Study Materials for 4-H Entomology

Updated August 2018

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The information in the 4-H Entomology curriculum was developed by many people over the last 40 years. This 2018 revision, including this workbook and all internet-based resources, was created by Molly Keck, Kerry Siders and Wizzie Brown, but includes material developed during the prior years. John Jackman, Bonnie Pendleton and Scott Armstrong conducted the last revision of 4-H Entomology in 2003. Noel Troxclair and Patrick Porter updated the material in 2016. The current author wishes to acknowledge and thank all of the people who worked on this program in the past.

I. Introduction

Why Study Insects?

Insects are extremely diverse and make up more than half of the species on earth. Insects are important as decomposers, pollinators, predators, and pests. They also are fascinating organisms with a wide range of behavior and life styles. Many insects also are admired for their beauty.

Understanding insects and recognizing key species is important because insects significantly affect crop production, livestock, human health, buildings, and our food. Insects are important in food webs and are critical organisms in the recycling of materials in the environment. Studying insects is well justified with all of the significant things that insects' impact.

Studying insects is a challenge because there are many kinds with unique characteristics. Moreover, the vocabulary used in entomology is specific to insect study. Nevertheless, learning about insects can be fun and provide great understanding about the world in which we live. One way to learn is to participate in contests.

4-H Contests

Entomology contests introduce youth to the fundamentals of entomology and develop skills in identification of common insects and their relatives. This document provides some basic information and an outline of materials that can be used to prepare for the contests. The basic entomological principles to be covered include: insect structure and function, metamorphosis, insect identification, and importance of insects to humans.

4-H entomology contests consist of two parts: (1) a written examination; and (2) insect identification. Each part is worth 50 percent of the total score. The written examination consists of true and false, multiple choice, matching, or completion questions prepared mainly from the study material in this document. Actual insect specimens, many of which will be selected from the enclosed list, are used in the identification portion of the contest. This document provides suggested material to prepare for the contests but note that this study material in not the sole source of information used in the contests.

District contests consist of three age divisions: junior, intermediate, and senior. The contests are prepared for those age groups. Material suggested for junior, intermediate, and senior contestants are reflected in this document. District contests and state contests are similar, but the state contest is typically more challenging. Tie-breaker questions are included with the contest. If there is still a tie, then spelling is used. Further ties will be decided with additional questions.

4-H members should collect and study as many insects as possible in preparation for these contests. Preparing a collection will help contestants learn identifying characteristics, biology, hosts, behavior, etc. Photographs and slides should also prove useful in studying identification of the insects.

II. Structure of Arthropods

Anyone studying insects should have a basic knowledge of insect structure. The following diagrams label the basic structural parts of insects.

To identify insects and understand their role in the environment, one must be acquainted with basic anatomy. Important features include types of mouthparts (chewing or piercing-sucking, including the modifications of these types), types of legs, (jumping, grasping, digging, swimming, running, etc.), and various modifications of wings, antennae, and other body parts. Anatomical features are useful in identifying habitat and food source. For example, we know that the praying mantis is an excellent predator because its front legs are modified to grasp prey and because of its strong, chewing mouthparts.

