NATURE STUDY

OVERTON AND HILL

NATURE STUDY

A PUPIL'S TEXT-BOOK

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OVERTON'S NATURE STUDY.

W. P. I

INTRODUCTION

TIME was in the history of our schools when a pupil was given a certain subject concerning which he knew nothing and cared less, and was expected to evolve from it a composition that should contain both good ideas and good English. No one seemed to realize that this was a double task that, like Janus, faced in opposite directions. Either way by itself was sufficiently difficult; but for a pupil to follow both simultaneously was quite impossible. Even to-day an inexperienced teacher too often regards English as the material for the manufacture of ideas rather than as a medium for expressing them. Thus it often happens that, in our elementary schools, the language lessons are a weary work and a strain on both teacher and pupil.

The seemingly natural plan of letting the child express his own thoughts in language either spoken or written marks a new era in the teaching of English. When we go a step farther and confine the language work to those subjects which must interest the child, we shall have ideal conditions.

The correlation of nature study with language lessons is almost inevitable. The child sees certain living creatures and is interested in their life and habits and almost involuntarily he tells what he sees; if the teacher is in sympathy with him, he likes quite as well to write about his observations as to tell about them. And since he is trying to express only what he knows and has experienced, his English is simple and straightforward; and, even when it is faulty, it may be corrected better by good example than by that ogre of school work in English, the blue pencil.

Dr. Overton's experiments in interesting the children of his native town in nature have proved to be of wide interest. No phase of his work has been more important pedagogically than his success in getting his pupils to make notes in the field. Each one of these notebooks which I have examined is a mine of wealth to the teacher of English, if she knows how to work it. In them are recorded observations about bird and beast, flower and insect, showing where the child's interest in the outdoor world was aroused. Such records, taken as starting points for further personal observations and for reading, will be a source of most interesting information about familiar objects, and must surely result in language lessons which will delight both pupil and teacher. The whole plan of Dr. Overton's book seems to me simple and excellent, and it can not fail to be of great use to the grade teacher.

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HOW TO USE THIS BOOK

Design of This Book. — These lessons are designed to furnish a year's work in nature study for pupils from eight to eleven years of age. They are upon subjects that are connected with everyday life, and the material for their study can easily be secured even in the larger cities. The subjects are arranged in the order of the seasons, beginning with early fall; but suggestions are given for continuing the study of many of the specimens throughout the whole period of their life histories. The lessons throw light on unfamiliar sides of familiar things, and afford a basis for future scientific studies, especially along biological lines. They are correlated with drawing and language in such a way that sketching and composition writing may lead to closer observation of the specimens, and that nature study may afford interesting and inspiring subjects for expression with pencil and pen. Most of the cuts are reproductions of photographs by the author.

Method of Use. — Throughout this book laboratory methods are outlined. Each lesson is divided into two parts, first, observing, sketching, and describing a specimen that is examined in the schoolroom; and, second, supplementary work which is intended to explain the meaning of what is observed, and to continue the observations by making use of additional specimens which the pupils find at home, or on walks and pleasure trips.

The first part of each lesson is printed in large type, and is designed to be given during a single period; but if time is limited, the drawing and composition work may be given in the succeeding lesson. A pupil first examines a specimen,

following the questions under the heading "**Observation,**" and then draws the specimen and writes about it. A short oral recitation on the observation questions should also be conducted. If the oral work is done at the beginning of a period, the pupils will have a guide for their writing; but if the writing is done first, the pupils can exercise the more originality and independence in their observations and expression. Whether the oral or the written work should be given first will depend on the class.

The supplementary work is printed in smaller type, and is designed to be given either as oral or as written work when the pupils have made their observations. In some of the subjects parts of this work may not be given until months after the first parts of the lessons have been given.

