individuals of a particular species or group prefer to live. There are many microhabitats within a larger system. They can be described in relation to the water itself. For instance, the water habitat can be divided vertically or horizontally.

Looking at the water from top to bottom, we discover three distinct microhabitats: the surface, the water column, and the **benthos** or bottom community. The water surface is home to insects adapted to living on the layer between air and water such as the water striders, or those using the surface from below to breathe like the mosquito larvae. Still others may live half in and half out of the water like some of the beetles. The water column itself is a busy place. Insects and many other organisms like fish are found in the water column. Nutrients that are food for the insects are found here as well as pollutants. These materials travel through the system as the water circulates. Insects may also be carried along

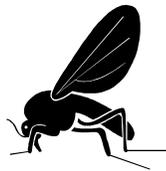


with the water flow from one place in the water column to another. The bottom or benthos provides additional habitat for some insects. They make their homes in the muddy or sandy bottom sediments or use materials such as roots and rocks for homes.

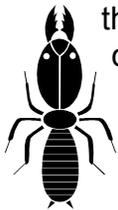
Aquatic habitats can also be divided along horizontal lines. Scientists study the distribution of insects from the shore through the splash zone, to the deeper water zones. Who and what lives within them can help characterize these areas.

## Aquatic Insect Adaptations

Insects have successfully used their adaptations to colonize all environments even the ocean. Using their wide variety of body forms, sizes, and behaviors has helped specific species inhabit unique microhabitats. For instance, some insects have combined their small size with their ability to fly. This allows them to escape from enemies and spread to new environments where they can find adequate amounts of food and protection. Other species have wide distributions, short life spans, or numerous offspring to help increase the odds of successfully completing their life cycles.



In this section, we will take a closer look at some of the adaptations for breathing, moving, eating, and reproducing that have helped aquatic insects thrive in their chosen habitats.



Insects need to breathe in order to supply their bodies with oxygen. Without oxygen insects would die. Most insects obtain oxygen directly from the atmosphere, because they evolved on land and then colonized

the water. Aquatic insects completing portions of their life cycles in or on the water have developed some interesting adaptations to solve their breathing problems. For example, mosquitoes breathe through tubes that they place on the water surface, and aquatic beetles carry bubbles of air with them under their wings. Some aquatic insects have life stages adapted to complete aquatic living, such as the mayfly. Mayfly larvae actually have gills and obtain oxygen directly from the water. Damselflies exhibit similar adaptations.



The wings and legs of aquatic insects are adapted for various types of locomotion. Efficient wings propel predatory insects such as damselflies and dragonflies through the air to catch their **prey**. They display incredible speed and agility in the air. Other aquatic insects perform aerial acrobatics during their mating rituals. Aquatic insect legs are adapted for swimming or grasping. The water boatman uses its pair of oar-like legs to “paddle” through the water while water

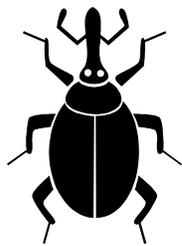
striders stay afloat due to surface tension and specialized structures on the tips of their legs. Mayflies have adaptations for living in rocky and fast running streams. These adaptations include flattened bodies and strong claws for hanging on.

Dragonflies

emerging from eggs laid in or near water use the claws on their feet to crawl onto plants.



Feeding adaptations can be categorized according to what the insect eats and how the insect eats. Groups based on what insects eat include **herbivores**, **detritivores**, and **carnivores**. Herbivores eat plant material. Detritivores eat dead plant tissues and other organic matter. Carnivores eat other organisms. Aquatic insects that are carnivores are also known as **predators**, because they hunt their food. The water strider is a predator that eats prey that fall onto the water surface. It uses its sensitivity to motion and water vibration to locate



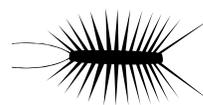
its food. It grabs its prey, stabs it with its sharp beak, and sucks its juices dry. In turn, predators of the water strider such as birds and fish take advantage of the fact that the water strider cannot detect motion above or below the water surface. Even the larval stages of some aquatic insects are adapted for predatory lifestyles. For example all of the dragonfly and damselfly

**larvae** have a large pair of jaws with teeth on the end that folds under their mouthparts. This apparatus called the **labium** looks like an extra arm and is designed to grab and hold their prey and place it close to the mouth of the larvae.

Trophic functional groups identify the mode of eating. These include the scrapers, shredders, engulfers, and piercers. Scrapers, such as some mayflies, are plant eaters with specialized mouthparts adapted for removing algae from the surface of submerged plants and other surfaces. Water mites and some chironomid larvae are examples of shredders. These insects break apart decomposing leaves into smaller pieces and eat them.