Figure 1. Ant body parts

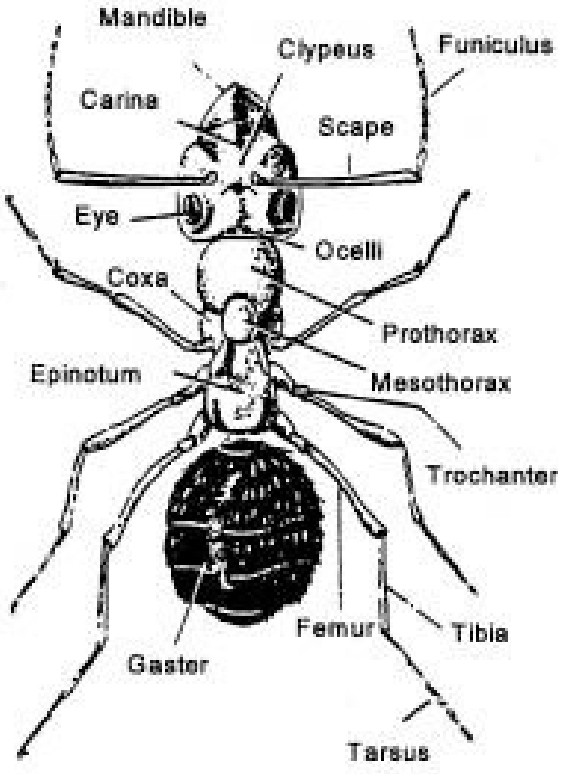


Figure 2. Beetle body parts

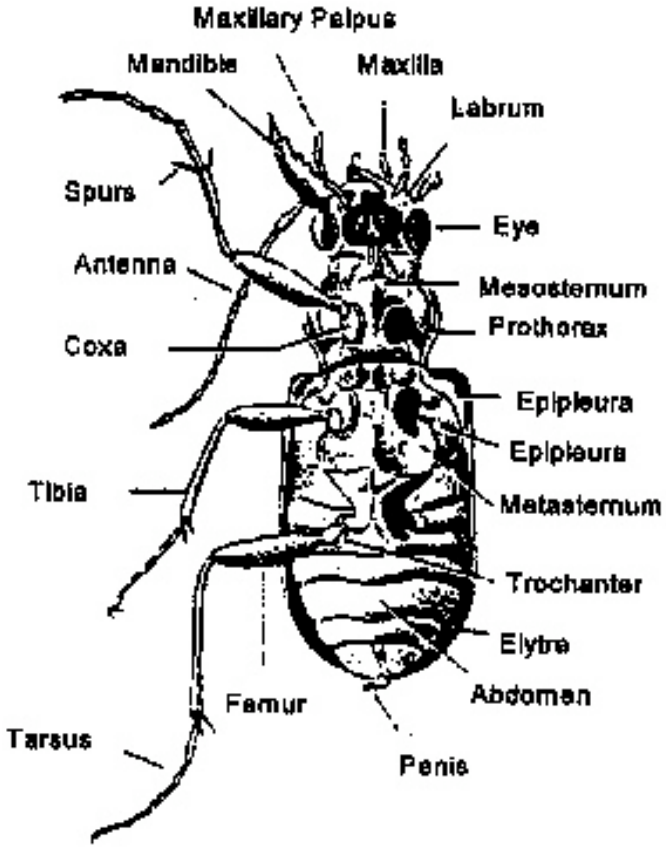


Figure 3. Spider body parts

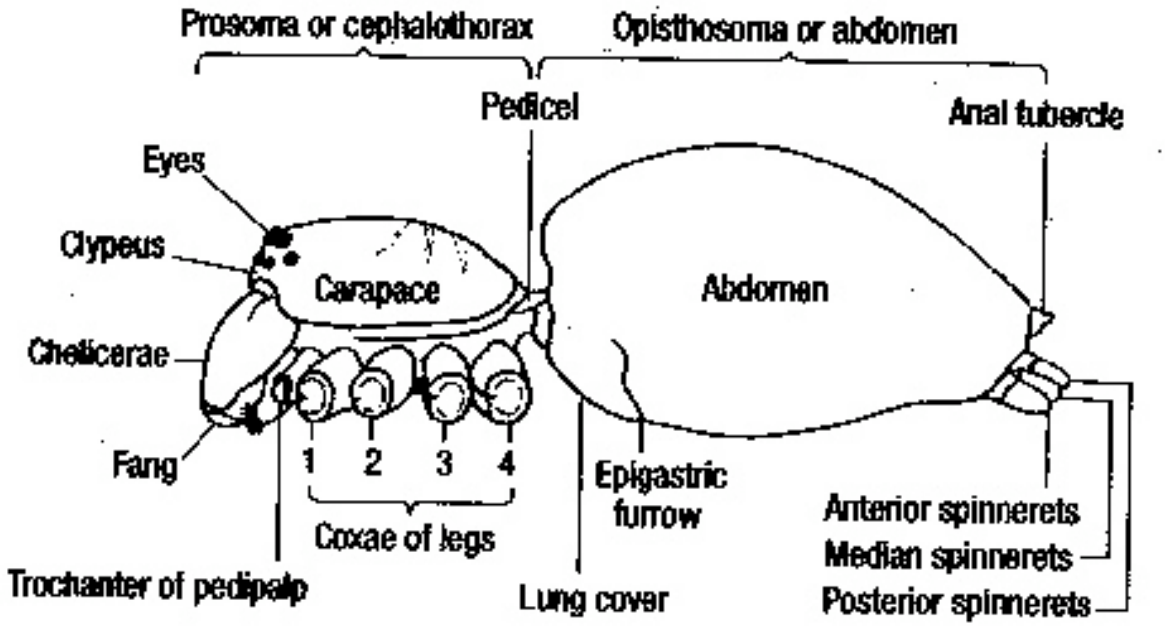


Figure 4. Spider leg parts