Method of the Composition Writing. — In composition writing there are two distinct processes: —

1. Expressing thought clearly.
2. Adjusting expression to accepted standards.

In compositions connected with nature study lessons emphasis should be placed on clearness of expression. Details of grammar, spelling, capitalization, punctuation, and penmanship belong to the period devoted to language proper, and, in a nature study lesson, should not be brought out so prominently that the pupils fear to write. While an advanced student should be able to write correctly without conscious effort, a child can not be perfect in the mechanical details of his composition without devoting more time and effort to them than to the subject-matter itself. A practical method for securing both clearness and correctness is to have the pupils write their nature study compositions during a single unbroken period, paying special attention to directness and clearness. Then let the teacher use these compositions as a basis for work during the language period.

Paragraphing. — One of the best means of securing clearness of expression is to have the pupils write in paragraphs, placing the title of each paragraph at its beginning. By this method the whole essay is divided into smaller compositions which are of such a size that a pupil can readily judge of their clearness and unity.

Personal Help. — Each composition should have in it something that originates with the writer, and that is not developed from the general class exercises. In both composition and nature study the best and most original work will be done when each pupil works individually. In this book the work is designed to be done by the pupils without direct assistance from the teacher; but bright as well as dull scholars sometimes have difficulty in beginning to write, and therefore, during each lesson, the teacher should go among the pupils and give a few words of personal help to those who are in immediate need of it.

Each pupil should also regularly receive criticisms of his work, and definite suggestions for its improvement. It will be well to make only one criticism and to suggest only one improvement at a time, so as to avoid confusing and discouraging the pupil.

Notebooks. — Early in the course of the lessons a dispute is likely to arise concerning the exact appearance of a specimen that some pupil has seen. Then the finder should be encouraged to look again, and while he is looking to write his observation as evidence of the reliability of his statements. If this exercise is done in a natural and informal way, other pupils will be eager to record their home observations, and to report them to the class. When interest has been aroused, have all the pupils keep notebooks in which to make a daily record of observations upon any object, whether it is mentioned in the book or not. Suggestions from the notebooks may often be developed into lessons for the whole class.

The Specimens. — In most of the lessons there should be enough specimens so that each pupil may have one, and some

be left over to replace those that are spoiled during the work. In a few of the lessons one or two specimens placed where the pupils can examine them will be sufficient. Have each pupil bring his own specimen if possible; otherwise have a few volunteers bring enough for the whole room.

If it is planned to preserve specimens, those that can not be dried may be kept in the following mixture: —

Formalin, one ounce.
Water, one quart.

This is a safe, reliable, and inexpensive mixture, and preserves both vegetable and animal tissues in nearly their natural colors. Insects may be painlessly killed by putting them in a tightly closed fruit jar containing a few drops of chloroform.

Kindness to Animals. — When live insects or animals are kept in the schoolroom the teacher should exercise the greatest care for their comfort, and should set them free as soon as possible, as an example of kindness to animals. While some may die because they have reached maturity, there can be no excuse for allowing any to die from neglect.

Devices. — Before giving a lesson the teacher should do the drawing and composition work in order to know what work to expect from the pupils, and what difficulties they will be likely to encounter.

It is often possible to appeal to an indifferent pupil by asking him to get a specimen that is difficult to obtain. The boy at the foot of the class often leads it in knowledge of the woods and fields and brooks.

A fruitful source of specimens is the walk to and from school. Go home with the pupils and show them the wealth of material at their doors. Occasionally take the pupils out for an informal walk or ride to search for specimens, and to observe things growing in their natural homes.

Have growing specimens of plants and animals in the school-

room, and make it a reward of merit for a pupil to be allowed to watch them during school hours.

Sometime during the year have a public exhibition of specimens and class work so as to gain the coöperation of the children's parents and older brothers and sisters. At the end of the year leave suggestions for study and observation which the pupils can follow up during the summer vacation.

Write to the Bureau of Nature Study, Cornell University, Ithaca, N.Y., for information about forming a nature study club among the pupils.

Knowledge required in Nature Study. — The object of nature study is not so much to get present knowledge as to develop the power and love of observation by which knowledge may be gained in after life. The teacher should never substitute lecturing for observation and investigation. Any one can observe specimens without possessing previous knowledge of what is seen. The greatest success is attained by those teachers who, whether or not they have had previous knowledge of the subject, are learners with their pupils. In the study of the great "Book of Nature," the best that a teacher or pupil can do is to read a few of its pages, and to get from them the inspiration to continue the reading.