Engulfers, such as the water beetle, are predators that eat their prey whole or in chunks. Piercers have a **proboscis** used to suck the juices from their prey. Filter feeders eat fine **detritus** or decomposed material that they collect from the water. Many of the insects feeding in this fashion including some caddisfly and chironomid larvae either have specialized structures in their bodies to collect detritus or build tiny nets in which to capture these minute particles.



Reproductive adaptations are critical for the survival of any organism. Aquatic insects have found a variety of adaptations useful

for the successful completion of their life cycles. These adaptations include reproducing large numbers of offspring relatively quickly and having adult stages of short duration

primarily for mating. Many adults do not even feed and die a few hours after mating. Additional information about life cycles and reproduction will be found in the following section.

## Life Cycles

Aquatic insects have developed life strategies that allow them to adapt to ever changing seasonal conditions in which they must reproduce enough offspring to carry



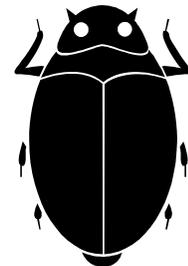
on the species. One of these strategies is a metamorphic life cycle. **Metamorphosis** means to change in appearance. Just as metamorphic rock is a rock that has changed from one form to another, so insects metamorphose or change form during their life from larvae to adults. The life cycles of many aquatic insects is split between land and water. Insects have learned how to complete all portions of their life cycle in water except the mating and reproductive processes.

The metamorphic process can be described as complete or incomplete. During **complete metamorphosis** the insect develops through the following four stages: egg, larvae, pupae, and adult. Mosquitoes are an example of an aquatic insect that has a complete metamorphic life cycle. The complete life cycle of the mosquito



takes about a month. The adult female, after having a blood meal, lays tiny white eggs in standing or slow moving water. Within a week the eggs hatch into larvae that breath through tubes that extend above the water surface. The primary purpose of the larvae is to eat and grow. They eat things that float in the water and in some species may even eat each other. As the larvae grow, they go through several changes to prepare themselves to become adults. During this time, they molt or shed their outer covering, as changes take place.

After this process the larvae stop eating and become **pupae**. Pupae continue to live near the water surface using breathing tubes for oxygen. After a few days, the pupae swims to the surface, the pupal skin splits open and the adult emerges. These adults search for mates. After mating the female adults lay their eggs in the water and die and the cycle begins again.

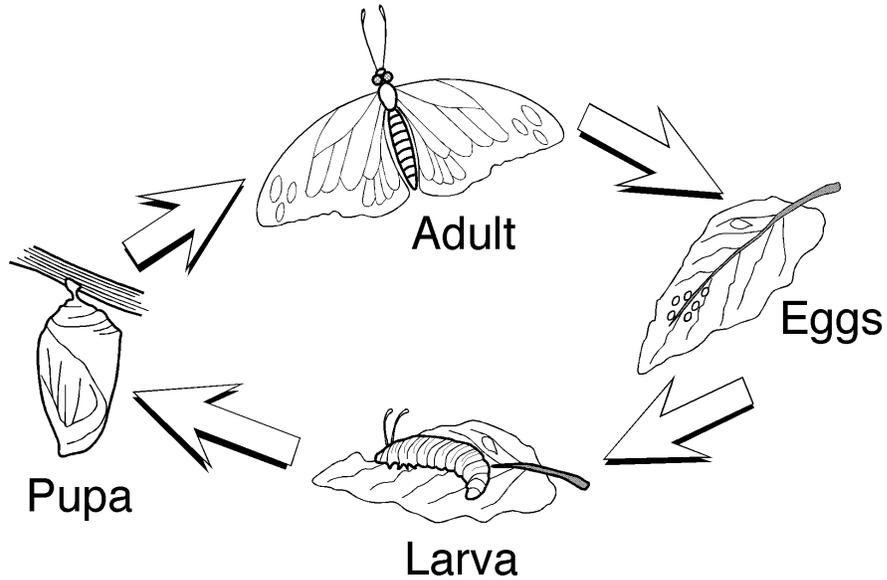


Other insects develop through **incomplete metamorphosis**. During this life cycle, the insect develops through egg, larval or **nymph** stages, to the adult. The