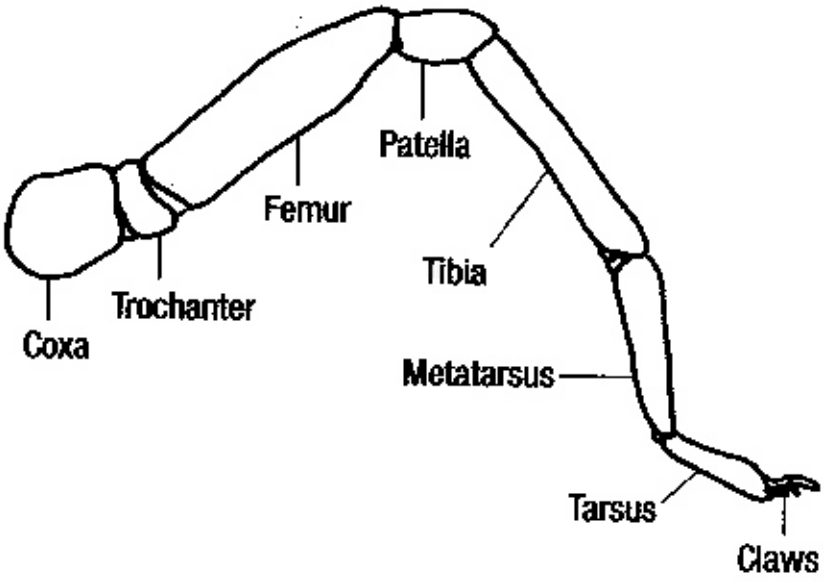


Figure 5. Grasshopper body parts

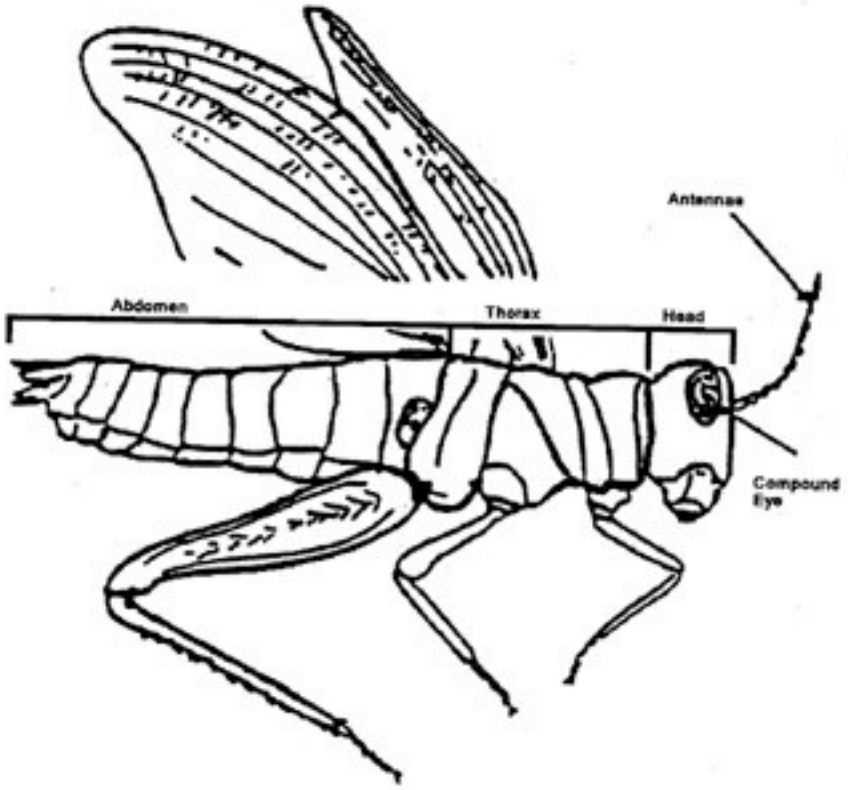


Figure 6. Grasshopper leg parts

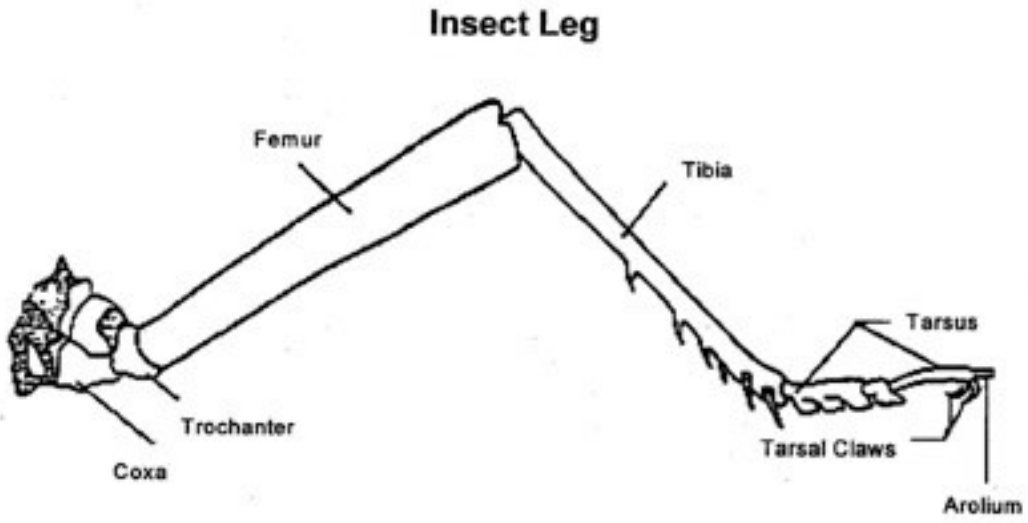
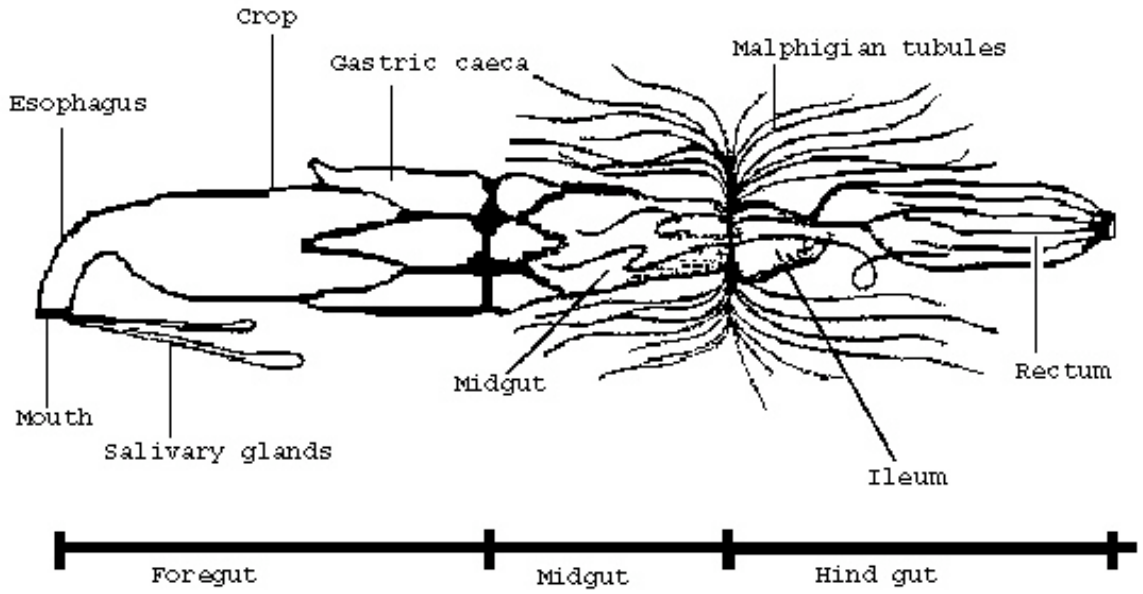


