DOCUMENT RESUME

ED 045 405 SE 010 134

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TITLE Interdisciplinary Outdoor Education, Insects.
INSTITUTION Shoreline School District 412, Seattle, Wash.
SPONS AGENCY Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.
PUB DATE 68
NOTE 62p.
AVAILABLE FROM Outdoor Education, Shoreline School District No. 412, Northeast 158th and 20th Ave., N.E., Seattle, Washington 98155 ($0.50)

EDRS PRICE EDRS Price MF-$0.50 HC Not Available from EDRS.
DESCRIPTORS *Elementary School Science, *Entomology, *Instructional Materials, *Science Activities, *Teaching Guides
IDENTIFIERS ESEA Title III

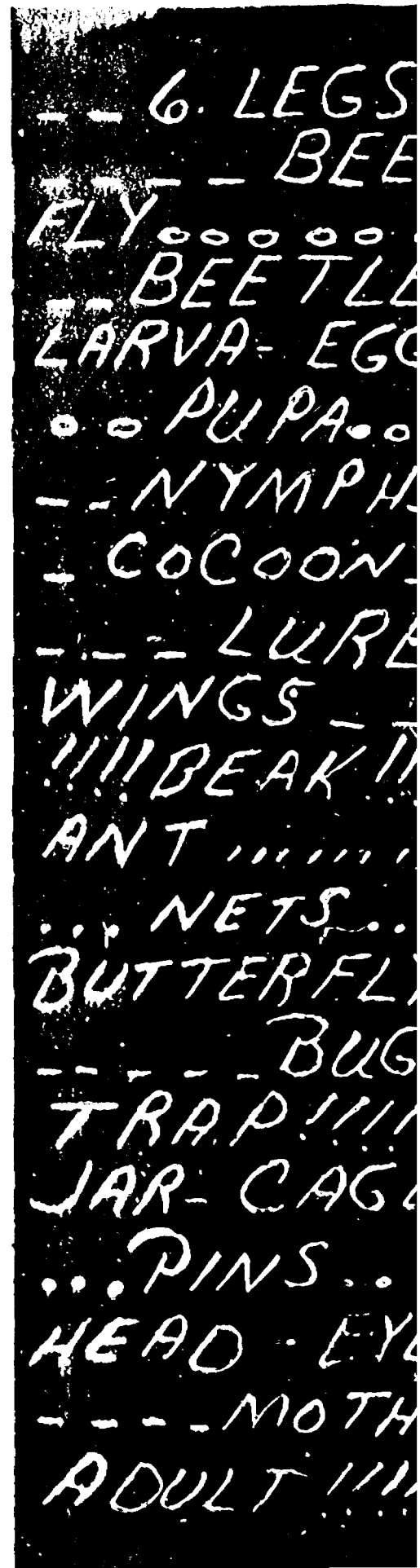
ABSTRACT

This manual is a teacher's resource and guide book describing activities for elementary students involving the collecting, killing, preserving, and identification of insects. Most activities relate to collecting and identifying, but activities involving terrariums and hatcheries, finding hidden insects, and insect trapping are also described. Background information relates to insect classification, techniques and equipment for collecting and preserving, and student collecting kits. Various reference lists provide the teacher and student with many possible resources, including companies which supply entomological equipment, student manuals, teaching guides, and general reading materials. This work was prepared under an ESEA Title III contract. [Not available in hardcopy due to marginal legibility of original document.] (PP)

INTERDISCIPLINARY OUTDOOR EDUCATION

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

INSECTS



AN INTERDISCIPLINARY OUTDOOR EDUCATION PROGRAM

Under Provisions of Public Law 89-10, Title III

OE Project No. 66-2682

Project: Insect Activities for the Immediate Grades

by

Edward E. Orsborn

Shoreline School District No. 412

King County

Seattle, Washington

1968

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School District No. 412
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Seattle, Washington 98155

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INTRODUCTION

WHY STUDY INSECTS

Too often man goes through life finding little enjoyment in the beauty of nature and knowing very little about it. If man learns to know more about his natural surroundings, he will be building towards a fuller understanding of life. The human race makes up a very small part of the total number of living creatures on our planet. Considerably more than half of all living things in the world, including plants, are insects. The famous naturalist, H. E. Jaques, pointed out that, "Lincoln attributed the great numbers of common people to God's love. It is apparent that Nature has likewise favored the beetles. Line up all the plants and all the animals of the world by species; every fifth one would be a beetle." Consider this a moment and reflect that the order of the beetles are but one of more than twenty-five orders of insects!

Dr. J. J. Holland, one of the world's greatest entomologists once said,

> "When the moons shall have faded out from the sky, and the sun shall shine at noonday a dull cherry-red, and the seas shall be frozen over, and the ice-cap shall have crept downward to the equator from either pole... when all cities have long been dead and crumbled into dust, and all life shall be on the very last verge of extinction on this globe; then, on a bit of lichen, growing on the bald rocks beside the eternal snows of Panama, shall be seated a tiny insect, preening its antennae in the glow of the worn out sun, representing the sole survival of animal life on this planet earth---a melancholy 'bug'."
>
> Life Nature Library, THE INSECTS p. 16

People, children and adults alike, could profit much by studying and examining Nature's other creatures who have been on this planet long before man arrived. The insects were living on the earth more than 40 million years ago; as fossils and amber specimens show us preserved insects almost identical with those we can find in our own back yards today.

Insects live on, and today they are man's greatest competitors in his struggle for existence. Insects destroy our crops, kill our animals, destroy our buildings, and often feed on man himself. They spread disease germs to the extent that they have killed more people than in all wars. Yet to give the impression that all insects are pests would be unfair, for most of them are of little or no importance and many, such as the ground beetles, ladybeetles, wasps and certain flies, are beneficial, as they feed on insect pests. Man derives many benefits from insects such as; honey, silk and pollination.

A more pedestrian answer to the question, "Why study insects?" could be that it's just plain fun! Fishing requires a license; insect hunting doesn't. Collecting rocks means packs full of heavy rocks; insects are light. Bird watching often requires searching the countryside; insects can be found even indoors! Mounting hunting trophies requires the services of an expert taxidermist; mounting insects requires only pins and cork.

When you get down to the core of the matter, it may all simply boil down to the fact that children like to collect things and what better way to get outdoors with a minimum of equipment for a maximum of pleasure than to collect and study insects!

ODD AND INTERESTING FACTS ABOUT INSECTS

From Entomology, a phamplet by the Entomological Society of America.

Insects were present on earth 250 million years ago; man has been on earth only a million years.

There may be as many as 2 million different kinds of insects.

More trees are lost to insects each year than are destroyed by forest fires.

Insects probably outweigh all other animal matter on the land.

About 200 million insects and mites may live in one acre of rich pasture land.

The total flight distance covered by honey bees in producing a pound of honey would be equal to twice the distance around the world.

One aphid and its offspring, if none died, could produce 1,560,000,000,000,000,000,000,000 individuals in a single season. (Dr. Lee Strong, of the U. S. Bureau of Entomology, tells us that if a single pair and their offspring could reproduce undisturbed for one year, they would create enough aphids to fill the entire Atlantic Ocean.)

Insects are found in a greater variety of places and surroundings than any other class of animals in the world.

Insects have as many as 4,000 different muscles; man less than 500.

The average bill we pay for insect losses and insect control in the United States amounts to 6-10 billion dollars.

A termite colony may contain 3 million individuals.

A single pair of houseflies starting April, theoretically can produce enough flies by August to cover the earth to a depth of 47 feet.

OTHER NOTES FROM ALL OVER

A silk cocoon contains as much as 3,000 yards of continuous filament.

A silkworm will eat mulberry leaves weighing more than 30,000 times its own weight.

ORDERS OF INSECTS AND THEIR CLASSIFICATION

Suppose someone dumped a thousand different postage stamps in a pile and asked you to arrange them in some orderly fashion to classify them and give each one a name different from all the rest. How would you do it?

Would you arrange them by color, size, price, shape, subject, or any other of at least a dozen ways? In any case, once you have them arranged, could you then successfully classify any new stamp or locate any old stamp quickly in relation to all the other stamps?

Consider now, that instead of stamps, you have an assortment of insects numbering into the millions. No two specimens exactly alike and you are asked to classify them. Thankfully, this enormous task has been accomplished and we should understand a little about it.

From the earliest time, living things have been given common names. The early American settlers gave things names and these names are still common to us; such as pine, oak, sunflower, cattail, rattlesnake, ground hog, prairie dog, dogwood, etc., to name a few.

Common names are confusing. No system was used in choosing common names. Take the flicker for example, a common woodpecker of the Eastern United States. Some call it a yellow hammer, others call it the golden-winged woodpecker. It is said that this bird has over fifty names. If it flew to Mexico, it would have another set of names in Spanish. In Brazil, it would have still other names in Portuguese.

Common names are misleading. They have no scientific basis and often give the wrong impression of plant and animal relationships. For example; what is a fish? The perch, cod, bass and salmon are fish. But what about the silverfish? It is an insect. We call clams and oysters shellfish. We call other animals in no way related or resembling a true fish by such names as crayfish, jellyfish and starfish.

Long ago in ancient Greece, Aristotle devised the first classification system. He simply divided all plants into three groups: (1) the HERBS, with soft stems; (2) the SHRUBS, with several woody stems; and (3) the TREES, with single woody trunks. He divided all animals into three groups on the basis of: (1) WATER-DWELLERS; (2) LAND-DWELLERS; and (3) AIR-DWELLERS. How would you use this system to classify the frog or the dragonfly?

Finally, in the 18th century a man named Linnaeus (lih-nee-us), a Swedish botanist, devised a sound and scientifically accurate system. It is still used all over the world today. He discarded the common names and gave

each thing a scientific name made up of Latin words. Latin is a common language which is not subject to change like "living" languages. In this successful system of classification, each scientific name described some common characteristics of the specimen and something about where the insect or object is found.

CLASSIFICATION OF A GRASSHOPPER COMPARED TO A LETTER'S ADDRESS

Kingdom:	Animal	(Animals only)	Country:	United States
Phylum:	Arthropoda	(Outer skeleton)	State:	Illinois
Class:	Insects	(Insects only)	City:	Chicago
Order:	Orthoptera	(Straight-winged)	Street:	Madison
Family:	Acridiidae	(Grasshoppers only)	Number:	20306
Genus:	Schistocerca	(Specific group)	Surname:	Smith
Species:	Americana	(Given to only this kind of grasshopper)	First Name:	John

WHY WE USE SCIENTIFIC NAMES

1. They are never duplicated.
2. They are used by people of all countries.
3. They are usually descriptive.
4. They show a systematic relationship to other organisms.

The 4-H Club Insect Manual (U. S. Department of Agriculture, Handbook No. 65) gives an excellent example of how the scientific name, in addition to helping to classify an insect or show relationships to other insects, is an aid in designating more clearly the particular insect referred to. There are several insects that have the same common name; such as, the potato beetle, the black blister beetle, or the tiny flea beetle. But if we say Leptinotarsa decemlineata, it doesn't matter if we are in the United States, England, or China, the entomologist knows the beetle to which we refer. If we analyze the Leptinotarsa decemlineata, we see that it means:

Leptinotarsa: From Leptos, meaning thin, and tarsos or tarsus, meaning part of the insect leg.

decemlineata: From deca, meaning 10, and linea, meaning lines. Thus we have Leptinotarsa decemlineata, an insect with small tarsus and 10 lines on its back.

The technical name of an insect often refers to some part of the insect, or to the plant or animal on which the insect feeds. It must be remembered in referring to the scientific name, only the names of the genus and species are given.

Most often children enjoy learning the scientific names of the insects, if for know other reason than it's fun to be able to read and use words that will stump Mom or Dad. Many games can be employed to learn the basic names of the orders; as the order is the major scientific name that is used in studying insects.

One of the first activities that can be used to learn the names of the major insect orders is to understand the meanings of the order names.

SOME INSECT ORDERS AND THEIR MEANINGS*

ORTHOPTERA (or-thop-ter-a) Grasshoppers: Orthos (straight), Pteron (a wing).

HEMIPTERA (hee-mip-ter-a) True bugs: Hemi (half), Pteron (a wing).

HOMOPTERA (hoe-mop-ter-a) Aphids, cicadas, leafhoppers: Homos (same), Pteron (a wing).

COLEOPTERA (call-ee-op-ter-a) Beetles: Coleos (sheath) Pteron (a wing).

LEPIDOPTERA (lep-i-dop-ter-a) Butterflies, moths, skippers: Lepis (scale), Pteron (a wing).

DIPTERA (dip-ter-a) Flies, mosquitoes, gnats: Dis (twice, from duo, meaning two), Pteron (a wing) i.e., Two clear wings; knobs in place of hind wings.

HYMENOPTERA (high-men-op-ter-a) Wasps, ants, bees, sawflies: Hymen (membrane), Pteron (a wing).

ODONATA (oh-da-nah-ta) Dragonflies, damselflies: Odous (a tooth). If you observe a dragonfly's mouth parts under magnification, it will be obvious how well named this insect is.

NEUROPTERA (nu-row-op-ter-a) Dobson flies, ant lions, aphis lions: Neuron (nerve), Pteron (a wing).