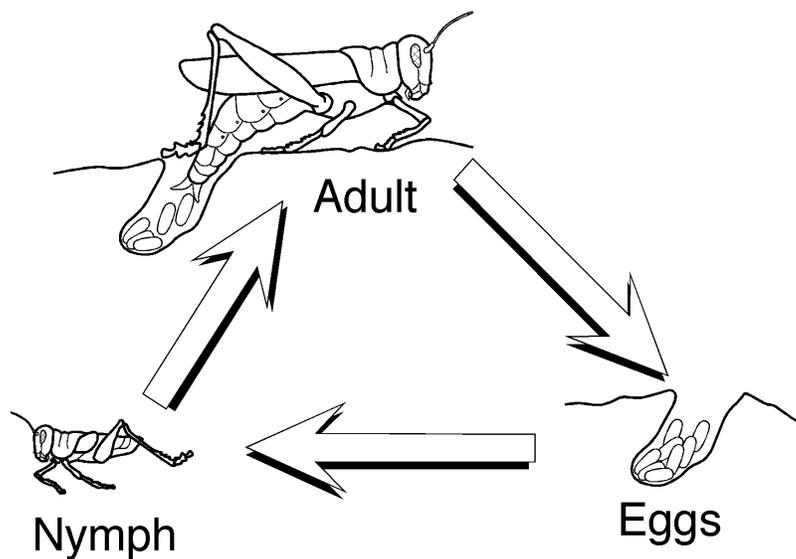
nymphs are similar in appearance to the adults though they do not have wings and may be colored differently

than the adult. Dragonflies, damselflies, mayflies, and true bugs all have this type of life cycle.

### Complete Metamorphosis



### Incomplete Metamorphosis



## Activity: Insect Observation

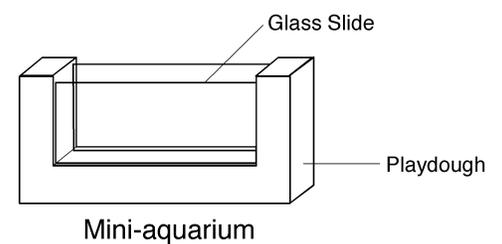
Taken from *The Guide to Common Aquatic Invertebrates of the Loxahatchee Basin* by Carlos L. de la Rosa, PhD. and Carlos A. de la Rosa

Scientists study insects to find out more about their ecological importance and to classify them. By classifying insects, researchers can compare different types of insects according to their behaviors and physical characteristics. By studying their importance within the environment, researchers learn how to control pest species and how to use other insects as natural pesticides.

**Objectives:** Students will be able to construct apparatus to use in collecting and observing aquatic insects.

**Materials:** Materials required for each student or each student group.

- 2 pieces of glass with sanded or rounded edges
- One can of play-dough
- PVC pipe or old coffee can (bottom removed), or bucket (bottom removed)
- Transparent covering (plastic bags can also be used)
- Rubber band
- Masking tape



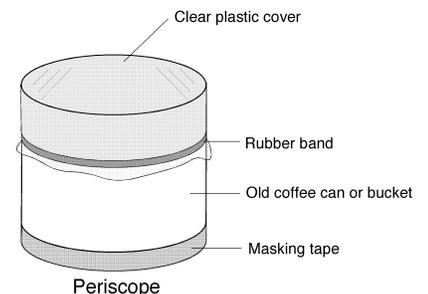
### Procedure:

#### Mini-aquarium Construction

1. Form a U-shaped sausage of play-dough.
2. Press the two pieces of glass against the play-dough, one on each side.
3. Fill it with water.
4. Place an organism in it.
5. Observe the organism.

#### Aquatic periscope Construction

1. Use the piece of PVC pipe, coffee can, or bucket as the base.
2. Make sure any sharp edges are covered with masking tape.
3. Cover one end of the cylinder with transparent plastic.
4. Use the rubber band to hold the plastic in place.
5. Place the end of the periscope into the water and look into the periscope.
6. Observe the water habitat. Identify insects using the attached sheet.
7. Have fun.



### Possible Extensions:

1. Have students record the types of organisms they collect.
2. Have students devise a classification system for their organisms.
3. Have students determine what adaptations they found for locomotion and feeding.

## Activity: Tools of the Trade

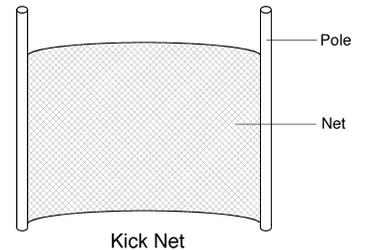
Information taken from The Guide to the common Aquatic Invertebrates of the Loxahatchee Basin by Carlos L. de la Rosa, PhD. and Carlos A. de la Rosa.

Entomologists study insects. You can be an amateur entomologist by using some tools of the trade. Most of these can be made or found in your home.

**Objectives:** Students will be able to collect and observe insects using readily available materials.

### Materials:

- Collecting and observation tools (see lists below)
- Observation recording tools (paper, pencil, computer, etc.)



### Procedure:

1. Discuss various types of collection apparatus and how certain apparatus are designed for particular purposes.
2. Compare some of the professional apparatus with the homemade versions.
3. Discuss steps used by scientists during the collection, observation, and recording process.
4. Have students collect insects and record observations.
5. Discuss the types of information obtained from the activity and why it would be important to have this type of information.