Figure 7. Grasshopper digestive tract



III. Metamorphosis

All insects undergo metamorphosis, a change in body form, as they develop from egg to adult. Insects with simple metamorphosis undergo changes only in size, but insects with more complex metamorphosis change in many ways. The most complex changes occur in such groups as flies, wasps, butterflies, and beetles. These insects have a larval or caterpillar stage that looks very different from the adult insect. The best-known example is a worm-like caterpillar that changes to the pupal or cocoon stage and, after many changes occur within the cocoon, a butterfly emerges. The three types of metamorphosis found in the insects are:

1. No Metamorphosis (or Ametabolous)

   Stages include egg, young, and adult. The main difference between the young and adult is size. Adults are never winged.
   Examples: bristletails and silverfish

2. Incomplete Metamorphosis (or Hemimetabolous)

   Stages include egg, nymph, and adult. Aquatic nymphs in these groups sometimes are called naiads.
   Examples: dragonflies, grasshoppers, cockroaches, mayflies, stoneflies

3. Complete Metamorphosis (or Holometabolous)

   Stages include egg, larva, pupa, and adult. The larvae look very different than the adults. The larvae may have different feeding behaviors and hosts than the adults. The pupae are non-feeding and typically rather inactive.
   Example: beetles, butterflies, flies, wasps

IV. Classification

Classification of living organisms is based on a scheme of grouping similar organisms together. Each group is in turn made up of smaller groups that share even more characteristics. The most precise group is a species. Individuals in a species are capable of interbreeding and reproducing additional members.

Multicellular animals are classified into the animal kingdom. The kingdom is further divided into lesser groupings. The names of groups in a typical complete classification of species are (the example is for a honey bee, *Apis mellifera* Linnaeus):

Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Order	Hymenoptera
Family	Apidae
Genus	*Apis*
Species	*mellifera*

Sometimes additional groups are used that are intermediate to the groups listed. These groups often use a prefix of super- (above) or sub- (below) to indicate the position of the new group in the above list. Thus, superfamily falls between order and family, while subfamily falls between family and genus.

Scientists refer to a species with the genus name, the species name, and the name of the author of the species which is the scientist who originally described the species. The genus name and species name typically are in italics, with the genus name capitalized but not the species name. The author's name is in plain type and appears in parentheses if the genus name was changed by other authorities since it was first described. Including the author's name often avoids confusion when investigating the proper names for species.

Technically, entomology is concerned only with the study of the class Insecta in the Phylum Arthropoda (all animals with segmented legs, segmented bodies, and exoskeletons). However, entomologists often study some members of other related classes including:

1. Class Arachnida - (ticks, mites, spiders, and scorpions)

2. Class Chilopoda - (centipedes)

3. Class Diplopoda - (millipedes)

4. Class Malacostraca - (sowbugs and pillbugs)

V. Insect and Arachnid Orders

We have prepared a guide to Insect and Arachnid orders that can be found as a separate publication on this website. Please

refer to this guide for a summary of the Orders.

VI. Study List of Common Texas Insects

On the main page of this website you will find a study guide for the common insects of Texas that are required for each level of 4-H Entomology. There is an html version for use with a web browser. This version has large photographs of each insect and occasionally shows more than one photograph per species. There is also a PDF version that has smaller photographs but may be printed easily. Both versions have the same information.

VII. Insect Importance and Management

Ninety-five percent or more of all insects are harmless or beneficial to man; however, some are harmful and compete with man by attacking or destroying his food, clothing, structures, and domestic animals. Also, insects spread diseases affecting man and his animals. Man's goal is to develop ways to regulate harmful insects without endangering the beneficial species, creating human hazards, or damaging our environment. Several tactics for insect control have been developed, including: insect-resistant crops, cultural practices, biological control, legal and regulatory measures, physical and mechanical controls, and chemical control.

Rarely is a single tactic satisfactory in controlling a pest species. A combination of tactics is usually used for effective management. Using the best or most appropriate combination of control tactics is sometimes termed "integrated control" and has led to the concept of Integrated Pest Management (IPM).

Biological control is an important aspect of integrated pest management. Damaging insects are attacked by various other insects, spiders, and other animals. These beneficial insects and spiders may act as predators which capture and consume or suck the body juices from other insects; examples are lady beetles, praying mantids, green lacewings, dragonflies, certain wasps, certain flies, certain bugs, and others. Other beneficial insects are parasites; whereby some developmental stage, usually the larva, infests the host insect from which it obtains protection and nourishment, usually causing death of the host. Most parasitic insects that attack other insects belong to the orders Hymenoptera and Diptera. Some species attack host eggs, others attack larvae or nymphs, others attack pupae, and still others attack the adult. Entomologists are trained to carefully evaluate the impact of beneficial insects and spiders upon potentially damaging economic pests.