CONTENTS

NATURE STUDY

I. HOUSE FLY

Material. — House flies in large-mouthed bottles.

Observation. — What is the shape of a fly's head? What is the shape of its neck? What is the color of its eyes? How much of the head do the eyes seem to cover?

Notice the two divisions of a fly's body. The front part is called the *thorax*, and the hind part the *abdomen*. What is the color of the thorax? What is the color of the abdomen? To which division are the wings fastened? To which are the legs fastened?

How many wings has a fly? What is their color? How are they marked?

How many legs has a fly?

Drawing. — Draw the picture of a house fly as you see it when you look down upon its back. Make your picture two or three times as large as the real fly, so that you may have room to draw each part clearly. First, draw it with very light lines, so that you can easily correct your work. When you have drawn it right, go over the lines and make them heavier.

Composition. — Write a description of what you have observed about a house fly. In writing this description follow this outline of topics, making each topic a separate paragraph. Write all you wish to say about each topic in its own paragraph.

The House Fly: —

Head	Wings
Body	Legs

SUPPLEMENTARY WORK

A Fly's Eating. — Watch a house fly as it eats. What is the shape of the lower end of the tube that it touches to its food? Where is the tube carried when the fly is not eating? The mouth parts of a house fly are not made for biting or to be thrust into the skin, but for sucking up bits from the outside parts of soft food.

House Fly (Magnified)

A Fly's Cleanliness. — Watch a house fly and notice how it often passes its fore legs over its head as a cat washes her face. Notice also that it rubs its wings with its hind legs, and that it rubs its legs together as if it were washing them.

Dust a fly with a little flour and see it clean itself. If you

can get a magnifying glass, look at a fly's body and legs, and notice that they are hairy, and that the lower joint of each leg, which the fly uses to clean the rest of its body, is like a stiff brush.

The Harm done by House Flies. — House flies may often try to keep themselves tidy, but they can not be perfectly clean, for they seek their food on rubbish heaps as well as in our kitchens and dining rooms. By bringing germs of disease into our houses they may be the cause of sickness. Typhoid fever

LIFE HISTORY OF HOUSE FLIES

and diphtheria may be caused by flies. As they can carry some diseases, flies should be kept out of a room where any one is sick.

The Life of a Fly. — Are all house flies of the same size? Do little house flies grow to become big ones? House flies lay eggs which hatch white or gray worms, called *maggots.* In this state a young fly is called a *larva.* It lives as a larva about a week, and then becomes a brown, hard-shelled object which looks much like a large kernel of wheat. In this state the young fly is called a *pupa,* and can neither eat nor move. After about a week spent as a pupa the insect bursts open one end of its shell, and goes off as a full-grown winged fly.

Like house flies, most other insects pass through the four forms of egg, larva, pupa, and winged insect.

In winter nearly all flies die, but a few crawl away behind chimneys and other sheltered places and there live until warm weather comes again. On sunny windows in the attic and barn you may often see house flies on the first warm days of spring. They, and others that have lived through the winter, will be the parents of the summer swarms of flies.

Other Kinds of Flies. — Around stables and on horses and cows you may often see blood-sucking flies that look like house flies. Notice that the stable fly has a sharp bill which it carries pointing forward from the under side of its head. When eating, the fly thrusts the bill into an animal's skin like a needle and sucks blood through it. In stormy weather the stable flies come into houses, and then people often mistake them for house flies.

STABLE FLY (Magnified)

On decaying meat you may often see black or blue flies somewhat larger than house flies. These flies are called *bluebottle* flies or *blowflies*. The *flyblows* which you may have seen on old meat are clusters of their yellowish eggs which hatch out larvas as house flies' eggs do.

There are many other kinds of flies. What kinds that come into our houses do you know? What kinds can you find about horses and cattle?