EPHEMEROPTERA (e-fem-er-aph-ter-a) Mayflies: Ephemeron (short-lived

ISOPTERA (i-sop-ter-a) Termites: Isos (equal), Pteron (a wing).

SIPHONAPTERA (si-fon-op-ter-a) Fleas: Siphon (a tube) Apteros (without wings).

ANOPLURA (an-off-lura) Blood sucking lice: Anoplos (unarmed), Oura (tail).

DERMAPTERA (der-mop-ter-a) Earwigs: Derma (skin), Pteron (a wing).

TRICHOPTERA (trick-op-ter-a) Caddisflies, thrips: Genitive Trichos (a hair), Pteron (a wing).

PLECOPTERA (play-cop-ter-a) Stoneflies: Pleco (plaited), Pteron (a wing)

MECOPTERA (me-cop-ter-a) Scorpion flies: Mecos (length), Pteron (a wing).

COLLEMBOLA (co-lem-bolla) Springtails: Colla (glue), Embolon (a bolt or bar).

*Order and pronounciation could be taken from "What Insect is That?", E. John DeWaard, Current Science and Science and Math Weekly.

A word of caution about the pronounciation of the scientific names and orders is important at this point. There is no completely universal agreement on the pronounciation. There are slight variations from area to area with variations on syllables and accents, but this does not alter the written value of the names. Much like the example of "toe-māt-o" vs the "toe-măt-o", it is still spelled and recognized as "tomato."

INSECT ORDER BULLETIN BOARD AND "INSECT PICTURE DICTIONARY"

For the average class on most levels, the classification of insects should be generally limited to the ORDER level. The children usually learn the orders quickly and the major orders should be learned first.

One successful activity that will assist in both learning the orders and providing a quick "sight" identification of insects is the INSECT ORDER BULLETIN BOARD.

1. Encourage the students to find pictures of insects in magazines and old discarded books. Ask them to bring to school as many pictures of insects as they can find. Caution them to take care to get permission before destroying any magazines or books for pictures as the pictures are to be cut out and trimmed for pinning to the bulletin board. Attempt to get at least one or more pictures of insects from each order of insects.
2. A committee of interested students can be formed to classify all the pictures according to the orders in which each insect belongs. For example, all the bees, wasps, hornets, and ants are placed under the order Hymenoptera. All pictures of mosquitoes, gnats, and flies are placed under the order Diptera.
3. Suitable labels of the orders are constructed and placed on the bulletin board as headings with the insect pictures arranged neatly under each heading.

The room would then have available an attractive "picture reference" to the insect orders which would allow students and teachers to quickly compare an unidentified specimen to visual characteristics of those on the bulletin board.

Further, several activities could be utilized that center on the bulletin board display.

1. The origin of the order names and their meanings could be studied and reports attached below each of the headings.
2. Drawing of insects could be placed under each order after study has been carried out on the similarities and differences of each of the orders.

3. The characteristics of each order can be studied for their contributions to each order's survival; for example, the Odonata is a carnivorous insect and its toothy mouth parts are essential for its survival. The scaly wings of butterflies not only give them their beauty, but also are vital for their survival through camouflage.

After the bulletin board display is dismantled, the pictures can be made into a class book and labeled "Picture Dictionary." This book can serve as a resource for future classes or can be consulted by class members who continue to study the insects.

CLASSROOM EQUIPMENT FOR COLLECTION AND PRESERVATION OF INSECTS

The Outdoor Education office has a supply of materials for loan for your use. Much materials, however, can be gathered from school science labs and homes. The following materials and their use can only serve as a guide, but have been found satisfactory for most studies.

1. An assortment of jars, the majority of which can be the baby food jar size.
2. Large quart, two-quart and gallon size jars come in handy.
3. Aquariums, fish bowls, coffee cans.
4. Cigar boxes.
5. Surplus plaster board, ceiling tiles, styrofoam, plastic foam sheets.
6. Corks, small squares of styrofoam.
7. Tweezers, forcep, vials, etc.
8. Magnifying glasses, steroscopes and hand lens.
9. Assortment of insect pins, sizes #2 and #3 (see section on pinning p. 16).
10. Vials of 80% alcohol.
11. Cut tagboard labels
12. Fingernail polish remover and carbon tetrachloride (see section on killing jars and agents p. 11).
13. Paper envelopes.
14. Spreading boards on loan from Outdoor Education office
15. Insect keys and resource materials.

NOTES AND SUGGESTIONS FOR USING MATERIALS

Jars and vials: The children will readily bring baby food jars and other containers. Caution should be observed in the possibility of breakage. Tape around jars will give more protection.

Aquariums and fishbowls: These containers make excellent hatcheries and rearin cages for live specimens, cocoons, etc.

Display and pinning board: Styrofoam sheets make the best displays. Ceiling tiles have been used, but they are often too hard and cause the fragile insect pins to be bent. Each child should have at least one display "board."

Corks and styrofoam squares: These are used for examination and displaying of single specimens. A two-inch square of styrofoam works very well.

Killing jars: It is advisable to allow only the teacher to handle and use the killing jars when employing agents; such as, carbon tetrachloride or other poisons. They should be placed out of reach and carefully labeled. Always wash hands after handling these materials.

INDIVIDUAL STUDENT COLLECTING KITS

A class study unit on insects requires some simple but basic equipment for the children to use in collecting and preserving insects. Most, if not all, the equipment consists of household items that are common and inexpensive. Professional equipment, of course, can be purchased from scientific supply houses, but an adequate collecting kit does not require much for the beginner.

Recommended equipment:

1. Several plastic or glass vials or small bottles.
2. Plastic envelopes.
3. Small plastic boxes.
4. A pair of light forceps or broad ended tweezers.
5. Some vials filled with 80% alcohol for killing and preserving.
6. A notebook and pencil.
7. Small water color brush.
8. Killing jars (see special section on killing jars. p. 11).
9. A collecting net
10. Hand lens or magnifying glass.

Notes and suggestions for use of collection kit equipment:

1. Collecting jars should have small holes pricked in their lids for air ventilation. Insects will be damaged by mold if kept from airing before they are dried and preserved.
2. The most practicable vials which are small and easily obtained are pill vials. The collection of these containers provides a good opportunity for parents to clean out the medicine cabinets of old pills and medications. Generally, the children in one classroom can provide several dozen vials from such a request. These containers can also be purchased cheaply from druggist.

3. Baby food jars can also be used. It is advisable, however, to wrap plastic tape around and under this type of glass jar to make them shatterproof if dropped.
4. Plastic envelopes are recommended by some collectors, but care must be exercised to avoid crushing the specimens. Small paper envelopes can also be used in the same manner.
5. Cotton filled boxes should be used only for butterflies and moths. The lepidoptera must be handled with extreme care as the scales are easily rubbed off. If they are placed in open containers, they will beat their wings and needless damage occurs. Avoid putting other insects; such as, beetles, bugs, and grasshoppers in containers of cotton. Their spiny legs and claws often become entangled in the cotton fibers with consequent loss of these body parts.
6. Try to include broad ended forceps or tweezers in the kit. If this type of tweezer is not available, at least include the common tweezer found in most homes. The tweezers used by stamp collectors are an excellent forcep. The forceps are used to pick insects out of holes in bark, from tunnels, etc. A pair of forceps are almost indispensable when close examination of a specimen is required. Lepidoptera specimens should always be handled by forceps.
7. Alcohol can be used for both killing and preserving insects. Vials of alcohol in the field collecting kit are expecially necessary for preservation of soft-bodied larvae specimens. (See special section on preservation of soft-bodied insects. p.

   Caution: Do not place hairy or scaly bodied insects; such as bees, flies, wasps, butterflies, moths, etc., in alcohol or any other fluid agent because this will result in damage to the specimens.

8. Too much emphasis cannot be placed on the importance of keeping notes on collecting insects. The notebook and pencil are as important as any tool in the kit. Information should be recorded as soon as possible while still in the field. The most important information to be recorded immediately upon capture is:

   a. Location (city, county, state)
   b. Date
   c. Habitat (flower, tree, stream, etc. Species of vegetation)
   d. Food of insect (nectar, carnivore, etc.)

   This information tells the Entomologist a great deal about the insect and aids in its identification. It also provides other

collectors about the nature of the specimen which will aid in their capture of the same species.

9. A small water color brush or camel's hair brush is used to pick up very small specimens. It is moistened with alcohol or water and will easily pick up hard-to-grasp insects.

HOW TO MAKE AND USE SAFE INSECT KILLING JARS*

A satisfactory method of killing insects may be something of a problem to the amateur collector, especially since cyanide, the substance most commonly used for this purpose is just as deadly to human beings as it is to insects. This agent is not recommended for use by school collectors.

Ethyl acetate is by far the most satisfactory chemical for killing insect specimens today, as it is quick, relatively non-toxic to people, and if used with a few drops of water in the killing jar, it keeps the specimens soft but undecayed for several days. Unfortunately, ethyl acetate is also the "glue-sniffers" narcotic and druggists will not sell it to minors. A further caution, it is also used as the thinner in Duco cement and is a great destroyer of plastics and the finish of furniture.

Another effective and easily handled killing agent is fingernail polish remover. It is expensive if bought in small bottles, but it will last for quite awhile as only a few drops are used in the killing jar. Its drawbacks are that it contains oil and this might cause some damage to specimens if it gets on them and it also will destroy plastics. If it is used, be certain that the killing jar is made of glass. Place some cotton in the bottom with a few drops of the polish remover on it and then press some pieces of cardboard on top of the saturated cotton. Prick some pinholes in the cardboard for the fumes to pass through for better effects.

Alcohol is another common killing agent as well as a preserving agent. Some collectors use it consistently as they point out that while it is killing the specimen it is also penetrating into the insect through the spiracles, breathing pores in the sides of most insects, which causes better preservation. If alcohol is used, follow the following table to dilute your alcohol for the purpose intended:

Approximate concentration of ethyl alcohol	Parts by volume of alcohol	Parts by Volume of water	Purpose
50%	10	9	For killing very delicate specimens
60%	12	7	For "stepping-up" delicate specimens. Rarely needed.

*Adapted from direction leaflet by permission of Alice Grey, Department of Insects and Spiders, The American Museum of Natural History.

70%	14	5	For preserving delicate specimens and killing tough ones.
80%	16	3	For preserving specimens of average or large size. Most commonly used.

Distortion and shrinkage often occurs when alcohol is used.

A weak and diluted solution of formaldehyde will also serve as a killing-preserving agent. It is a bit slower than other agents and distortion and shrinkage occurs with brittleness. Use 10 parts of 40% formaldehyde to 90 parts water.

Carbon tetrachloride is a very common killing agent. It is recommended that the teacher be the only one to handle it, as its fumes are very toxic. A few drops in a killing jar will dispatch any insect. It takes from an hour to several hours to kill the insects. If the insects are removed too soon from the killing jar, they may appear to be dead, but cause consternation when they revive on the pinning board, so precaution should be taken that insects have been given enough time in the killing jars before they are removed.

Procedure:

First, find a strong glass bottle small enough to fit in your pocket or collecting kit and wide enough at the mouth to admit the largest insect you are likely to catch. If you are interested only in small species, a vest-pocket size test tube or little glass vial would be handy. If you are planning to collect all kinds of insects, make it two jars at least, since butterflies and moths should have one to themselves. Some of the tiny scales with which they are covered come off in the bottle and cling to the other specimens thus spoiling their appearance, while the weight and the kicking of one big beetle can ruin a dozen butterflies. Further, never kill scaly and hairy bodied insects; for example, moths, butterflies, flies, bees, wasps, etc., by immersion in a liquid as this will ruin their appearance.

Each jar should have a tight stopper. A screw cap must fit closely without the usual waxed cardboard lining. The wax might soften in the fumes of the killing fluid and smear the specimens. Some collectors prefer a cork, which can be removed with one hand, especially if it has a loop handle of cord or small chain.

Secure some plaster of paris. A pound will be plenty and can be bought for a few cents at any paint or hardware store.

Fill a teacup about 1/3 full of water, less if your bottle is very small. With a spoon, gently scatter the dry plaster on top of the water and let it sink without stirring. When almost all the free water is absorbed and all the plaster is wet, stir carefully until the mixture is smooth. This method of mixing prevents the formation of air bubbles in the plaster.

Pour the plaster into the clean bottle until it is about 3/4 of an inch deep, less for a little vial. If the surface is not flat, knock the bottle gently to settle it. Then wait for the plaster to set.

If, while you are stirring, the plaster becomes too thick to pour, do not try to soften it by adding more water. Throw it away, wash the container and start all over again. Never pour left-over plaster down the drain. It may set in pipes and stop them up. Dump it out on an old newspaper and put it into the garbage. Wash the cup and spoon right away with plenty of water.

Feel the bottle while the plaster is setting. You will find it warm. When the plaster has cooled, but while it is still damp, remove any plaster which may have splashed onto the sides of the bottle. This can be done by scraping with a knife and dusting with a dry cloth. Label the bottle "POISON INSECT KILLER" and leave it open in a warm place until it is perfectly dry. This will usually take twenty-four hours, but you can hurry it up, if you have to, by putting the bottle on a hot radiator or in an oven with the door slightly open.