The significance of any insect to people in agriculture, medicine, etc. is of great practical importance. Not all insects are harmful; in fact, many are considered very beneficial. For this reason, people should know the difference between pest insects and beneficial insects. Also, some insects cannot be classified as either pest or beneficial. These insects are neutral or variable as far as people are concerned. Failure to discriminate among these insects can lead to serious economic losses and other problems.

VIII. Collection and Preservation of Insects

Why Collect Insects?

The insect world includes some of the most fascinating creatures ever to exist on earth. In size, they range from microscopic to several inches in length. Many exhibit dazzling, bright color patterns. Some insects are harmful to plants, animals, and man, but most

insects are beneficial. Some insects, like honey bees, have been cultured by man for many generations.

Insects may be collected as a hobby and for the enjoyment of observing them as a part of nature. They may also be collected for scientific studies. There is no better way to learn about insects than to collect them.

When and Where to Collect Insects

Insects are present in virtually every habitat. The more places a person looks for insects the greater will be the variety collected. Insects may be found flying in the air or buried in the soil. They may be found in the water, on vegetation or under logs, stones, and debris.

Insects are most abundant in the spring and summer. However, insects can be collected any day of the year. Some species can be found under bark, in rotting logs, or under debris even on the coldest day of the year.

Certain insects, such as moths, are active at night and may best be collected at night. Others, such as dragonflies and most beetles, are active during the day and are therefore collected more easily during the day.

Collecting Equipment

Many insect specimens are lost because proper equipment, such as a net, vial of alcohol or killing jar, is not available at the time the specimen is sighted. The collector should be equipped to take advantage of any opportunity that may be encountered.

Containers. The collector should be equipped with a variety of containers in which to hold specimens collected. Many prize specimens are damaged or ruined because of inadequate containers for holding and transporting. Containers should be large enough to accommodate specimens without cramping or bending them. This requires large containers for dragonflies, butterflies, and other large, delicate insects. Adequate containers should be provided to prevent crowding as well as to isolate rare or delicate specimens. Some of the most available containers collectors use include: cigar boxes, pill boxes, jars, test tubes, vials, and medicine bottles.

Sweep net. A sweep net is one of the most important pieces of equipment an insect collector should have. With a sweep net, the collector can capture flying insects and insects found on vegetation. The net may also be used to collect aquatic insects. However, nets designed for collecting aquatic insects are heavier than most sweep nets.

Beating cloth. A beating-cloth or beating umbrella may be placed beneath vegetation. The vegetation is then shaken by hand or beaten with a stick. Insects dislodged from the bush or shrub fall on the beating cloth and can be collected.

Aspirator. An aspirator acts like a miniature vacuum cleaner. It is used to collect small insects.

Light traps. Light traps are used at night and attract a wide variety of night-flying insects. Many varieties of light traps exist. Some collect the specimens alive and others draw the insects into a killing agent, such as rubbing alcohol.

Bait traps. Bait traps are useful in collecting many beetles and flies. The design of bait traps varies from elaborate devices to a simple tin can buried to soil level and baited with carrion or decaying fruit. The ingenious collector will succeed in constructing a trap to fit his or her needs and desires.

Bait. An effective bait can be made with fresh fruit. Fill half of a 1-gallon container with mashed fruit, such as peaches and/or bananas, and add a cup of sugar. Allow it to stand for about a week, but do not cover it tightly. During this week, add a little more sugar to the mixture each day to continue the fermentation process. Yeast can be added to speed up the process. Before using the bait, add about a cup of brown sugar to the mixture. Apply the bait with a brush to the trunk of trees in the early evening. By nightfall there should be plenty of insects ready to be collected.

Light sheets. A simple white sheet with a bright light source shining on it can be hung outside at night. This is an effective way to attract moths and other nocturnal insects. Blacklights, mercury vapor lights, or incandescent lights are all good for attracting insects.

Berlese funnels. An effective trap for collecting small soil and leaf litter insects is the Berlese funnel. This trap can easily be made by placing wire mesh into a funnel. Position the funnel over a jar of rubbing alcohol and place a bright light source over the top of the funnel. Add some soil and leaf litter onto the mesh in the funnel, turn on the light, and wait 3 to 4 hours. The small insects in the material will try to escape from the light by burrowing down further into the material, past the wire mesh, and into the jar of alcohol. Use an eye dropper to remove the insects from the alcohol.

Killing apparatus. Killing jars may be constructed in a number of ways. All consist of a container (usually a jar) with a killing agent. Select a jar that has a tight lid that is easy to open and close. Use a jar that is large enough to hold the insects you will collect. A wide-mouth quart jar is probably the largest size needed, but smaller jars are more useful. It is always a good idea to add a paper towel or a few tissues to the jar to absorb moisture that accumulates in the jar. Some collectors prefer to line the bottom of the jar with about an inch of plaster of paris. To prepare jars using this technique, mix the plaster of paris with water, pour it into the jar, and let it dry before you use it.

The most common killing agent used in killing jars is ethyl acetate (finger nail polish remover). Only a few drops of ethyl acetate are needed in a killing jar because the vapor kills the insects. You may need to add a few drops each day or whenever the insects do not die quickly. As an alternative to killing agents, insects may be killed by placing them in a freezer overnight.

Remember that some insects should be killed and preserved in alcohol. Rubbing alcohol is good to use for this purpose. Vials or small bottles containing alcohol are needed to separate insect specimens for proper maintenance of the collection.