II. MOSQUITO

Material. — Some wigglers in wide-mouthed bottles half full of water, placed on tables where the pupils can examine them at their leisure. Look for wigglers in uncovered cans or pails or barrels of water that have stood outdoors for some days where mosquitoes are flying. In such places any small creatures that swim quickly away from the surface when the water is disturbed are almost certainly wigglers. Keep the wigglers several days for the lessons on pupas and adult mosquitoes. Cover the bottles with mosquito netting to keep the insects from flying away when they become full-grown mosquitoes.

1. THE WIGGLER

Observation. — What is the size of a wiggler? What is its shape? What is its color? In what part of the water does it usually rest? Does it rest with its head, or with its tail, downward? Does a resting wiggler touch any part of its body to the surface of the water?

Jar a bottle of wigglers. What do the wigglers do? How does a wiggler move its body when it swims? How long does it remain away from the top of the water? When it stops swimming does it rise, or does it sink? Do you think it is heavier, or lighter, than water?

Drawing. — Draw a picture of a jar of water containing wigglers. Draw a line across the jar to show the surface of the water, and then draw some wigglers in the water as you see them at rest.

Composition. — Write a letter to some friend telling what you have observed about wigglers. In your letter write what you would say if you were talking to your friend.

SUPPLEMENTARY WORK

Mosquitoes' Eggs. — You may often see black specks floating on the water where you find wigglers. The specks may be flakes of soot from a chimney. Pick up one of them and crush it between your fingers. If it is made up of long grains,

WIGGLER (Magnified)

it is probably a raft of eggs which a mosquito has laid on top of the water. Each egg hatches out a tiny larva called a *wiggler*. In the life of a mosquito the egg is the first stage, and the wiggler the second.

How a Wiggler breathes. — A wiggler breathes air through a tube that extends sidewise from its body near the hinder end. It often comes to the top of the water to breathe, and it rests with its breathing tube open to the air.

What Wigglers eat. — Look carefully at a wiggler at rest, and observe its mouth parts. Notice how it keeps them moving. It is taking in particles of food too small to be seen with our naked eyes. The natural home of wigglers is in stagnant water, in such places as cisterns, rain barrels, hollow

stumps, and pools. In these places the water is often yellow with impurities. The wigglers live on the bits of matter that are in the water.

2. THE PUPA

Among the wigglers you may see a few that are different in shape, and that swim with their bodies in a different position from the others. These are in the third stage of the life of a mosquito, and are called *pupas*.

PUPA OF MOSQUITO (Magnified)

Observation. — What is the shape of a mosquito pupa? What is its color? When it is still, does it rest with its head or its tail downward? While it is at rest what part of its body touches the surface of the water? Where are its breathing tubes? What parts of a full-grown mosquito do you see in the pupa? Do you find some empty wigglers' skins in the water with the pupas? In what part of the water are the skins?

Drawing and Composition. — Draw a picture of the pupa of a mosquito three or four times as large as a pupa is. Write a short paragraph describing the pupa, and another paragraph telling what the pupa did while you looked at it.

SUPPLEMENTARY WORK

The Habits of a Mosquito Pupa. — When a wiggler is about to become a pupa, it sheds its skin. A wiggler usually spends two or three days as a pupa and eats nothing during that time. It no longer breathes by the tail end of its body, but by means of two tubes that extend upward from its back. It moves about freely.

3. THE FULL-GROWN MOSQUITO

Observation. — How many days did you keep the wigglers before one changed to a winged mosquito? Look at a mosquito. What is the shape of its head? What is the shape of its bill? What is the shape of a mosquito's thorax? What is the shape of its abdomen? Is the thorax sharply divided from the abdomen? How many wings has a mosquito? What is their shape? To what part of the body are they joined? How many legs has the mosquito? How many joints do you see in a leg?

Drawing. — Draw a picture of a mosquito as you see it when you look at it from one side. Make the picture three or four times as large as a real mosquito. A mosquito is somewhat humpbacked. Draw the head and body in the shape that they really are on the mosquito.

Composition. — Write a description of a mosquito. Write it in paragraphs like those in the outline for the composition on the house fly.