Dry plaster of paris is an excellent blotter and can soak up an astonishing amount of liquid before becoming visibly wet. That is the secret of this kind of killing jar. If you saturate the plaster in your bottle with a volatile liquid; for example, carbon tetrachloride, which is poisonous to insect, it will kill your specimens quickly and safely for hours without slopping at all.

Saturate the plaster in your jar at the beginning of every day's collecting. The liquid may run down the inside of the bottle or dropped in with a medicine dropper or spoon. It will be absorbed more quickly if the whole surface of the plaster is not covered with liquid at one time, as this tends to seal in the air which must come out before the fluid can occupy its space. The damp part of the plaster will be slightly gray and you can watch the stain spread until it reaches the bottom all around. The bottle is then ready to use.

A jar intended for heavy bodied insects may be cushioned with several strips of paper towelling which absorbs the moisture of the specimens and helps to prevent them from clawing and biting one another. A Lepidoptera bottle should contain nothing but moths and/or butterflies and not too many of them at once.

A pair of tweezers are very useful for taking specimens out of a bottle. For butterflies they are essential as these cannot be touched with the fingers without ruining their appearance. Slender, pointed tweezers can probably be bought at a drug store, but smooth broad ended stamp forceps, which you can find in a stamp collectors shop, are better for butterflies.

If possible, mount your specimens on the same day that you catch them. If there is not much time for this, put them away between layers of thin glazed cotton or soft paper in a tight box. The box should be left open in a warm dry place for several days until the insects have dried out thoroughly. Then, before closing, put in some paradichlorobenzene moth flakes to prevent mold and keep out the carpet beetles.

ACTIVITIES FOR STUDENTS IN INSECT COLLECTING AND IDENTIFICATION

A. Construction of Individual Collecting Kits:

1. Gather materials:
   a. Boxes to hold collecting materials such as fishing tackle boxes, sewing boxes, cigar boxes, etc. The hardier, more durable boxes in place of cardboard containers are preferred for obvious reasons. Be certain to label the "insect kits" with each student's name.
   b. Vials, bottles, envelopes, match boxes, etc. for holding specimens collected while in the field. Make certain that most of the bottles and vials have air circulation holes punched in their lids to insure against specimens molding.

      Caution: If fingernail polish remover is going to be used as a killing agent, do not place it in contact with plastics as it will melt the plastics!

   c. Safeguard all materials by inspection. Do not allow poisons or other dangerous materials to be included in these kits. If glass jars are to be included, guard them against shattering by wrapping plastic tape around them. If possible, construct compartments in the kit to facilitate the storing of specimens and tools.
   d. Be sure to include some boxes filled with cotton. Boxes large enough to hold butterflies and moths should be filled with soft cotton. Take care never to place butterflies, moths, bees, wasps or flies in alcohol or other liquids as these scaly and hairy bodied species will be damaged by immersion.
   e. Include forceps or tweezers for handling specimens and a

small water color brush to pick up very small insects.

f. A couple vials or bottles of diluted (60-75%) ethyl alcohol should be included for preservation of some soft bodied insects while in the field. A few drops of glycerin should be placed in each vial to keep the specimens soft and pliable until later more adequate preservation.

g. Make quite certain that pencils and notebooks are included in a collection kit. Take care to emphasize the importance of recording information about the place and time of capture and all other information about habitate, food, insect home, etc.

2. Designate and organize a "insect kit" storage space.
   a. An area should be provided in the classroom for storage of insect kits.
3. Construction of "killing jars."
   a. Note special section on construction of killing jars p. 11.
   b. It is recommended that once killing jars are constructed, that considerable instruction and discussion is held to understand the use and dangers of toxic agents.
   c. If each student constructs a killing jar, it could be suggested that these jars then be placed in a safe location in the classroom and kept there until the end of the project or unit. The handling could be supervised or conducted entirely under the supervision of the teacher.
   d. If fingernail polish remover is used for the killing agent, be certain that the killing jars are made of glass because the chemicals in the polish remover will "melt" plastics.
   e. In any case, no matter what type of container is used, always carefully tape the killing jar with plastic tape and label in large letters: DANGER POISON. If possible include an antidote instructions.
   f. Care should be taken to consider emotional considerations of collectors and adults on the subject of killing jars, toxic materials in the classroom and other potential objections. If the teacher handles all the "dispatching" of insects, then possible confrontations can be avoided.

B. Utilize Community Resource Speakers:

1. Contact local exterminator firms for possible materials, films, demonstrations and speakers.
2. Often such exterminating firms have interesting materials that the class can use for study and display; such as, hornet nests, termite damaged woods, etc.
3. Contact the local field office of the state or national Agricultural Department for materials and speakers.
4. Contact the nearest University's Department of Entomology for assistance.

5. Invite local collectors to visit the class and display their collections. Extreme care must be exercised to insure against inadvertent damage to their collections. Such understanding and cooperation is not difficult for the children after they themselves have worked to build a display collection.

C. Construction of Spreading Boards:

1. *See special section on construction and use of spreading boards p. 204-206.
2. A splendid and very easy spreading board can be made in a few moments from a block of plastic foam obtained from the Outdoor Education Office or from local business concerns.
3. A "contest" can be organized to see who can make the best spreading board. Enforce "soap-box derby" rules to insure that the children themselves make the boards rather than fathers. Provide each child with detailed instructions. In some cases, local businesses might provide the materials.

D. Construction of Collection Display Boxes:

1. Cigar boxes make excellent display boxes, but cigar boxes are very difficult to obtain. The deeper boxes are preferred to avoid bending the insect pins when the box is closed.

   Materials:

   a. Cigar box, 2 x 6 x 8 inches or larger.
   b. Piece of double faced, corrugated cardboard or preferably plastic foam.
   c. Glue.
   d. Common pins.
   e. Moth balls.

2. Cut cardboard or plastic foam to fit bottom of box.
3. Smear glue on bottom of box and insert cardboard or plastic foam.
4. Box may be lined with white paper.
5. Heat head of pin with lighted match.
6. Insert hot head of pin into moth ball and cool.

   Note: The moth ball or naptha flakes are to insure against one of the greatest dangers to a collection -- small insects invading the collection and eating it!

*Hillcourt, William. Field Book of Nature Activities and Conservation. G. P. Putnam's Sons, New York, 1961.

E. Construction of Butterfly Mounts:

1. Gather materials:
   a. Piece of window glass 4 x 4 inches.
   b. Piece of cardboard same size as glass.
   c. Thin layer of cotton same size as glass.
   d. Picture binding; such as passe partout tape, or cloth tape.
   e. Butterfly with wings spread and dries.
2. Make mounts by:
   a. Spreading thin layer of cotton on cardboard.
   b. Arranging butterfly on cotton.
   c. Placing glass over butterfly.
   d. Binding edges of cardboard to glass with binding tape.
   e. String may be attached for hanging mount or a strip of cardboard may be glued on the back of mount for support.

F. Insect Record Sheets Suggested by the 4-H Club Insect Manual:

1. The teacher and class should discuss what information they will attempt to gather for recording on each insect. The particular form of their record sheet is not as important as including certain information such as:

   a. Date of capture.
   b. Location of capture (general location, country, city, state).
   c. Habitate of capture (swamp, vegetable garden, lawn, pond, etc.).
   d. How captured (by hand, net, beating, etc.).
   f. Food of insect (lapping nectar, on decaying flesh or vegetable, etc.).
   g. Stage of growth cycle (pupa, egg, larva, adult, nymph).
2. 3 x 5 cards can be dittoed to record this information.
3. Notebooks can be recorded for this information, etc.

The following page shows an Insect Record Sheet.

INSECT RECORD SHEET

1. Common name of insect _____

2. Description:
   a. Size (indicate by mark) _____
   b. Color _____
   c. Mouth parts: Chewing _____; sucking _____; lapping _____
   d. Number of wings _____

3. Where does insect live: Air _____; soil _____; water _____; in host _____

4. On what does insect feed:

Item	leaves	blossoms	fruits	branches	stems	roots

Flowers: _____
Shrubs: _____
Orchard trees: _____
Hay crops: _____
Grains: _____
Vegetable crops: _____
Other crops: _____

Wood _____; wood products _____; woolen _____
furs _____; fabrics _____; food materials _____
stored products _____; man _____
animals _____; other insects _____
tiny plants or animals in water _____

5. Habits:
   a. How does it spend the winter: egg ___; larva ___; pupa ___; adult _
   b. Where does it spend the winter? _____
   c. Kind of life cycle:
      (1) Complete (four stages) _____
      (2) Incomplete (less than four) _____

6. Economic importance: Pest _____; beneficial _____ questionable _____

7. Control for pest: Stomach poison _____; sanitation _____
   contact spray _____; cultural practices _____

G. Collect and Preserve Immature Insects* (early spring):

1. Equipment:
   a. Small vials (size of man's largest finger) with stoppers.
   b. 5% solution of formaldehyde.
2. Procedure:
   a. Dilute formaldehyde to 5% solution.
   b. Distribute solution in vials to students.
   c. Field trip. Make survey of abundance of important pests in hibernation or on crops.

Note: See special section on preservation of soft bodied insects p. 41).

H. Construction of Insect Rearing Cages:

1. Equipment:
   a. Each student should have a list of common insects about the area.
   b. Glass cylinder with both ends open; such as, lamp chimney.
   c. A piece of cheesecloth or empty can for cover.
   d. Flowerpot or can in which to grow plant.
   e. Screen wire.
   f. Sticks of wood or plants for insects to feed on.
2. Procedure:
   a. From life cycle presented in books or bulletins, decide which insects can be reared during the season or summer.
   b. As far as possible, have each student select a different insect to rear.
   c. Outline procedures for rearing insects. See special section on rearing insects in the following:

      Peterson, A., Entomological Techniques, 1959, Edwards Brothers, Ann Arbor, Michigan. (Note: This book is available only through Dr. A. Peterson, 2039 Collingswood Road, Columbus, Ohio 43221. The price is $8.50, plus postage.)
      Siverly, R. E., Rearing Insects in Schools, 1962, Wm. C. Brown Company, Dubuque, Iowa ($2.75).
      Moore, C. B., The Book of Wild Pets, 1954, C. T. Branford Company, Boston ($6.50).
      DeWaard, E. John, What Insect is That, 1965, Current Science and Science and Math Weekly Unit Book, American Education Publications, Education Center, Columbus, Ohio 43216.

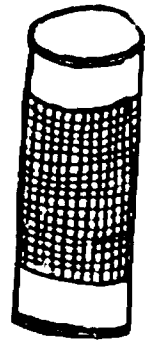
*4-H Club Insect Manual, Agricultural Handbook No. 65.

Hillcourt, William, Field Book of Nature Activities and Conservation, 1961, G. P. Putnam's Sons, 200 Madison Avenue, New York 16, New York.

d. Glass cage:
   (1) Place open ended glass cylinder or old lamp chimney over plant and firm it in soil.
   (2) Fasten cheesecloth or empty can over top.

Lamp Chimney
Breeding Cage

e. Screen cage:
   (1) Roll screen to make cylinder of desired size.
   (2) Place cylinder can in bottom.
   (3) Fill can with soil.
   (4) Insert plants or sticks in soil. Firm soil around base of wire cage.
   (5) Place second can on top.



Wire Screen and
Can Breeding Cage

I. Insect Identification Contests:

1. Contests can be organized during study units on a number of identification topics. Some suggested contests could be:
   a. Butterflies vs. moths. (Of course the real specimens would be best, but pictures could work.)
   b. Beetles vs. bugs.
   c. Families of the Hymenoptera order; for example, bees, wasps, ants.
   d. An assortment of the several major orders.
   e. The more obvious immature stages. (This is a difficult area because even experts are often fooled.)

J. Insect Trading:

1. Insect collectors often swap specimens just as stamp collectors and coin enthusiasts. This can be a lot of fun and at the same time quite instructive because care must be taken that one doesn't get a "bad" swap by discovering too late that an important part is missing or damaged. Each "swap" should be carefully inspected and only good specimens accepted.
   a. Trading can take place within a classroom or a school.
   b. Trading can take place within a district between schools.
   c. Trading can be arranged with schools across the country. This has an added advantage of utilizing the language arts skills in letter writing and postal studies. Contact collectors across the country through teachers, pen-pals, distant relatives and friends.

K. Utilize Outings and Camping Trips for Insect Collection:

1. Children can be prepared for more adventure on outings with their parents if they can include a family insect hunt in their camping trip. The kits prepared by children are ideal for such outings.
2. Field trips from the school just for collecting purposes.

L. Making Insect Surveys:

1. Select areas on or around school grounds or in Outdoor Education areas for a class survey.
   a. Stake out areas with string and then by careful searching, locate and collect as many different insects as time and energy allows.
   b. Take care to record where and how each specimen was found. Label each specimen and label the record to avoid confusion later.
   c. Probably many of the specimens will be unidentified immediately, but this can provide for a great deal of

activity later in research to provide identification.

d. Children may be "specialists" for certain orders and can use some of their skills as "field consultants" during the survey. Such designated children, either by choice or appointment, often take such "status" so importantly that they actually do give a great deal of effort to becoming well versed on the habits of particular species or orders.