Other equipment. A variety of other equipment and tools will come in handy on any collecting trip. Some of the equipment a collector should have are: forceps or tweezers, dissecting needle, a knife, magnifying glass or hand lens, notepad, camel's hair brush, vials of preservative, eye dropper, and scissors. Other items that come in handy are: shoulder bag for equipment, string, tape, rubber bands, glass slides, cardboard, cotton, and insect pins.

Preservation of Insect Specimens

Properly preserved insect specimens will last indefinitely. There are various ways of preserving insects. The proper method is based upon the type of insect to be preserved. Most are mounted dry on pins. Many small specimens are best glued to small cardboard

Points which are then mounted on pins. Some are preserved in alcohol and others may be mounted on microscope slides. The following list will aid in determining what method should be used for killing and preserving different adult insects.

Kill and preserve in alcohol; mount on slides:

Phthiraptera (lice)
Siphonaptera (fleas)
Thysanoptera (thrips)

Kill in ethyl acetate; mount on pins:

Blattodea (roaches)
Coleoptera (beetles)
Dermaptera (earwigs)
Diptera (flies): Tiny ones may be killed and preserved in alcohol.
Hemiptera (true bugs):
Hymenoptera (bees, wasps, ants, etc.): Small gall wasps and parasites may be killed in alcohol.
Lepidoptera (moths and butterflies)
Mantodea (mantids)
Mecoptera (scorpionflies)
Odonata (dragonflies)
Neuroptera (lacewings, antlions, dobsonflies etc.) Orthoptera (crickets, grasshoppers) Phasmatodea (walkingsticks)

Kill and preserve in alcohol:

Ephemeroptera (mayflies)
Blattodea (termites)
Plecoptera (stoneflies)
Psocoptera (barklice)
Thysanura (silverfish)
Trichoptera (caddisflies)
Hemiptera – mealybugs, aphids, whiteflies, and scale insects

Larvae of insects should be killed in boiling water and allowed to remain in the water until they float to the top, which takes from one to five minutes, according to size, then preserved in alcohol. Skipping the boiling water step allows enzymatic activity to continue in the insect, and this will cause the larva to darken over time in the alcohol.

Centipedes, millipedes, mites, spiders, ticks, and other small arthropods, although they are not insects, are frequently handled by entomologists. All these should be killed and preserved in alcohol. The smaller ones are usually mounted on slides.

Pinned specimens. Properly pinned specimens are valuable and useful. Improper pinning detracts from the look and value of any specimen.

Common household pins should not be used to pin specimens. Special insect pins should be used. Insect pins may be purchased in various sizes from a number of biological supply houses. Size 2 or 3 pins are used for most specimens. Specimens should be mounted squarely, not at an angle. All specimens should be mounted at the same distance from the head of the pin. A pinning block may be used as a spacer to help keep specimens and labels at a uniform height.

Pins are placed in specimens to avoid hiding or damaging appendages or areas used for identification. The standard methods for pinning some of the common insects are:

1. Grasshoppers, katydids, etc.: Pin through the back part of the thorax to the right of the middle line.
2. Stink bugs and other large Hemiptera: Pin through the scutellum to the right of the middle line.
3. Bees, wasps, and flies: Pin through the thorax slightly behind the bases of the forewings and to the right of the middle line.

4. Beetles: Pin through the right wing cover near the base.
5. Moths, butterflies, dragonflies, and damselflies: Pin through the middle line of the thorax at the thickest point, between and slightly behind the bases of the forewings.
6. Small specimens may be mounted by gluing the specimens to a paper or plastic point on a pin.

Relaxing chamber. Many times, it is impossible to pin specimens immediately after they have been collected and killed. Most of these specimens dry in an awkward or difficult position to pin. These specimens may be relaxed so that wings or legs may be moved, even months after they have been collected. To accomplish this, the insects have to be placed in a relaxing chamber for a period of time. This allows muscle tissue to absorb enough moisture to make them elastic.

A relaxing chamber is nothing more than a sealed container, such as a large jar, containing sand or a similar media saturated with water. A bit of alcohol may be added to prevent the growth of fungi. A wire screen or small dish is used to prevent the specimen from coming into direct contact with the wet media. Insects are placed in the container and left until their appendages move freely. Specimens are then removed, pinned, spread in the desired shape, and allowed to dry. To keep insects from drying out, they can be placed in the freezer for as many as three days.

Spreading board. Spreading boards are structures used in spreading the wings and legs of insects and to hold them in the desired position until they are dry. They may be made from small pieces of soft pine, cork, balsa wood, or Styrofoam and purchased from a biological supply house. Insects are pinned on the board, spread in the desired position, and allowed to dry. Small specimens dry in one to two days while larger specimens may take several days.

Preserving in alcohol. Small, soft-bodied insects such as aphids and thrips would soon dry out and shrivel or become distorted if not preserved in alcohol. Those insects that should be preserved in alcohol have been listed previously. Many specimens (especially larvae) turn dark when preserved in alcohol. The smaller of these specimens may be prevented from turning black by replacing the alcohol about two to three days after the specimens have been preserved. Killing and leaving large larvae in boiling water for one to five minutes before placing them in alcohol may prevent them from turning dark.