SUPPLEMENTARY WORK

How a Wiggler becomes a Mosquito. — While a wiggler is in the form of a pupa, wings and legs are growing beneath the skin, and its body is changing to the body of a full-grown mosquito. When the change is complete, it floats on the water, its skin splits down its back, and a full-grown mosquito crawls out and flies away, leaving an empty skin on the water. Watch the wigglers till one comes out of its pupa case.

How Mosquitoes Eat. — Look carefully at the mosquitoes that come from the jar of wigglers. They have long slender bills through which they suck their food. Some of them have feathery feelers on their heads, and can not use their bills for piercing the skin or for biting. These are the father mosquitoes, and are sometimes called *fuzz-bills.* If they eat at all, they must sip liquid food as house flies do. The mosquitoes that bite us are all mother mosquitoes. Their feelers are so small that you can hardly see them.

MOTHER MOSQUITO (Magnified)

Kinds of Mosquitoes. — There are many kinds of mosquitoes, differing somewhat from one another in looks and in their mode of life, but all of them spend the early part of their lives as wigglers under water.

The Harm done by Mosquitoes. — When a mosquito sucks blood, it leaves behind a bit of poison which causes a raised spot and an itching on the skins of some people.

Germs of malaria live inside the bodies of one kind of mosquito. When these mosquitoes bite a person, they may leave some of the germs beneath his skin, and so may cause him to have malaria.

FATHER MOSQUITO (Magnified)

How to get rid of Mosquitoes. — We can not get at full-grown mosquitoes to kill many of them, but we can easily kill the wigglers in the water. Since mosquitoes usually live only a few days, a place will soon be free from them if we keep new broods from flying away from the water where they are hatched. We can do this by emptying cans and pails and barrels of water in which wigglers might grow. We can drain the pools, or we can stock them with fish which eat the wigglers. We can keep the water of stagnant marshes covered with kerosene or other oil so that the wigglers can not get air. Since some mosquitoes may be bred in partly filled vases and bouquet holders in our houses, we should change the water in them every day or two.

III. BUTTERFLIES AND MOTHS

Material. — Some caterpillars kept in the schoolroom until they undergo their changes. Use green worms from cabbage plants, or red spiny caterpillars from hop vines, or smooth yellow and black caterpillars from milkweeds. Each of these will usually complete its changes within two or three weeks. Other kinds of caterpillars may be used, but many of them do not complete their changes until winter has passed.

1. THE CATERPILLAR

Observation. — What is the size of the caterpillar that you observed? What is its shape? What is its color? How many joints has its body? Is its body naked, or is it covered with spines or hairs?

Notice two kinds of legs on the caterpillar. How many legs are on the front end of its body? What is their shape? How many legs are on the hinder half of its body? What is their shape?

Notice a caterpillar's jaws. Do they move sidewise or up and down? Does a caterpillar suck the juices of leaves, or does it lap its food from the surface, or does it bite off its food? Does the caterpillar eat the middle or the edge of the leaf?

Drawing. — Draw a picture of a caterpillar. First, in very light lines, draw a figure about the size and shape of the caterpillar. Then, in heavy lines drawn over the light ones, make the head and tail ends in

their correct shape, and the wavy lines of the back to show the correct number of joints in its body. Draw its legs, and then the spines or hairs if it has any.

Composition. — Write a description of the caterpillar that you observed. In the first paragraph write about its body, in the second paragraph about its legs, in the third about its jaws.

Nest of Web Worms

SUPPLEMENTARY WORK

What Caterpillars are. — Caterpillars are the larvas of butterflies or of moths. They are hatched from eggs which are laid by the winged insects. They eat leaves and young plants.

Many of the worms that damage our trees and crops are caterpillars. In order to find out what kind of butterfly or moth they become you have only to shut them up until they change to full-grown insects.

Web Worms. — Some kinds of caterpillars spin dense webs in which they live at night and on damp days. You may often see their webs on fruit trees, where the caterpillars sometimes strip the limbs bare of leaves.