M. Utilize the Interests of Children and Adults Outside of Class:

1. A few well placed and interesting signs posted around the school will result in a surprising number of excellent "donations" from younger children. The younger brothers and sisters of the children take a lot of pride in being able to contribute to their brothers and sisters school project. In addition, the custodians and your teaching colleagues will be on the look out for specimens and once they have become aware of the abundance and beautiful variety of insect life around them, they will often give you considerable help.
   a. Through language arts and art activities attractive displays can be prepared and presented to the younger primary children. The older collectors can prepare interesting talks about the displays and this often results in a rash of "contributions" by the smaller children.

N. Life Cycle Display:

1. Study the life cycles of a variety of insects.
2. Collect specimens from each stage and preserve them in a recommended solution of alcohol or formaldehyde (See section on preserving soft bodied insects p.
3. Prepare cards with information about these stages and attach them to the preserved displays.
4. Be sure to collect and preserve examples of insects that have incomplete metamorphosis (egg-nymph-adult) and complete cycles (egg-larva-pupa-adult)

O. Study of Wasp Nests:

1. Attempt to collect wasp nests from different species of wasps or hornets. Take care not to be stung. If nests are collected with living wasps or hornets in them, kill the inhabitants by spraying with insecticide or some other killing agent that will not contaminate the nest for study.

   Note: If larva is left in the nest after the adults are ex-

terminated it should be used for study as soon as possible because the larva, unless removed will begin to decay and make the room quite unpleasant.

2. Study the construction of the nest and note its similarities and differences from nests of other species.
3. If possible, remove and preserve different growth stages of the larva and eggs.
4. Sketch the construction of the nest.
5. Attempt to determine the origin and composition of the materials from which the nest was made.
6. Collect adult specimens that inhabit such nests.
7. Contact local exterminators for possible donations of nests that they are often called upon to remove from homes.

P. Study of Ant Colonies:

1. Find an ant hill and carefully study the life of the ants on the surface.
2. Place sugar and sweets near the entrance holes and observe the reaction of the ants.
3. Place living and dead insects on the colony and observe the reaction of the ants.
4. For superb background information on ants, read the section in the Life Nature Library, The Insects, page 160-180.
5. Carefully dig up an ants' nest and observe the four stages of an ant's life. See if you can find some ants taking care of their "cow."
6. Construct or borrow ant "farms" and conduct studies on ants in the room.

Q. Study of Insect Anatomy:

1. Collect a variety of insects and study them carefully under magnifying lenses.
   a. Look for three body segments:
      (1) Head
      (2) Thorax
      (3) Abdomen
   b. Study the leg parts:
      (1) Attached to thorax
      (2) Femur, tibia, tarsus, claws
      (3) Look for pollen baskets on bees
   c. Study the mouth parts of insects:
      (1) Sucking
      (2) Biting
      (3) Chewing

d. Study the wings of insects:
   (1) Hard sheaths on beetles
   (2) Scales on butterflies and moths
   (3) Veining on dragonflies
e. Study the antennae on butterflies and moths:
   (1) Butterflies have knobs on antennae
   (2) Moths have "feathery" antennae
f. Study how an insect breaths:
   (1) Examine insects for the small holes on their abdomen called spiracles. These are breathing pores.
g. Study insect eyes:
   (1) Compound eyes
   (2) Single eyes

R. Student Research Reports on Insects:

This is an unlimited field. There is an abundance of information and much of it is written for young children. Below is a list of just a few possible topics.

1. What is an insect?
2. What is an insect skeleton like?
3. How many eyes does an insect have?
4. How does an insect breath?
5. How does an insect hear?
6. How do insects communicate?
7. How do insects protect themselves?
8. Where do insects lay their eggs?
9. What is insect metamorphosis?
10. How much food does a young insect eat?
11. Why do young insects keep losing their skins?
12. What is a Pupa?
13. How does a caterpillar change into a butterfly?
14. How fast can insects fly?
15. Where do insects go in the winter?
16. How many insects are there?
17. What are the major orders of insects?
18. How does a firefly's light work?
19. How can you tell a moth from a butterfly?
20. Tell about the largest and smallest insects.
21. What are social insects?
22. What is life like inside a beehive?
23. How do insects care for their young?
24. What is life like inside an ant colony?
25. What are termite colonies like?
26. What is the life of a silkworm?

27. What is a "Mexican Jumping Bean?"
28. What are some strange insect homes?
29. What are some diseases carried by insects?
30. How do insects help us?
31. How can you tell insects from other animals?
32. What is the work of each part of an insects body?
33. Of what value is a compound eye to an insect?
34. How is the life history of a butterfly different from the life of a grasshopper?
35. What are the differences between queen, worker and drone bees?
36. Report on the preying mantis.
37. How does a honeybee make honey?
38. What causes bees to swarm?
39. How do honeybees keep warm in winter?
40. How do honeybees keep cool in summer?
41. How do wasps make paper?
42. In what ways are bees helpful to us?
43. What are "ant cows?"
44. Where are bugs not bugs?

S. Investigation of Solitary Bees and Wasps:*

Even though we think of the social insects to be led by the bees and wasps, it is a fact that the social bees and wasps make up only a minority, while solitary bees and wasps make up about 98% of all the kinds of bees and wasps in the world.

Wasp nests nearly always contain paralyzed animals left there for food for the wasp larva. The wasp stings the animal, usually insects, to paralyze it so that the egg which is then deposited on it will hatch to find fresh food. Caterpillars are the most common prey for wasps with spiders making up a second large food supply.

The wasp usually digs or finds a burrow, often in sandy soil, that is several inches in length. The burrow is then stocked with one or more caterpillars or spiders with a fertilized egg placed on the prey or beside it. Within days, the egg hatches out and the emerging larva will eat the stored supply of food while it grows into a pupa and then into an adult wasp.

*Nature and Science, Volume 4, Number 15, April 24, 1967, pages 15-16.

Evans, H. E., Wasp Farm, The Natural History Press, Garden City, New York, 1963.

Wasp and bee traps can be made and will provide interesting study and experimentations. If such a project is attempted, it is highly recommended that the resource materials be reviewed first. The investigation outlined below is adapted from the April 24, 1967, of Nature and Science.

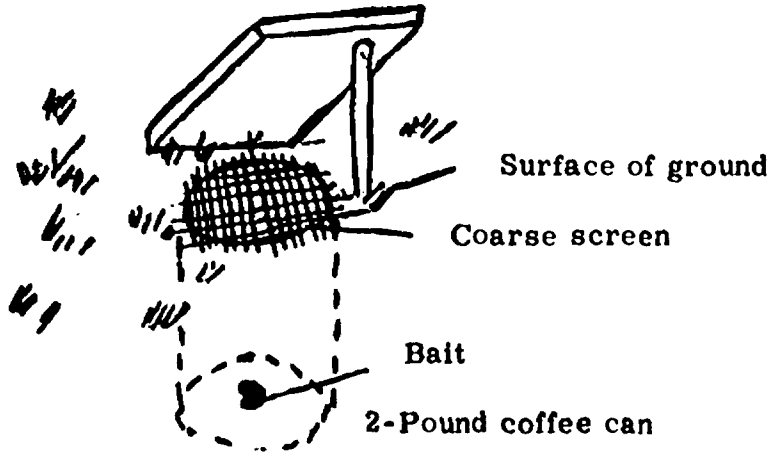
1. Materials:
   a. Knot free, seasoned white pine blocks 6" long x 3/4" thick. (Any wood can be used, but the pine is recommended.)
   b. Wire and rubberbands
   c. Glue
   d. Plastic wrap
2. Construct 25-30 trap nests in the following manner:
   a. Cut the blocks to size (6 x 3/4 inches.)
   b. Bore holes in an end of each trap nest. Use several different sizes of holes from 3/16 to 1/2 inches in diameter. The holes should be the depth of the drill bit at its longest depth.
   c. An alternate way of making the holes is to cut or gouge slots along the surfaces of blocks of wood with a router or dato saw. Cover the slots with another piece of wood. Tie or fasten the pieces of wood together with wire or rubber bands. This type of nest is much easier to open.
   d. Another way of utilizing the trap nest it to construct it in the manner described in #c above with the addition of wrapping each nest with plastic wrap before covering the hole with another piece of wood. Staple or glue the plastic wrap into position. Then hold the entire nest together as before with string, wire, or rubber bands. This type of nest allows the observer to lift off the top piece of wood while the bee or wasp is working inside the nest and see the action occurring inside. This will allow you to follow the entire development of the larvae with little disturbance to the nest.
   e. Place the nest traps outside around your home or on the school grounds, either singly or in bundles wired or tied together in groups. Never place them on the ground. Put the nests in a variety of places; such as, trees, fences, window sills, etc. Some can be placed in the shade; some in the sun.
   f. Each nest should have labels for identification. Careful records should be kept for any real value to be gained.
3. When the nests have been placed and observation shows that they are being used, the following activities may be followed:
   a. Observe the time the female is gone from the nest.
   b. What does she carry when she returns?
   c. How does she carry it?
   d. Is it larger than she is? How does she manage it?

e. What happens if you change the position of the nest while she is gone?
f. What happens if you block the entrance of the nest before she returns? While she is in the nest?
g. What happens if you place objects in the nest?

4. When the nest has been finished and the entrance has been plugged with mud or some other similar materials, remove the nest and open it. If the nest is constructed from drilled holes, then it will have to be carefully split open with a knife. Be careful not to dump the contents or crush the larva. Open the nests at different times after the completion of the females work. The sooner it is opened, you will have a better chance of observing the eggs and larva. After a few days or weeks, the cocoon will be the only thing to observe.
   a. Observe the position of the egg.
   b. How long does it take the larva to eat the prey?
   c. What kind of prey is in the nest?
   d. How long does the prey stay fresh?
   e. Feed similar prey to the larva.
5. Do not let the nest get too dry during the investigation. Carefully replace the split half and hold it in place with rubber bands. Store it in a container; such as, jars or plastic bags.

T. Construction and Use of Pitfall Insect Trap:

1. A pitfall trap is simply a jar or can buried in the ground up to its upper rim. The rim is level with or slightly below the surface of the ground. A board can be propped up over the jar or can to shed rain if the weather is poor.



2. Activities:
   a. Place a dozen or more cans or jars around the school grounds or in the collecting area in different places. Place them in lawns, under trees, bushes, hedges, tall grass, gardens, near garbage cans and under rotting boards. Attempt to place them in as many different habitates as possible. Record the number and kinds of insects you collect in different places. What areas attract the most insects? What areas collect the same types of insects?
   b. Place insect bait in the cans. Experiment with different kinds of baits. Different natural baits are attractive to different kinds of insects. Some that are used by collectors are; flowers, aphid excretion, known as honeydew, fermenting sap that flows from wounds in trees, rotting or overripe fruits, carrion, animal excreta and rotting fungi.
   c. Some collectors make their own bait from molasses, syrup, and fermenting fruit juices. This can be placed in and around the pitfall trap.

U. How Much Does a Ladybird Beetle Eat?

1. Ladybird beetles, often called ladybugs, are very beneficial insects which enjoy the pesty aphids as their main diet. Aphids can be located on many plant stems by careful searching. These insects suck out the plant juices causing great harm to plants. Even though these insects are very small, it has been estimated that, starting with one female, there could result 822 tons of aphids in eighteen weeks!
   a. Place a ladybeetle in a jar or bottle. Put a little moist paper in the jar to keep the air humid. Take a leaf containing aphids and brush all but ten aphids off and then place it in the bottle with the ladybird beetle. Take the leaf out the next day and see if all the aphids were eaten. If they were, add ten more. If these were eaten, then increase the number. Record how many aphids a ladybird beetle can eat daily. How many can this insect eat in a week? Figure out how many can be eaten in a month. Compute how many it could eat in a year.
   b. Attempt to compute the weight of the aphid to the comparative weight of the ladybird beetle. How much does the beetle eat in relation to its own weight? How does this compare to a 100 pound boy?
   c. Try to collect a large number of aphids and experiment with using them as bait for insects.

V. *Capturing Moths and Butterflies by "Sugaring":*

1. Moths are frequently taken by the use of a prepared bait known as "sugaring." It may also be used for butterflies.
   a. Mix brown sugar and stale beer drippings into a frothy paste. Other ingredients may be added such as smashed over-ripe bananas or grapes. If allowed to ferment for a few days, it is all the better.
   b. With a brush, apply this bait to tree trunks, fences, stumps, etc., located on the side of a woodland or along paths in forested areas if comparatively open and not too dense.
   c. After dusk or during the night, check your "sugaring" stations and pick the moths and butterflies from the bait. Beetles and other insects are often attracted to the bait as well as the moths, so take along jars in which to place these specimens.