### Possible Extensions:

1. Visit a local entomologist.
2. Visit a local business to learn more about the importance of insects in our daily lives. (Places to visit could include a local zoo, botanical garden, butterfly house, crop research facility, pesticide plants, or government entomological research facility.)

### Tools for Collecting

- Kitchen strainer
- Small aquarium net
- Make a net from a coat hanger and an old sock
- Forceps
- Eyedroppers

### Professional Collecting Tools

- Artificial substrates
- Plankton or drift nets
- Kick nets

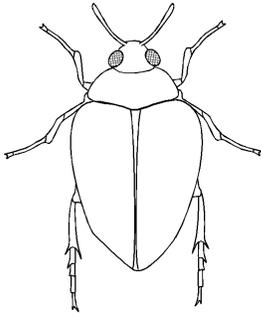
### Tools for Observing

- Flat white pan
- Wide mouth jar
- Magnifying lens

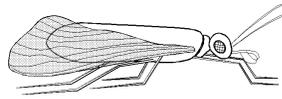
### Recording Information

- Locality where collected
- Date of collection
- Type of habitat
- Collection method used

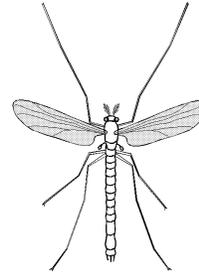
**Insect Identification**



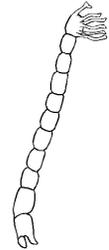
**Beetle**



**Caddisfly**

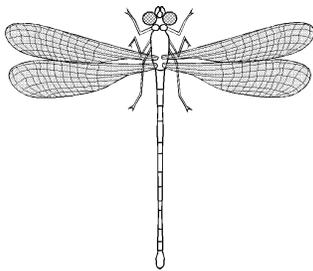


**Adult**

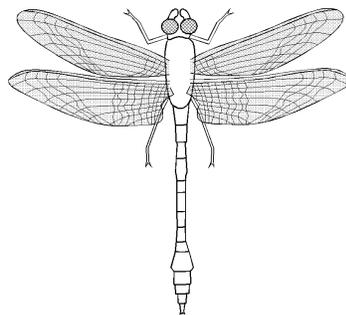


**Larva**

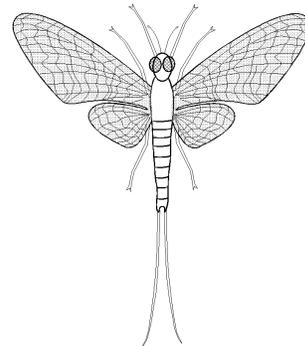
**Chironomid Midge**



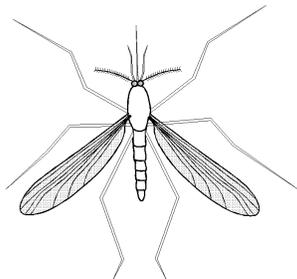
**Damselfly**



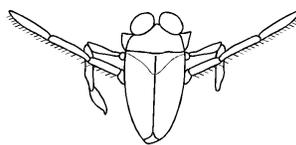
**Dragonfly**



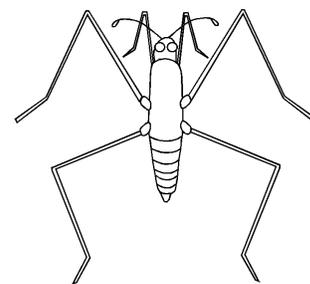
**Mayfly**



**Mosquito**



**Water Boatman**



**Water Strider**

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## Student Information: Incredible Insects

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All of us have come in contact with **insects**.

Many of us could tell stories about pesky flies and mosquitoes or beautiful butterflies. Insects are often misunderstood creatures. Many people are frightened of insects, because they know very little about them. These adaptable creatures are one of the most successful groups of organisms on earth representing more than 75% of all animals. They have been able to inhabit a wide range of places from the driest deserts to the highest mountaintops.

Insects are an important part of our **ecosystem**. They help to decompose plants and animals that are then used by other organisms for food. Insects provide us with products such as wax, silk, and honey. They also **pollinate** many of our crops. Insects can even be used as biological pesticides to control unwanted **pests**.



Only about one percent of all the insect species are considered to be pests. These unwanted insects can destroy large amounts of crops resulting in a loss of income for farmers. Other insect pests carry diseases that can be harmful to humans or **domesticated** animals.

Scientists have gained useful information by studying insect **adaptations**. Researchers have developed pesticides by watching what insects eat and how they eat. Scientists can also determine ecosystem health by studying the insects found in a particular place. For instance, if only one type of insect is found where there should be many types, scientists can use this information to find out what is causing the problem.