How to raise Caterpillars. — Shut the caterpillars in a lamp chimney, fruit jar, or small box. Cover the top or sides with mosquito netting to let in air. Feed the caterpillars with leaves from the same kind of plant that they were on when you found them. Take away the old leaves, and put in new ones every day. Keep the cage clean, for caterpillars naturally live on clean plants and in fresh air. Give the caterpillars a little care each day. They will thrive and soon undergo a wonderful change.

2. THE PUPA

When a caterpillar reaches its full size, it sheds its skin and becomes a pupa which looks entirely different from the larva. It remains motionless for a few days or weeks while further changes take place that make it a winged creature.

Observation. — How long did you keep the caterpillar before it changed to a pupa? In what part of the cage did it go to become a pupa? Look carefully at the pupa to see how it is held in its place. What is the size of the pupa that you observed? What is its shape? What is its color? Touch it to find out whether its shell is hard or soft. Does it move at

all when you touch it? Look for the skin that the caterpillar shed.

Drawing and Composition. — Draw a picture of the pupa that you saw. Write a paragraph telling how the caterpillar that it came from had prepared itself for its change, and another paragraph describing the pupa.

SUPPLEMENTARY WORK

Caterpillar Silk. — A few kinds of caterpillars bury themselves in the ground when they are about to change to pupas, but most kinds hang themselves up by threads of silk which they spin. Put a small caterpillar, such as a measuring worm, on the end of a lead pencil and then make it drop off. It often catches itself by a thread that it spins while it is falling. Wait and see what the caterpillar does when it gets over its fright.

Cocoons. — When some kinds of caterpillars are about to become pupas, they spin coverings, or *cocoons*, in which they lie until they change to winged insects. Many of the pupas pass the winter in their coverings. Those caterpillars that spin cocoons become *moths*. Sometimes you may find a green caterpillar as large as your thumb lying under a walnut or maple tree. Put one in a cage and feed it. When it is ready to change to a pupa, it will spin a thick cocoon around itself. Watch the caterpillar as it spins. If you keep the cocoon until next spring, a beautiful moth will probably come from it.

3. THE BUTTERFLY OR MOTH

Observation. — What is the shape of the butterfly's head? How is it joined to the body? How many feelers has it? What is the shape of its feelers?

What is the shape of the tip of a feeler? Look for the butterfly's tongue. What is the shape of the butterfly's thorax? What is the shape of its abdomen? With what are the thorax and abdomen covered? How many legs has the butterfly? How many wings has the butterfly? What is their color? What is their shape? What markings do you see on them? With what are they covered?

Drawing. — Draw a picture of a butterfly with its wings in the position in which you saw them. First, using light lines, draw its body, head, and feelers, and then draw its wings. Try to put in the principal markings on its wings. Then go over the lines again and make them heavy.

Composition. — Write a description of the butterfly that you observed. Make a paragraph about its head, another paragraph about its body, and a third paragraph about its wings.

SUPPLEMENTARY WORK

Difference between a Butterfly and a Moth. — In every stage of their lives butterflies and moths are much alike. During the egg and caterpillar stages there is no apparent difference between them.

A butterfly pupa is naked and is hung by a thread. Most moth pupas are covered with a silken cocoon. A few bury themselves underground.

A butterfly's feelers are slender and have knobbed tips, while a moth's feelers are often feathery and are never knobbed.

LIFE HISTORY OF THE VIOLET-TIP BUTTERFLY

A butterfly rests with its wings standing on end, while a moth either spreads its wings out sidewise or folds them flat on its back.

Most moths are night flyers, but butterflies fly only by day.

Some Common Kinds of Butterflies and Moths. — From green cabbage worms there come the small white and yellow butterflies that are common in summer and early fall.

From a spiny, hop-vine caterpillar there comes a beautiful dark red butterfly with violet edges on its wings. It is called the *violet-tip* butterfly.

From the striped, light green caterpillars on milkweeds there come large brown butterflies whose wings are marked and bordered with black. These are the *monarch* butterflies.