W. Collect and Study Examples of Plant Damage by Insects:

1. Many insects are collected after signs of their presence are noted by damaged plants. The gall swelling a tree branch, common on alders, the twisted or folded leaf, the brown and dying leaves on shrubs and trees are all present mute evidence to the presence of an insect pest.
   a. When collecting insect specimens, take care to bring back the plant on which the insect was found. Inspect it for damage. Note the type of damage and the type of specimen collected from it. Records of this nature would give clues to other young collectors to observe when they are searching for the same type of insect.
   b. Bring a class some examples of termite damage with, if possible, some of the termites still in the wood. Place the wood sections in an aquarium or some othe insect proof container. Cover the top with fine me or gauze. Darken the container for a period of tin then remove the cover and often the termites can be ved for a short period of time before the light drives t back into the wood.
   c. Look for leaves with little burrows etch ross the face of the leaf. This is the larvae of an insec h feeds between the epidermal layers of a leaf.
   d. Inspect the collected plants carefully f s. If eggs are discovered, attempt to hatch them by i ining the plant in a micro-environment in a terrariu is also applies to the study of larva specimens found plants.
   e. Plant an "insect garden." Somewhere school grounds an early spring garden plot may be pla that is just for insects. Plant a variety of vegetables e no insect-

icides. Invite insects by spicing your garden plot with baits; such as, overripe and crushed fruits, brown sugar, fruit juice pastes, etc. Unless slugs or rats are overly attracted, it might provide an interesting source of specimens. Many types of traps could be tested and the growth cycles of different specimens could be observed. This is an untested idea, but it may work better than expected. In any case, it could provide a unit on gardening!

X. Studying Wasps*

1. Hornets, yellow jackets, Polistes, mud daubers, and the cicada killer are all wasps, which is: a group of beneficial insects that attack and destroy harmful insects found around homes and in gardens.
2. Hornets and yellow jackets kill such pests as; house flies, blow flies, and caterpillars. Polistes kill corn earworms, arymy-worms and other garden pests. Wasps can attack people as well as insects. Hornets, yellow jackets and Polistes may sting you if you go near their nests, so use extreme caution. Mud daubers and cicada killers usually will not sting unless you touch them or get them caught in your cloths.

3. When a wasp stings, it injects a venonmous fluid under the skin. The venom causes a painful swelling that may last for several days. In some people, a wasp sting can result in severe illness or death. It is always recommended to survey your students in conducting any insect collecting project for allergies to insect stings or bites. Usually, their parents know of this allergy and will inform you. Such children can participate in activities of the class that don't involve the danger of coming in contact with living insects that may sting or bite. Even though they may be watchful for stinging insects and are intent on only capturing beetles or some other harmless insects, they may be stung by a bee or hornet quite by accident. Always give prompt attention to any individual stung by an insect. If the victim has a history of hay fever, asthma, or other allergies, call a doctor immediately.
4. Activities:
   a. Observe and collect with extreme care the nests of wasps. Wasps can be identified by the nests they build and where they build them.
      (1) Hornets, Polistes, and mud daubers build nests above ground.
      (2) Hornets and Polistes nest in trees and shrubbery and under eaves.
      (3) Mud daubers nest under eaves and porch roofs and behind shutters; they do not nest in trees and shrubber

*Home and Garden Bulletin No. 122 from the U. S. Department of Agricultur

(4) Yellow jackets usually build their nests in the ground, but sometimes build them above ground.
(5) Cicada killers nest in the ground.

b. Hornets and yellow jackets build football shaped paperlike nests. Polistes build paperlike nests that resemble a honeycomb. Mud daubers build clay or mud-cell nests. Cicada killers dig holes about 1/2 inch across in slopping ground and pile the excavated soil beneath the opening.
c. Hornets, yellow jackets and Polistes abandon their nests in the fall. The old nests are not reused and usually disintergrate or are torn apart by birds or squirrels. These insects are perpetuated by the hibernating queens. Mud daubers and cicada killers overwinter as resting larvae in their nests.
d. You can destroy wasps by applying insecticides to their nests. Treat the nests at night when there is less danger of being stung.

TERRARIUMS AND HATCHERIES

At the same time as field collections of insect specimens are being made, be on a sharp lookout for eggs and cocoons. Look for insect eggs inside a twisted leaf, under bark or for the larval stages in plant galls. Search for cocoons under the eaves or places that are protected from the weather. The milkweed plant is the source of Monarch butterfly eggs.

The key to successful hatcheries is to duplicate the natural environment as closely as possible and to avoid extremes in temperature and moisture. As in any terrarium, a micro-climate must be set up. This is especially true if you are trying to raise insects from eggs. Each insect has its own temperature and humidity requirements. Before attempting to raise any insect, take care to study its requirements.

You will have better success if you try to raise insects that are plant feeders. Insects that feed on living plants may be caged over potted plants or fed frequently with fresh material from their host plant. With little ingenuity a suitable cage can be prepared. The important thing is to have it tight enough to keep the insects in and yet provide for sufficient ventilation so that the container will not "sweat." Some loose, slightly moist soil and ground litter should be provided in case the insect is one that pupates in or on the gound. Insects that feed on decaying animal matter should also have the cage provided with slightly moist soil or sand.

Insects that infest seeds and those that cause plant galls may be reared merely by enclosing the seeds or galls in a tight container. Such materials should not be permitted to become too dry; neither should it be kept moist, else the material and the specimens will mold.

Adult moths, butterflies, beetles and many other insects may be obtained by collecting pupae and caging them until the specimens emerge. In this way, the best specimens of moths and butterflies may be secured. Always permit the reared specimen to harden and color completely before killing it, but do not leave it in the cage so long that it will damage itself in trying to escape.

Very often bark and wood infested by boring insects; such as, beetles, are found. If these are placed in glass or metal containers, excellent specimens of the adults may be obtained. Cages of wood and cardboard should be avoided for obvious reasons. Such materials can often be collected and caged during the winter months, the period of effective field collecting being thus extended.

For further readings:

Peterson, A., Entomological Techniques, 1959, Edwards Brothers, Ann Arbor Michigan. (Note: This book is available only through Dr. A. Peterson, 2039 Collingswood Road, Columbus, Ohio 43221. Price $8.50 plus postage.)
Silverly, R. E., Rearing Insects in Schools, 1962, William C. Brown Company, Dubuque, Iowa. ($2.75).

FINDING HIDDEN INSECTS*

Objective:

To demonstrate with a "bug betrayer" that:

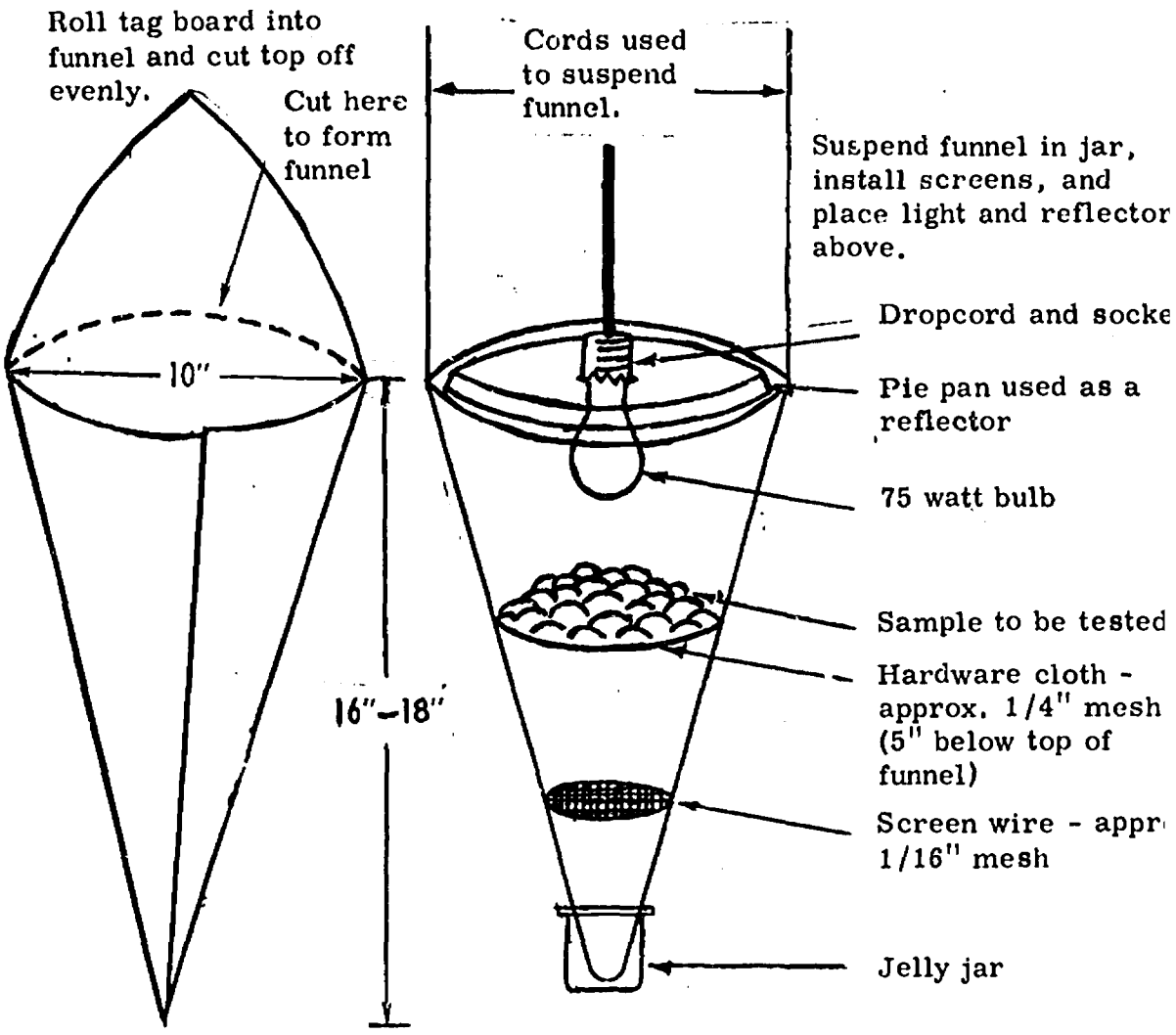
1. Insects and other living things, both destructive and beneficial, are frequently present in materials where their presence is unsuspected.
2. They can be driven from their hiding places with the heat from a light bulb.

Introduction:

Living things are often found in places where the untrained observer does not expect them and in places where they cannot be located by visual inspection alone. This is one reason why many items; such as soil, plant material, etc., are restricted or prohibited from moving internationally or interstate.

In performing this experiment, students will be duplicating a process used by U. S. Department of Agriculture scientists in their inspection work. For example, a modified Berlese funnel made of metal, but otherwise similar to the one in this experiment, is used by plant quarantine inspectors to locate the khapra beetle, world's worst pest of stored grains, in debris and grain samples taken from ship's holds. A similar arrangement is used with smaller screens to isolate and discover extremely small or sometimes microscopic pests.

*U. S. Department of Agriculture Classroom Science Project No. 1 P. A.-786



Materials Required:

1. One sheet of "tag board" or heavy construction paper approximately 20 by 30 inches.
2. Two sheets of aluminum foil 10 inches by 30 inches.
3. One half-pint jelly jar or a one-quart fruit jar.
4. Two pieces of window screen approximately 12 inches square.
5. One piece of 1/4 inch mesh wire hardware cloth approximately 12 inches square.
6. One 75 watt light bulb and drop cord.
7. One aluminum pie pan 10 inches in diameter or a commercially built reflector for the drop cord.

Procedure (refer to diagrams):

Using masking tape, attach the aluminum foil to one side of the piece of "tag board" or construction paper. The foil should be stretched and smoothed against the tag board or construction paper, depending upon which is used, and then should be taped securely in place at the center seam. Next roll the tag board or heavy construction paper into a cone with the aluminum foil on the inside. The cone should be constructed so that it will be 10 inches in diameter at the top, 16 to 18 inches high and have a 1/2 to 1 inch opening at the bottom after the excess material at the top is cut off. Use the masking tape to fasten the cone together and hold the shape, then cut off the extra material at the top to form the finished cone. Place a strip of masking tape down the inside seams of the funnel so that the interior is smooth and free from crevices.

Cut one piece of the screen wire to a size that will allow it to be placed inside the funnel approximately 12 inches below the top. Make sure it fits tightly against the sides of the funnel and cups down slightly in the center. Cut the piece of 1/4 inch mesh wire hardware cloth to a size that will allow it to be placed inside the funnel approximately 6 inches below the top. (It should not be farther down than 7 inches or closer to the top than 5 inches.) Then cut the second piece of screen wire the same size as the hardware cloth and lay it to one side for use later.

Note: An easy way to measure the sizes required for all screens is to place an ordinary compass normally used to draw circles inside the cone at the points where the screens will be located. When opened to touch each side of the cone, the compass will show the inside diameter of the cone at the point, and the radius of the screen required will, of course, be one-half the diameter.

Suspend the funnel in a vertical poisition, large end up. The funnel may be supported in any one of the following three ways:

1. Hung by four wires attached to small holes in the top;
2. Set inside a wire coat hanger that has been previously bent outward (so that it forms an approximate square) to the correct size to fit around the funnel several inches below the top. The hook of the coat hanger is then placed between books stacked to the proper height to hold the funnel upright; or
3. Set the funnel in the neck of an ordinary 1-quart fruit jar. This is the least desirable method, as the funnel tends to tip and wobble when in use.