Mounting on microscope slides. Only very small insects such as thrips, lice, and aphids are usually mounted on slides. This technique requires special equipment and a certain amount of skill. The specimens are placed on the left-hand side of a microscope slide and a drop of mounting medium is added. Then a cover-slip is placed over the medium and specimen. After the mounting medium dries, the edges of the cover-slip should be sealed to prevent absorption of moisture which may stain the mount. Mounting on slides is an excellent way to preserve and study small soft-bodied insects.

Labeling specimens. A proper label greatly increases the scientific value of a specimen. All specimens, whether pinned, preserved in alcohol, or placed on slides, should be properly labeled.

Minimally, a label should contain information about the location where the specimen was collected, the date collected, and the name of the collector. Labels must be printed in permanent ink, which is non-soluble in water or alcohol.

Pinned specimens should have a proper label attached below the specimen. Specimens preserved in alcohol should have the label inserted into the vial with the specimen, although many specimens have the label attached to the outside of the vial. Specimens mounted on slides should have the label glued to the upper side of the slide and to the right-hand side of the specimen.

IX. Glossary

alate - winged form of insect
aphid - an insect in the family Aphididae, order Hemiptera, sometimes called a plant louse
beneficial insect - any insect that has a life style that is advantageous to man. Insects that preserve the balance of nature by feeding on others, pollinators, and recyclers are examples of beneficial insects.
carnivore - an insect that feeds on a living animal
caterpillar - the immature stage of any Lepidoptera (butterflies and moths)
cephalothorax - e.g. spiders, a single body segment with the head (ceph) and chest (thorax) areas fused together
cerci - paired appendages on the end of the abdomen of many insects which are used for sensing, defense, or mating
chelicerae - front pair of appendages of an arachnid often specialized with fangs
chewing (mouthparts) - any mouthpart that is used to break up food into smaller pieces to aid in digestion; other mouthpart types are piercing-sucking and sponging
clavate - Clublike antennae enlarged at the tip.
collophore - a tube-like structure on the underside of the first abdominal segment of Collembola
compound eyes - the large multi-faceted eyes of insects
coreids - a member of the family Coreidae, order Hemiptera
corium - the elongate, thickened basal portion of the forewing of Hemiptera
cornicles - tubular structure on each side of the abdominal region of aphids from which pheromones are expelled.
coxa (pl. = **coxae**) - basal portion of the leg
crepuscular - having activity periods during low light levels at dawn and evening
cursorial - adapted for running
dactyl - literally a finger or finger-like projection on an insect body part
dealate - winged form that has shed its wings, like a reproductive termite or ant
defoliate, **defoliation** - removal of foliage from plants, often by chewing insects
detritivore - any organism that eats decaying organic matter
diapause - an insect resting stage, usually induced by environmental signals or extreme conditions like winter or summer
dimorphic - having two distinct forms
dorsal - relating to or situated near the back
estivation (**aestivation**) - a resting stage (quiescence) resulting from continued high temperature or xeric conditions; diapause; hibernation
exoskeleton - the outer portion of an insect body which may be relatively soft like a caterpillar or hardened like many beetles
femur (plural: femora) - a segment of an insect leg; the third and usually the largest segment
filiform - linear shaped as the antennae of ground beetles
frass - solid larval insect excrement; plant fragments made by wood-boring insects, usually mixed with excrement
furculum (plural: **furcula**) - the elongate fork-like appendage on the end of the abdomen (folds under the body) of Collembola which is used as a spring action for leaping

genera - plural of **genus**; a genus is a group of plants or animals with similar characteristics

girdle, **girdling** - damage of a plant that encircles the stem or branch and cuts off the transportation system of the plant

gradual metamorphosis - see metamorphosis

harmful insect - an insect pest that destroys homes, buildings, crops, or hurts animals

hemelytron (pl. = hemelytra) - the front wing of a Hemipteran which has the base more thickened than the membranous outer portion

herbivore - an insect that feeds on living plants

imago - the adult stage of an insect

instar - an insect stage between molts. The term applies to juvenile stages only.

larval stage (**larva, plural: larvae**) - an immature insect, sometimes used to include all immature stages, even eggs. Usually this term refers more specifically to the feeding stages of insects with complete metamorphosis like grubs, caterpillars, and maggots.

lateral - relating to or situated near the side of the body rather than the upper or lower surfaces

maggot - in most Diptera, legless larva lacking a distinct head, with cephalic (head) end pointed and caudal (rear) end blunt

membranous - thin and semi-transparent; like a membrane

mesothorax - the second section of the insect thorax which includes the attachment points for the second pair of legs and the first pair of wings

metamorphosis - change in form during an insect's growth and development

complete metamorphosis (**holometabolous**) - This type of metamorphosis includes a pupal stage. Immature insects are called larvae and usually look very different from adults. The stages are egg, larva, pupa, and adult. Complete metamorphosis is the most advanced type of metamorphosis and is found in Superorder Endopterygota. This group includes lacewings, beetles, butterflies and moths, fleas, bees and wasps, and several other orders.

incomplete metamorphosis (**hemimetabolous**) - This type of metamorphosis does not include a pupal stage. Immature insects are called nymphs (or naiads in some aquatic insects). The stages are egg, nymph, and adult. The immature stages frequently look similar to adults, only they do not have fully developed wings and reproductive organs. Incomplete metamorphosis is less advanced than complete metamorphosis. Incomplete metamorphosis is present in the Paleoptera (mayflies and dragonflies) and Superorder Exopterygota (stoneflies, cockroaches, grasshoppers, and several other orders.)