From the green caterpillars on parsley and carrots there come black butterflies with long projections on their hind wings. They are called *swallowtail* butterflies.

From the fuzzy caterpillars that spin webs on trees in the fall small white moths come out during the following spring.

Raise a few different kinds of caterpillars in a cage, to find out what kind of butterflies or moths they become.

How Butterflies and Moths eat. — Butterflies and moths live principally by sucking honey from flowers through their long hollow tongues. On many kinds you can easily see the tongue coiled up like a clock spring. Many kinds have no tongues, and do not eat in the winged form.

Enemies of Butterflies and Moths. — Of all the worms and caterpillars that are hatched out each summer, only a few become winged insects. The rest are eaten up by other creatures. A song bird eats dozens of caterpillars each summer's day, and all through the winter the woodpeckers, chickadees, and other birds are seeking the pupas under the bark of trees and in the shelter of fences.

Tomato Worm and Cocoons of Ichneumon Flies

Small insects also destroy the larger ones. On tomato and potato vines you sometimes see green caterpillars whose backs are covered with white things that look like grains of rice. These are cocoons, and were spun by tiny worms that had been living in the tomato worm's flesh. If you should try to keep the tomato worm, it would soon die, but from each cocoon you would get a small black fly (ichneumon fly) that would lay its eggs beneath another tomato worm's skin if it had the chance. Flies like these are plentiful, and their young destroy many of the caterpillars that escape the birds.

Preserving Butterflies and Moths. — Butterflies and moths may be killed painlessly by putting them in a tightly closed fruit jar with a few drops of chloroform. After at least an hour

Drying Frame

take them out and pin their outstretched wings to a board to dry. The dried specimens must be kept protected from carpet beetles and other insects that would eat them up.

This lesson is continued in Lesson XIV, on Cocoons.

IV. MUSHROOMS

Material. — Umbrella mushrooms or toadstools brought by the pupils themselves, if possible. Look for them in pastures and lawns after a rain, on decaying stumps and trees, in woods, and along the edges of swamps. Get a variety, so as to compare the different kinds.

Some mushrooms are deadly poison if eaten. So no pupil should taste any mushroom in the field or schoolroom; but all mushrooms may safely be handled.

Observation. — How many inches tall is the mushroom that you are studying? What is its shape? What is its odor? What is its color? How does it feel to the touch? How was it fastened to the ground?

How many inches across is the top part of the mushroom? Notice its skin; can you easily peel it off? How thick is it?

Notice the folds or gills on the under-side of the top part. How many are they? What is their shape? What is their color?

Break the stem in two. Is it soft, or firm and stringy? Is it hollow? Do you find any worms inside?

Drawing. — Draw a picture of the mushroom, showing it tilted a little away from you, so that some

of the folds on its under side can be seen. The lower edge of the top is a circle, but as you look at it, does it look like a circle, or do its front and back edges seem near together, as if the ring were flattened? Draw the ring as it looks in the position in which you see it.

Composition. — Write a description of the mushroom that you have been studying. Make a paragraph about the appearance of the whole plant, another paragraph about what you find when you examine the top part carefully, and a third paragraph about the stem. Choose your words so that they shall describe this mushroom and no other.

UMBRELLA MUSHROOMS

SUPPLEMENTARY WORK

Toadstools. — Umbrella mushrooms are commonly called *toadstools,* whether they are good to eat or not. Some are as large as dinner plates, and others are as small as peas. They vary in color from white to purple and dark red. They grow on all sorts of soil, from sand to decaying wood. Notice them when you see them, and keep count of how many kinds you find.

Other Mushrooms. — Other kinds of mushrooms are shaped like shelves, and grow on trees and stumps. These kinds are often as hard as wood. Other kinds, that grow on trees, are branching masses of yellow and red that at a distance look almost like flames.

SHELF MUSHROOMS

You may sometimes find a small mushroom that is like a cone standing with its large end up, and holding some grains about the size of pinheads. This is called a bird's-nest mushroom, because it looks like a nest with eggs.