Cut a hole in the center of the aluminum pie pan slightly larger than the small end of the 75 watt light bulb. Insert the bulb through the hole with the pie pan turned upside down, and screw the bulb into the socket of the drop cord. The pie pan should touch the glass portion of the bulb only,

and it acts as a reflector. Position the drop cord over the center of the funnel and lower it to a point where the bottom of the bulb is 4 to 5 inches above the top screen inside the funnel. This completes construction of the "bug betrayer," scientifically known as a modified Berlese funnel.

Operation of "Bug Betrayer":

Have students collect the samples listed above either at home or on the school grounds. Samples may be collected in paper sacks. After a sample is collected, the student should twist the neck of the sack shut securely and tie a piece of string around it to prevent the possible escape of any living organisms in the material. Samples may be collected anytime during the day or evening in fall or spring. In the winter, living organisms generally burrow down too deeply to be detected.

Place an individual sample on the top screen of the funnel. When using soil or other fine material, place the second piece of screen wire on top of the 1/4 inch mesh screen so that the material will not drop through. Crumble the soil up finely not more than 1/2 inch deep.

When using leaf mold, forest litter, and decayed plant materials, place it directly on the 1/4 inch screen. Loosen the sample with the fingers and make a layer 1 1/2 to 2 inches deep.

After a sample has been placed on the top screen in the funnel, place the half-pint jelly jar under the funnel. Elevate it so that the edges of the jar touch the sides of the funnel. (If a 1-quart jar has been used to support the funnel, let it be the collecting jar instead of using the half-pint jar.) Lower the light bulb and reflector into place and turn on the light. The heat drives the living organisms in the sample downward. Most of them will be small enough to drop through the lower screen into the collecting jar. Any larger organisms will be found on the screen wire at the end of the experiment.

Specimens usually begin to drop into the jar within 10 to 15 minutes after the light has been turned on, although soil samples sometimes require a longer time. It requires 1 1/2 to 2 hours to drive all living organisms out of a sample. At least 75 per cent of the samples listed for this experiment will yield living organisms if collected and tested in the fall or spring.

Avoid use of sand, gravel, or peat moss as such materials do not contain living organisms. When using extremely dry material (such as dead leaves), keep the light bulb at least 2 inches above the top of the material in the funnel and be alert to any possible fire hazard. Never operate, or allow the funnel to be operated, unattended. If a pupil has piled the sample too high and smoke is detected, turn off the light immediately. Adjust it higher and sprinkle water on the sample. This reduces the fire hazard

without impairing the operation of the funnel.

Activities:

1. After the class has learned to use the funnel, have several students visually examine a sample before placing it in the funnel. Collect and record the number and types of living organisms detected. Then place the sample in the funnel, using care to include all debris that was separated out during the visual examination. Then record the specimens missed during the visual inspection but detected by the funnel. In at least half of the cases, this will demonstrate man's inability to detect the presence of all living organisms by visual insepction alone.
2. The "bug betrayer" yields living specimens of the organisms detected. These may be transferred to a larger jar for additional inspection by the class if desired. Have pupils note and catalog the different types of organisms discovered in a sample, recording the type of material, place where it was obtained; such as, "compost heap," "dead leaves in yard," "soil in flower bed," etc. Teach them to note both the similarities and differences in types of organisms obtained from different environments. For example, dead leaves generally yield tiny spiders, mites, lice, aphids and bugs but few worms; compost yields many of the above plus worms and larvae; soil generally yields grubs and may or may not yield tiny worms depending on conditions of temperature, moisture, etc.

Learning Concepts from the "Bug Betrayer":

Stress to the class that all samples will not contain living organisms. However, the experiment demonstrates that many samples do contain them, both beneficial and harmful. This illustrates how man can accidentally spread insects and other organisms to other States, countries, or even continents where the organisms could not have spread without man's help. In many cases, man spreads a destructive pest to another region or continent without taking along its natural enemies. This often results in great economic damage to our food, forest and ornamental plants. This is why agricultural quarantines restrict or prohibit movement of many fruits, plants, seeds, bulbs, and all soil and decayed vegetable matter into the United States from abroad or, in some cases between States within our country.

The class will soon note that the living organisms driven out of their natural habitat run about and quickly hide under any leaves or soil placed in the jar with them. This is a natural instinct which allows these organisms to escape from their natural enemies and survive.

Advanced students may wish to use this tool to collect specimens. The organisms may be killed when the class is through observing them by pouring

ordinary rubbing alcohol into the jar. A better killing and preserving solution is compounded as follows:

1. 80% ethyl alcohol
2. 15% formalin
3. 5% glycerine

Killed specimens are then removed with a toothpick and placed on a paper towel to air dry.

TRAPPING INSECTS WITH LIGHT*

Objective:

To show students how insect traps operate and how insect survey and dectection work is conducted.

Introduction:

Insect traps are widely used by research scientists to collect insect specimens for scientific study or to determine what insects are found in certain areas. In addition, U. S. Department of Agriculture survey and detection teams, working in cooperation with State departments of agriculture, operate insect traps throughout the United States and its possessions to discover any new plant pest infestations which may occur.

Early detection of foreign plant pest invasions - or of the movement of domestic plant pests to another area of the country - is extremely important in the control or eradication of such pests before they become widely established and seriously damage our food, forests, and ornamental plants. For example, a 1956 invasion of Florida by the Mediterranean fruit fly became established, and eradication cost $10 million in Federal, State, and industry funds. The network of fruit fly traps was greatly expanded after this invasion and when the pest, which attacks citrus and other fruits and vegetable crops, got into Florida again in 1962, it was trapped immediately.

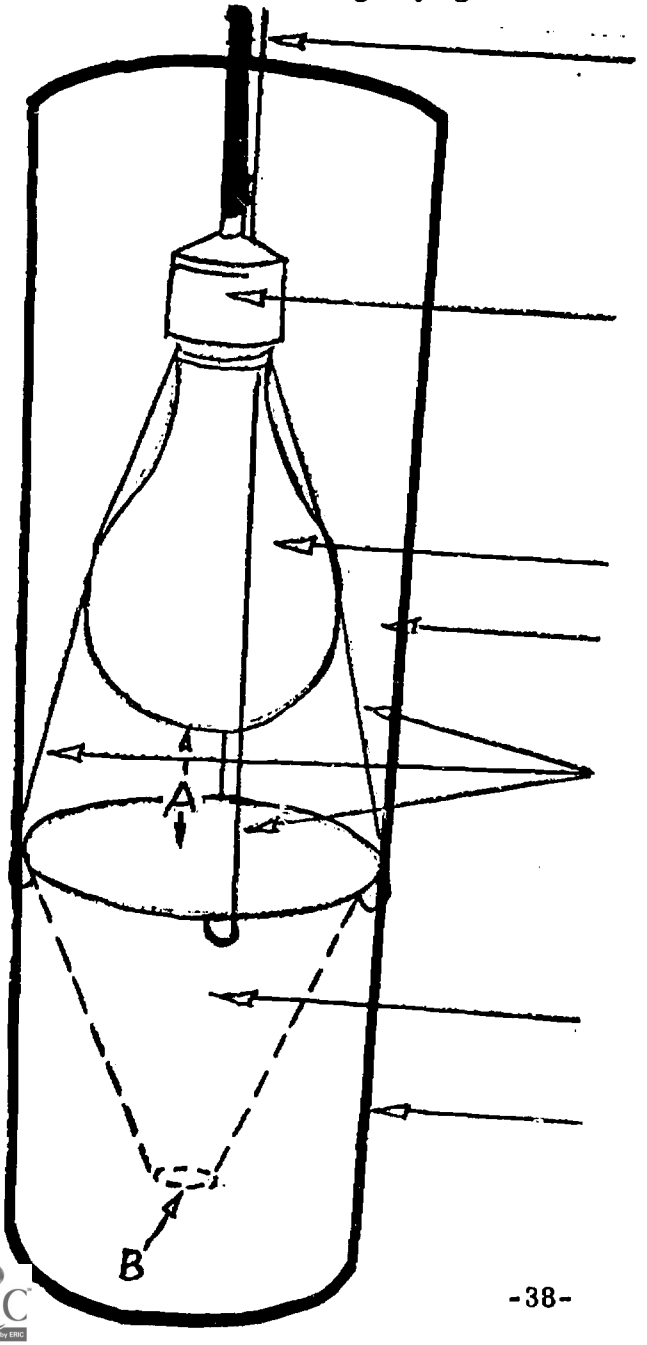
Result: The "Med fly" was eradicated at approximately one-tenth the cost of the 1956 program.

Fruit fly traps are baited with a food lure that attracts the specific insects that survey and detection teams are looking for. Another specific lure is used to trap the gypsy moth, a forest pest confined largely to New England and parts of New York State. Called "gyplure," it attracts only male gypsy moths to traps about the size of paper cups, and scientists do not have to "sort through" a number of other insects to determine whether any gypsy

*U. S. Department of Agriculture Classroom Science Project No. 2, P. A. -787

moths have spread into a new area. Insects are color-blind but many respond more readily to specific wavelengths of light. Japanese beetle traps use this response. The traps, including a baffle above the collecting cup, are the correct color to reflect the wavelength of light which attracts this insect to the trap.

These "specific" traps are valuable to regulatory officials who make surveys for particular insects. In addition, these teams and research groups use "general" traps to survey the overall insect populations of an area. One of the frequently used general attractants is light, and the light trap which the class will build duplicates in principle the complex light traps used by scientists to survey an area for night-flying insects. Many of these insects are never seen during daylight hours.



Cord used to hand trap

Dropcord with socket

40-60 watt light bulb

Baffle extends 6" above top of container

Lightweight wires used to suspend container from socket

3" plastic funnel with spout cut off

Container 3" diameter x 5" tall

A=1" distance from bulb to container.

B=1/2 to 5/8" diameter.

Materials required:

1. One outdoor extension cord approximately 30 feet long and weatherproof socket.
2. One 40 or 60 watt light bulb.
3. One transparent plastic container approximately 5 inches high with 3 inch diameter opening, such as those used to package ice cream.
4. One plastic funnel 3 inches in diameter.
5. One piece of white construction paper 5 inches wide and 6 1/2 inches long.
6. Three pieces of lightweight wire, each 10 1/2 inches long.
7. Masking tape.
8. Small nail (4-penny or 6-penny), pair of pliers.
9. One piece of heavy cord about 2 feet long.

Procedure:

Hold the nail with the pliers and heat the point. Then burn three small holes through the plastic container approximately 1/2 inch below the top. Space the holes an equal distance apart around the container. Next, insert the end of the three pieces of wire into the holes, one piece of wire per hole, and bend the ends up inside the container. For simplicity, use lightweight wire easily bent by hand. The wires should be cut off to equal lengths, each approximately 10 inches long. These wires are used to suspend the container beneath the light.

Next, cut the spout off of the plastic funnel with a sharp knife, leaving a hole 1/2 to 5/8 inch in diameter. Then place the funnel on the container with the plastic rim of the funnel resting on the top of the container. Using two pieces of masking tape, fasten one side of the funnel securely to the container. This forms a hings, allowing the other side of the funnel to be raised when removing insects from the trap. Use one piece of masking tape to hold the side of the funnel opposite the hings down securely while the trap is in operation.

Tape the construction paper to the rim of the plastic container on the side where the hings is located above the holes where the wires are attached, forming a baffle approximately 5 inches wide around one-half of the container and 6 inches high.

Using the wires previously attached to the container, hang the trap below the light bulb which has been screwed into the extension cord socket beforehand. The bulb should be positioned directly over the center of the funnel with the lower end of the bulb approximately 1 to 1 1/2 inches above the top of the container. Tie the piece of cord securely around the socket. This completes construction of the light trap.

Operation of the Trap:

Using the cord that was tied to the socket, hang the trap outside the schoolroom window, in a tree in the schoolyard, or in the teacher's or a pupil's backyard. During early fall or late spring, the light trap will catch insects almost any place outdoors. Plug the extension cord into an electrical outlet.

Turn on the light at dusk. Larger insects attracted to the light fly toward it, strike the baffle, and fall into the trap. Smaller ones are attracted to the light, fly around it, and many fly into the trap. Within an hour after dark, at least a dozen insects will have entered the trap. Ideally, the trap should be operated all night, but several dozen insects can be collected before midnight if the operator wishes to turn off the light then. About 25 percent of the insects trapped manage to escape; the remainder fail to find their way back up through the opening.

After turning off the light, plug the hole at the bottom of the funnel with cotton or a rag to keep the insects inside until the class is ready to remove them. To remove the insects, simply release the piece of masking tape opposite the hings and baffle and dump them into a quart glass jar for further observation. Moths that have entered the trap can be so transferred by cupping one hand over the edge of the container and the glass jar to prevent their escape during transfer. Most of the smaller insects will allow themselves to be poured into the jar without attempting to escape.