no metamorphosis (**ametabolous**)- There is no metamorphosis except for the gradual development of adult reproductive structures. Insect groups with no metamorphosis include the Archaeognatha and Thysanura. The ametabolous insects are considered to be the most primitive insects.

metathorax - the third section of the insect thorax which includes the attachment points for the third pair of legs and the second pair of wings

mite - a member of the order Acarina (ticks and mites)

molt, molting process - in insects, the process of shedding the exoskeleton

naiad - a term for immature insects that are aquatic from the orders Plecoptera,

Odonata, and Ephemeroptera. This term is now being replaced by the more general term "immature" insect.

nasute (plural: nasuti) - a (type of) soldier in certain termites in which the head narrows into an anteriorly pointing “nozzle” through which sticky defensive liquids are squirted.

necrosis - death of tissue in plants or animals

nymph - an immature stage of hemimetabolous insects (those with incomplete metamorphosis)

ootheca (plural: oothecae**)** - a bean-like hardened egg capsule produced by female cockroaches

osmeterium (pl. = **osmeteria**) - scent-producing area behind the tibia

overwinter - time spent during the winter months. Insects are often in hibernation or at least rather immobile in colder temperatures.

ovipositor - the egg-laying apparatus of an insect. The stinger of a bee is actually a modified ovipositor.

parasitic insect (**parasite**) - an insect that feeds on a host but does not kill it. Some insect parasites live on large hosts like dogs, cows or man, and usually do not kill them; however, most parasites, like fleas and lice, keep an animal from being in "top condition." Some parasitic insects are good, since they destroy harmful insects; others are harmful. In entomology we often misuse the term "parasite" when we are talking about an insect that lays its eggs in or on another insect and the developing larva usually kills it. This common usage of the word is actually incorrect because, by definition, parasites do not directly kill their hosts. In this case the insect would correctly be called a parasitoid (see below).

parasitoid - an insect that spends a significant portion of its life history within a host and causes the death of the host, usually before it can reproduce.

parthenogenesis - egg development without fertilization

pedipalps - second pair of appendages of the cephalothorax corresponding to the mandibles of insects

petiole - the stalk that attaches the leaf blade to a stem

phytophagous - plant eating; an insect using plants as a food source

phytotoxemia - a toxic reaction in plants

predaceous insect (**predator**) - an insect that attacks, kills, and eats other insects

proboscis - a nose, or in the case of butterflies the coiled sucking mouthpart

pronotum - the plate on top of the prothorax

prothorax - the front part of an insect thorax which includes the attachment points for the front legs

protozoan - a microorganism in the kingdom Protozoa

pseudergate (plural: pseudergates) - literally means “false worker” because the pseudergate has at each molt four differentiation possibilities, including: 1) remaining a pseudergate, 2) passing through two nymphal stages and become a winged adult, 3) passing through a presoldier stage or white soldier to a soldier, or 4) molting directly to a supplementary (teritary) reproductive

psocids - any insect in the order Psocoptera, which includes booklice and barklice

pupal stage (**pupa**) - the stage in complete metamorphosis between larva and adult. For example, the cocoon in butterflies

pustulate - covered with small, blister-like swellings

rosetting - malformation of a plant resulting in a bunched irregular growth of the leaves

scavenger - an insect that feeds on dead plants or animals

scutellum - a triangular shaped section on the back of Hemiptera and some Coleoptera and Diptera. It is often the identifying characteristic of Hemipterans.

secondary reproductive - a caste of subterranean termite; also called supplemental reproductives. When reproductive termites develop from nymphs, they are called secondary reproductives (primary reproductives are the king and queen). If they develop from pseudergates, they are called tertiary reproductives. Supplemental reproductives may be responsible for most of the egg production in the colony.

soldier termite - see termite.

spinneret - a small tubular appendage from which silk threads are exuded by spiders and many larval insects

stadium (pl. = stadia) - the period between molts in a developing arthropod. An insect with an egg, three larval stages, and a pupal stage would have 5 stadia; egg (1), larva (3) and pupa (1). Some authorities count the adult stage as a stadium.

subgroup - a subset of a group with related characters. The term group is a general and non-specific collection of similar organisms regardless of taxonomic hierarchy.

subimago - the first winged stage of a mayfly. This is the only order to have a winged stage that molts. The final stage is the imago, or adult.

tarsi (plural) (singular is **tarsus**) - a foot. Insect feet are made of several segments and may have pads, hairs, or hooks.

tegmen (plural: tegmina), a hardened covering like the forewing of many Orthoptera and Hemiptera

termite - any eusocial, small, soft-bodied, wood-eating insect in the order Blattodea

soldier termite - a caste of termites with specific structures to defend the colony, such as large mandibles or nasute heads with nozzles that produce sticky defensive substances.

worker termite - a caste of termites that do most of the work in the colony. Worker termites can all be immature termites and formd that do not develop into reproductive forms or soldiers.

tertiary reproductive termite - supplementary reproductives forming from pseudergates

Tettigoniidae - a family of Orthoptera often called long-horned grasshoppers which includes katydids

thorax - the second body segment of an insect. The thorax has all wings and legs attached to it.

true bugs - insects in the order Hemiptera. They are usually characterized by a scutellum, a triangular-shaped section on the back.

venation - the pattern of veins in the insect wing

vestigial - small, poorly developed, degenerate, nonfunctional

wing pads - incomplete wing structures like those formed on immature grasshoppers

X. Information Sources

Internet sites

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