Activities:

1. Once the class has learned to construct and use this simple light trap, construct several and allow pupils to collect night-flying insects in their backyards, orchards, or outside city apartment windows. Compare and catalog the various collections, noting the hours during which the traps were operated, location, type of light used, and number of different types of insects collected.
2. The 3/8 to 5/8 inch opening in the bottom funnel is a medium size, allowing collection of a wide variety of insects. A larger opening will allow most of the smaller insects to escape, trapping only larger moths; a smaller opening can be used to collect mostly small insects, keeping out the larger moths which often prey on the smaller bugs.
3. Use different color bulbs and compare results of two traps placed near each other utilizing the following:

    a. A colored bulb. Blue bulbs will attract some different insects than clear ones. Yellow bulbs will repel most insects, hence, their use in porch lights, but will attract a few.
    b. A clear bulb.

4. Attempt to use some "blacklight" bulbs. Compare these with clear and colored bulbs.

Some insects eat others while in the traps. Moths often flutter about and will lose scales off their wings. For this reason, scientists place a killing agent inlight traps so that all specimens will be retained whole. Liquid killing agents, such as alcohol, will damage scale winged specimens. If this type of specimen is wanted use carbon tetrachloride, but use it with due caution. It is a toxic poison and its vapor is dangerous.

Background Concepts From the Use of the Light Trap:

The response of organisms to stimuli, including light, is called, "tropism." Response to light is called, "phototropism." Insects attracted to light, hence those that will be caught in a light trap, are those having "positive phototropism." Most moths, beetles and flies are in this group. Insects that are repelled by light are those having "negative phototropism." Many stored product pests and most roaches are in this group. Have the class learn these terms and their application to insects.

Different insect species respond differently to various "wavelengths" of light. This is why yellow bulbs repel many insects that are attracted to clear bulbs, and why blue bulbs attract still other insects more readily. Scientists sometimes use black light, ultraviolet, in some traps to attract specific types of insects that are attracted to light that humans cannot even see!

Most insects fly around and feed at night, and thousands of different ones exist that pupils have never seen. The light trap offers an ideal way to demonstrate the abundance of insects to be found during an early fall or late summer evening.

PRESERVATION OF SPECIMENS IN LIQUID PRESERVATIVES

Do not place moths, butterflies, order, Lepidoptera, or flies, wasps, bees, order Diptera and Hymenoptera, in liquids in the adult stage because the liquids will damage their hairy bodies.

Insects may be dropped into the liquid preservative alive or dead. An advantage of placing live insects in liquid preservatives is that the preservative can enter the insect through the spiracles, breathing pores; but a disadvantage is that this often causes shrinkage and distortion.

Non-hairy and non-scaled insects, such as many beetles and soft-bodied larva, can be killed by immersion in boiling water. Place them in lightly boiling water and allow them to remain until the water cools. This is recommended if you intend to preserve them in a liquid as it retards decomposition until the preservative takes affect.

Grain (ethyl) alcohol is the most widely used preservative. It should be

used at about 75% strength. Its disadvantages are that it discolors some specimens and it causes tissues to become brittle. To avoid this brittleness, it is highly recommended to add a 2% solution of glycerine or a few drops if it is a small vial. If the specimen is to be later dry mounted, it will need to be washed carefully to get the glycerine off. Take care not to drop the solution on your work area as when the alcohol evaporates the remaining glycerine will cause sickness.

Formulas:

AGA Solution:

	Parts
Commercial ethyl alcohol	8
Distilled water	5
Glycerine	1
Glacial acetic acid	1

AGA solution keeps specimens soft and relaxed. Many collectors prefer it to alcohol for preservation of small specimens. There is a tendency for discoloration.

Alcohol (ethyl or methyl):

Take the number of ccs. of 95% alcohol, commercial ethyl alcohol, equal to the concentration desired and add water until the total volume is 95 cc. For example, to make 75% alcohol, take 75 cc. of commercial ethyl alcohol and add 20 cc. of water, making 95 cc. Add 2 cc. of glycerine.

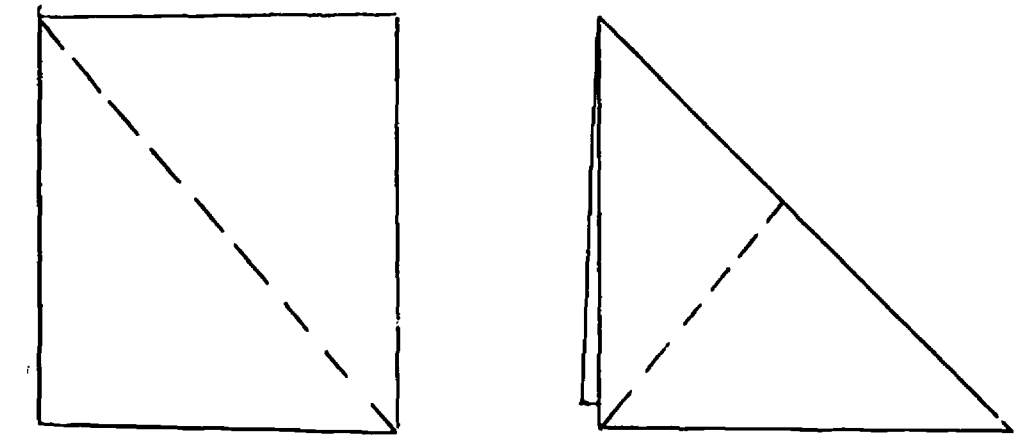
Barber's Fluid:

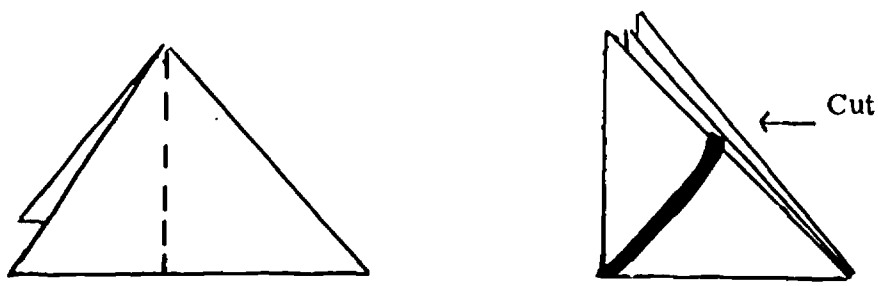
Commercial ethyl alcohol	53
Water	49
Ethyl acetate (acetic ether)	19
Benzol (benzene)	7

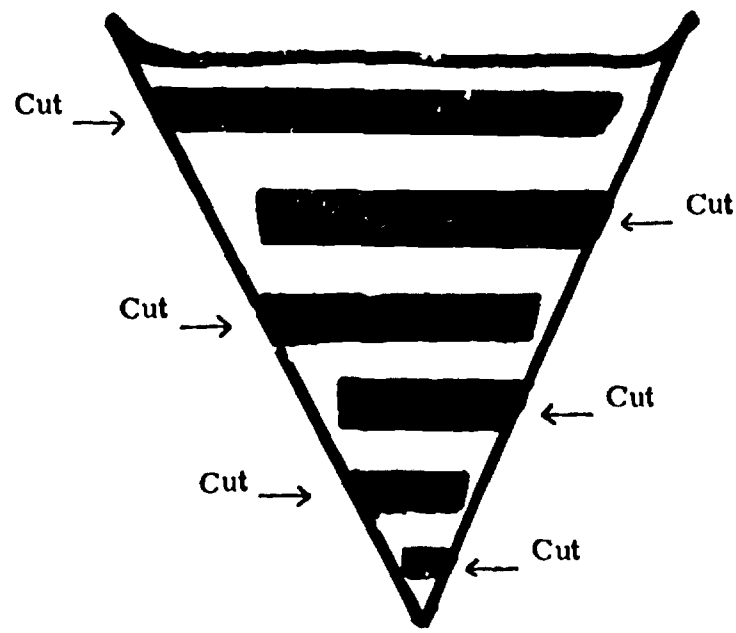
Formal Acetic Mixture:

Formalin (40% formaldehyde)	10
Glacial acetic acid	10
Water	80

Instructions for Cutting Out a Spider Web







3. To collect spider webs makes an interesting project. First find a web, then take some dark construction paper or cardboard large enough to cover the whole web and some white spray paint. Spray the spider web gently with white enamel paint. Place the paper back of the web without disturbing the web. Snip off the web around the edges and capture the web from its surroundings. You now have a complete and perfect web captured on your paper. After it is dry, you may want to spray it with a plastic spray to preserve it.

   These instructions for collecting webs are taken from The Web Weavers, Bonston Beacon Press, 1964, and also can be taken from the Golden Book of Nature Activities and Science in Your Back Yard by Elizabeth K. Cooper, New York, Harcourt, Brace & World, Inc.

OTHER POSSIBLE EXPERIENCES WITH SPIDERS: *

1. Watching the weaving of a web gives an excellent opportunity for making first a story, then a dance of the web weavers. In the Golden Book of Nature Activities is a diagram showing the order in which web weaving for the orb web is done. Using sticks stuck in the sand, or chairs, let the children dramatize the spider's routine, and don't forget to "jerk" the strand each time. They may also want to dramatize the spider and the insects he catches. "Won't you come into my parlor?" might start this activity. After the web weaving and the story have been dramatized, they may well telescope into a single dance.
2. Older children may want to use a pencil or crayon instead of physical activity to diagram the making of the orb web. (Or try to make one with nylon fishing cord or silk thread will certainly show how difficult the process is for them!)
3. After the story has been read, or perhaps as a spontaneous suggestion from the children beforehand, the group may want to have its own "Great Spider Zoo" and invite some other class in to view the collection of spiders, webs, and drawings, and to share the dance the class has created.
4. Because the children will probably not have had much past experience with spiders they may be interested in making their own "spider books," with pictures of the various spiders they have found and drawings of the type of web they have seen. If real webs were collected, they might be used as the covers for these booklets.

*Wensburg, Katherine, Experiences With Living Things, Beacon Publishing Company.

STUDENT ACTIVITY: STUDENT ACTIVITIES WITH INSECTS

Stories about spiders.

DISCIPLINE:

Language Arts and Science

BACKGROUND:

"Stories abound to enrich classroom study of spiders. A Greek legend about the godess Arachne is the source of the scientific name of the spider class. American Indian legends about the spider are plentiful. The tale of Robert Bruce inspired to continue a fight for his country's freedom by the persistence of a small spider has as much impact upon children today as when it was first told." (From Experiences With Living Things, an introduction to Ecology for 5 to 8 year olds.

ACTIVITY:

Read a story to summarize the outdoor collecting experience.

HISTORICAL STORIES:*

Spider. There are many old wives' fables about spiders, the most widespread being that they are venomous. Shakespeare alludes to this more than once --

> Let thy spiders, that suck up thy venom,
> And heavy-gaited toads lie on their way.
> Richard II, III, ii.

> There may be in the cup
> A spider steep'd, and one may drink, depart,
> And yet partake no venom.
> Winter's Tale, II, i.

During the examination into the murder of Sir Thomas Overbury, one of the witnesses deposed "that the countess wished him to get the strongest poison that he could." Accordingly he brought seven great spiders.

Other tales were that spiders would never spin a web on a cedar roof, and that fever could be cured by wearing a spider in a nutshell round the neck.

Spiders were credited with other medicinal virtues. A common cure for jaundice in country parts of England was to swallow a large live house-

*Brewer, E. Brewer's Dictionary of Phase and Fable, 1963, Harper & Row Publishers.

spider rolled up in butter, while in the south of Ireland a similar remedy was given for ague.

Yet another story was that spiders spin only on dark days: --

> The subtle spider never spins,
> But on dark days, his slimy gins.
> S. Butler: On a Noncomformist, iv.

Bruce and the spider. In 1305 Robert Bruce was crowned king of Scotland at Scone but, being attacked by the English, retreated to Ireland, and all supposed him to be dead. While lying perdu in the little island of Rathlin he one day noticed a spider try six times to fix its web on a beam in the ceiling. "Now shall this spider, said Bruce, teach me what I am to do, for I also have failed six times." The spider made a seventh effort and succeeded; whereupon Bruce left the island (1307), collected 300 followers, landed at Carrick, and at midnight surprised the English garrison in Turnberry Castle; he next overthrew the Earl of Gloucester, and in two years made himself master of well-nigh all Scotland, which Edward III declared in 1328 to be an independent kingdom.

Frederick the Great and the spider. While Frederick II was at Sans-Souci, he one day went into his ante-room, as usual, to drink a cup of chocolate, but set his cup down to fetch his handkerchief from his bedroom. On his return he found a great spider had fallen from the ceiling into his cup. He called for fresh chocolate, and next moment heard the report of a pistol. The cook has been suborned to poison the chocolate, and, supposing his treachery had been found out, shot himself. On the ceiling of the room in Sans-Souci a spider has been painted, according to tradition, in remembrance of this story.

Mohammed and the spider. When Mohammed fled from Mecca he hid in a certain cave, with the Koreishites close upon him. Suddenly an acacia in full leaf sprang up at the mouth of the cave, a wood-pigeon had its nest in the branches, and a spider had woven its net between the tree and the cave. When the Koreishites saw this, they felt persuaded that no one could have entered recently, and went on.

USING NATURAL RESOURCES STUDENT ACTIVITIES WITH INSECTS

CONCEPT:

Using natural resources from the out-of-doors to develop on site activities in music, art, language arts, creative dramatics and science.

What motivational stimuli do composers rely upon to write music, the poet a poem, or the artist to paint a picture? Before a child can understand this type of stimuli he must have experienced an emotional response to something beautiful, awe inspiring, humorous, sad, unpleasant, etc. Then he can express these emotions in some form of creative activity. Since the children respond to different stimuli, exposure to many experiences in the out-of-doors with varying types of emphasis is desirable.

ACTIVITY:

This experience can be done on the school site. Divide the classroom into small groups to tour the school grounds, or assign a certain area where the children may explore individually for any of the following:

EXAMPLE: Insects. Find a single insect and watch its pattern of flight. Listen for any sounds that it may emit. Does it have a characteristic "buzzing" sound to its flight? Does the crawling insect or bug move about at random or does it tend to move in a straight line? Is its motion rapid, sluggish or moderate? (pitch, tempo, rhythm) Is he searching for food? Is he carrying food? Did you find him on a flower, on a blade of grass, in the sand or a crack in the cement, or was he crawling up the brick surface of the building? (mood, atmosphere).

The same type of investigation can be carried out with birds. Their color and nests, songs and flight. Trees, the response to a breeze, the wind or a storm, the type of shade, the difference of light penetration through the leaves of a deciduous tree or a conifer, as a nesting place for birds, as a home for insects, how it beautifies the school grounds. Does it furnish food for man or animals? Natural phenomena, rain, sunlight, sunrise, sunset, wind, storm. Animals, evidence of, animal calls, hoof beats, etc.

FOLLOW-UP ACTIVITY:

The above suggestions can be utilized as preparation for a number of activities to be carried on later in the classroom. They can be approached as motivation for creative outlets developed as the result of the experience or the emphasis can be directed toward a single goal.

MUSIC:

Suggestions for development are listed below:

As a listening experience include background information on the composer. This is usually found on the record jacket or album cover.

Record series usually found in all school districts:

1. Bowman Orchestral Library Nature and Make Believe BOL #52
   Animals and Circus BOL #51

2. RCA Victor-Record Library for Elementary Schools

   Listening Activities:

a.	Insects	Dance of the Mosquito	Liadea
		Moths & Butterflies	Elgar
		The Bee	Francois Schubert
		Butterfly	Chopin
b.	Flowers	To A Water Lily "Woodland Sketches"	
		To A Wild Rose	MacDowell
c.	Birds	Little Bird	Edward Grieg
d.	Seasons	Spring Song	Mendelssohn
e.	Natural Phenomena		
		Grand Canyon Suite	Ferde Grofe
		Sunrise, Sunset, Cloudburst	
f.	Animals	Deer Dance	
		Rogue River Indian "Suite Primeval"	Skelton
		Carnival of the Animals	Saint Saens

OTHER FOLLOW UP ACTIVITIES:

This may be expanded to include original poetry, songs, or essays. It may be done as an oral or written experience.

As an Art experience, provide the freedom for artistic expression through design and color, through rhythm of line or form, free use of materials to express what was seen and felt emotionally.

For creative dramatics in the elementary grades, have the students imitate the insects or birds, animals, trees, plants, without revealing their identity. Make a guessing game out of the experience.

As a science activity, examine the structure of specimens under a magnifying glass or dissecting scope.

RESOURCE INFORMATION FROM NATIONAL GEOGRAPHIC MAGAZINES

Most school libraries have current and back issues of The National Geographic Magazine. These magazines provide very valuable sources of beautiful colored pictures and interesting stories about insects. Some stories that are of interest and information to teachers and students are listed below.

Insects, General:	June 1958, pages 838-855, "The High World of the Rain Forest," Guy Neale.
	January 1954, pages 71-90, "Man's New Servant, the Friendly Atom," F. Barrows Colton.
	April 1959, pages 558-569, "Natures Alert Eyes," Constance P. Warner.
	March 1961, pages 406-419, "Hunting Africa's Smallest Game," Edward S. Ross.
	May 1959, pages 632-699, "Giant Insects of the Amazon," Paul A. Zahl.
Aphids:	June 1961, pages 851-859, "Rose Aphids," Treat Davidson.
Butterflies:	August 1957, pages 193-217, "Keeping House for Tropical Butterflies," Jocelyn Crane.
	April 1963, pages 588-598, "Mystery of the Monarch Butterfly," Paul Zahl.
	June 1958, pages 838-855, "The High World of the Rain Forest," Guy Neale.
Crickets:	September 1953, pages 385-394, "Natures Expert Fiddlers," Catherine Bell Palmer.
Dragonflies:	August 1955, pages 215-229, "Dragonflies-Rainbows on the Wings," James G. Needham.
Fireflies:	May 1951, pages 697-704, "Torchbearers of the Twilight," Frederick G. Vasburgh.
	July 1962, pages 48-59, "Wing-Borne Lamps of the Summer Night," Paul A. Zahl.

Honeybees:	August 1959, pages 188-217, "Inside the World of the Honeybee," Treat Davidson.
Mantis:	May 1950, pages 685-692, "Praying Mantis," John C. Pitkin.

COMMERCIAL SUPPLY COMPANIES OF ENTOMOLOGICAL EQUIPMENT

Carolina Biological Supply Company, Burlington, North Carolina, 27216

Central Scientific Company, 1700 Irving Park Road, Chicago, Illinois, 60613

Clay-Adams Company, Inc., 141 East 25th Street, New York, New York 1001

E. H. Sargent Company, Inc., 4647 West Foster Avenue, Chicago, Illinois, 60630

General Biological Supply House, 8200 South Hoyne Street, Chicago, Illinois, 60620

Southern Biological Supply Company, 517 Decatur Street, New Orleans, Louisiana, 70130

Standard Scientific Supply Corporation, 34-38 West Fourth Street, New York, New York, 10012

Supply Department, Marine Biological Laboratory, Woods Hole, Massachusetts, 02543

Ward's Natural Science Establishment, Inc., Box 1712, Rochester, New York, 14603

REFERENCES FOR TEACHING OF ENTOMOLOGY

Beirne, B. P., 1955. Collecting, Preparing and Preserving Insects. Canada Department of Agriculture, Ottawa, $2.00.

Borror, D. J., 1964. An Introduction to the Study of Insects. Holt, Rinehart & Winston, New York.

Chu, H. F., 1949. How to Know the Immature Insects. Wm. C. Brown Company.

Edwards, J. G., 1963. Spreading - Blocks for Butterfly Wings. Turtox News 41 (1) - 16-19.

Frost, S. W., 1959. Insect Life and Insect Natural History. Dover Publications, Inc., New York.

Jaques, H. E., 1947. How to Know the Insects. Wm. C. Brown Company, Dubuque, Iowa.

Kalmus, H., 1960. 101 Simple Experiments with Insects. Doubleday & Company, Inc., Garden City, New York.

Oldroyd, H., 1958. Collecting, Preserving and Studying Insects. Hutchinson & Company, Ltd. London.

Siverly, R. E., 1962. Rearing Insects in Schools. Wm. C. Brown Company, Dubuque, Iowa.

Swain, R. B., 1948. The Insect Guide. Doubleday & Company, Inc. Garden City, New York.

Telford, H. S., 1941. A Convenient Mount for Insects. Journal of Economic Entomology. 34 (2) - 320.

BEGINNING FIELD BOOKS AND MANUALS FOR YOUNG PEOPLE

Beirne, B. P., 1955. Collecting, Preparing and Preserving Insects. Science Service, Entomology Division, Canada Department of Agriculture, Ottawa, Ontario.

Curran, H., 1951. The Golden Playbook of Insect Stamps. Simon & Schuster, New York, $.50.

Ross, E. S., 1953. Insects Close Up. University of California Press, Berkeley, $2.25.

Swain, R. B., 1948. The Insect Guide. Doubleday & Compnay, Inc., Garden City, New York, $3.50.

Zim, H. S. & Cottam, C., 1951. Insects: A Golden Nature Guide. Simon & Schuster, New York, $1.00.

BOOKS OF INTEREST TO THE CASUAL READER

Cheesman, E., 1953. Insects: Their Secret World. Wm. Sloane Association, New York, $3.50.

Clausen, L. W., 1954. Insect Fact and Folklore. MacMillan Company, New York, $3.50.

Crompton, J., 1954. The Life of the Spider. Mentor Books, New York, (Pocket book edition) $.35.

Crompton, J., 1955. The Hunting Wasp. Houghton Mifflin Company, Boston, $3.00.

Curran, C. H., 1951. Insects in Your Life. Sheridan House, New York, $3.50.

Fabre, J. H. (introduction by Teale, E. W.), 1950. The Insect World of J. Henri Fabre. Dodd, Mead & Company, New York (Pocket book edition) $.35.

Fabre, J. H. (retold by R. Stawell), 1953. Fabre's Book of Insects. Tudor Publishing Company, New York, $3.00.

Gual, A. T., 1953. The Wonderful World of Insects. Rinehart & Company, Inc., New York, $4.00.

Gertsch, W. J., 1949. American Spiders. D. Van Nostrand Company, Inc., New York, $7.50.

Maeterlinck, M. (introduction by Teale, E. W.), 1954. The Life of the Bee. Mentor Books, New York, (Pocket book edition) $.35.

Michener, C. D. & Michener, M. H., 1951. American Social Insects. D. Van Nostrand Company, Inc., New York, $6.50.

Morley, D. W., 1953. The Ant World. Penquin Books, Baltimore Maryland (paper bound) $.65.

Morley, D. W., 1955. The Evolution of an Insect Society. Charles Scribner's Sons, New York, $3.95.

Richards, O. W., 1953. The Social Insects. Purnell & Sons, Lmtd., $4.75.

BOOKS FOR THE MORE SERIOUS STUDENTS, AMATEUR OR PROFESSIONAL

Chu, H. F., 1949. How to Know the Immature Insects. Wm. C. Brown Company, Dubuque, Iowa, $3.00, (paper bound, $2.50).

Hatch, M. H., 1953. The Beetles of the Pacific Northwest. Part I. Introduction and Adephaga, University of Washington Press, Seattle, $5.00.

Imms, A. D., 1951. Insects Natural History. Blakiston Company, New York, $5.00.

Jaques, H. E., 1949. How to Know the Insects. Wm. C. Brown Company, Dubuque, Iowa, $2.50.

Jaques, H. E., 1951. How to Know the Beetles. Wm. C. Brown Company, Dubuque, Iowa, $4.50.

Kaston, B. J., 1953. How to Know the Spiders. Wm. C. Brown Company, Dubuque, Iowa, $3.00.

Lutz, F. E., 1948 (revised). Field Book of Insects. G. P. Putnam's Sons, New York, $4.50.

Ribbands, C. R., 1953. The Behavior and Social Life of Honeybees. Bee Research Association, Lmtd., London, $4.50.

Yearbook of Agriculture, 1952. Insects. U. S. Government Printing Office, Washington, D. C., $2.50.

REFERENCES TO PUBLICATIONS DEALING WITH INSECT IDENTIFICATION

Britton, N. E. The Hemiptera or Sucking Insects of Connecticut. Connecticut Geological and Natural History Survey, 1923.

Brues & Melander. Classification of Insects. Harvard College Museum of Comparative Zoology.

Carpenter, S. J. & LaCasse, W. J. Mosquitoes of North America University of California Press.

Che, H. F. How to Know the Immature Insects. W. C. Brown Company, Dubuque, Iowa.

Craighead, F. C. Insect Enemies of Eastern Forests. USDA Misc. Publication 657.

Curran, C. H. The Families and Genera of North American Diptera. Ballow Press, New York.

Ferris, G. F. Atlas of the Scale Insects of North America, Series 1-5. Stanford University Press.

Gordon, E. J. Coleoptera or Beetles East of the Great Plains. Published privately, $3.50. (Now at San Jose State College, San Jose, California. Can be purchased from the author.)

Hall, D. H. The Blow Flies of North America. Thomas Say Foundation Publication, Vol. 4, Baltimore, Maryland.

Holland, W. J. The Butterfly Book. Doubleday & Company, Garden City New York.

Holland, W. J. The Moth Book. Doubleday & Company, Garden City, New York.

Imms, A. D. A General Textbook of Entomology. Dutton & Company, (revised edition), New York.

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Klotz, A. B. The Field Guide to the Butterflies of North America. Houghton Mifflin Company, Boston, Massachusetts.

Lutz, F. E. Field Book of Insects. G. P. Putnam Company, New York.

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Morgan, H. The Dermaptera and Orthoptera of Illinois. Bull. Natural History Surv. of Illinois, 1934.

Morse, A. P. Manual of the Orthoptera of New England. Proc. Boston Society Natural History, Vol. 35.

Palmer, M. B. Aphids of the Rocky Mountain Region, Vol. 5, 1952, Thomas Say Foundation.

Snyder, T. E. The Termites of the United States and Canada. National Pest Control Association, New York, 1954.

Swain, Ralph. Insect Guide. Doubleday & Company, Garden City, New York.

Thomas, Charles C. A Handbook of the Dragonflies of North America. Springfield, Illinois, 1929.

Urquhart, F. A. Introducing the Insect. Henry Holt and Company.

U. S. Department of Agriculture, 1952. Insects Yearbook. Bibliography, pages 732-737.

Wheeler, W. H. Ants: Their Structure, Development and Behavior. Columbia University Press.