Some common kinds of ground mushrooms look like balls, and are called *puffballs.* When ripe their inner parts become a brown or purple dust, that flies out like dust when you crush the balls. This dust is made up of very small balls called *spores.* Each spore can grow and produce new puffballs.

EARTHSTAR

One kind of mushroom looks like a small puffball set in a star. It is found in bare, sandy fields and woods, and is called an *earthstar.* If you find one, wet it and let it dry again, and see what the rays of the star do.

Spores of Umbrella Mushrooms. — Cut off the top from a full-grown mushroom, and place it right side up

on a piece of smooth paper under a tumbler. In a few hours you may get a print or picture of the gills made by the spores that fall from them. The wind carries spores everywhere, and so mushrooms are likely to be found wherever there is the right kind of soil.

Spore Print

Mushroom Plants in the Soil. — Mushrooms have no real roots, but they spring from a network of frail threads that look almost like mold. These threads are the real plants. They grow beneath the surface of the soil, and the parts above ground are only their fruit. The threads growing through a tree trunk or other substance cause decay, just as mold does.

Food Mushrooms. — Have you ever eaten mushrooms? What do they taste like?

The common kind of mushroom that we eat always grows in open fields. It is all white except its gills, which are pink or brown. It has a pleasant odor, and the skin easily peels from its top. But you should not taste any of the mushrooms until some one has shown you how to know them.

V. DANDELION

Material. — For the first part of the lesson, dandelion flowers, and for the second part, ripe dandelion heads that are open, — both brought by the pupils if possible.

1. A DANDELION FLOWER

Observation. — How large is a dandelion head? What is its shape? What is its color? What is its odor? About how many colored petals has it?

Break apart a head and take one of the yellow petals. What is the shape of the petal? Notice the slender stalk that rises from the center of the petal. Into how many parts is its tip split? Where is the greenish seed to which the petal is fast?

Look carefully at the green fringe underneath the flower. About how many points has it?

How long is the flower stalk of the dandelion that you are studying? What is its color? Is it solid or hollow? Is it hard or soft? What is the color of the juice? How does the juice taste?

Drawing. — Draw a dandelion flower, showing its colored petals, its green fringes, and its stalk.

Draw also a single one of the colored petals and its seed two or three times enlarged.

Composition. — Describe a dandelion flower. Make a paragraph about each of the topics in the following outline: —

The whole flower.
A single petal.
The green fringe.
The flower stalk.

SUPPLEMENTARY WORK

Florets. — What we call a dandelion flower is a cluster of many flowers called *florets*. Each floret is a blossom with one seed, and is as separate from the other florets in a head as an apple blossom is from the other apple blossoms in a cluster. At the bottom of each floret is a drop of honey which bees are looking for when they crawl over the plant. Are all the florets open at once?

Dandelion Plant

Dandelions on a Lawn. — Dandelions spring up everywhere on our lawns and along our fences, and nothing seems to kill them. Can you cut the leaves off with a lawn mower? Can animals bite them off readily? Can you pull a dandelion plant

up easily? How does its bitter juice protect the plant? A dandelion plant can grow close to the ground out of the way of harm, but it raises its ripe seeds up on slender stalks, and the wind and passers-by scatter them.

Dandelions have fleshy roots which furnish a store of food for the plants to use at any time. In early spring the plants quickly grow, and help to make our lawns green before the grass starts, and later they decorate our yards with yellow blossoms.

How Dandelion Flowers sleep. — Have you ever noticed what a dandelion flower does at night? Although the yard may be yellow with the flowers all through the day, at nightfall none can be seen, for the heads close up as if they were asleep. The flowers then look like large buds.

Other Sleeping Flowers. — Did you ever go to pick flowers by lantern light and find them closed, as if their buds had not opened? About what time of the day do morning glories close? What other flowers do you know that are closed at night?

Look at a clover plant, or a locust tree, at night. What is the difference between the day position and the night position of their leaves? Some flowers, like the evening primrose, are closed during the day and are usually open only at night.

2. A RIPE DANDELION HEAD

Have you ever blown a ripe dandelion head to pieces to see if your mother wanted you? If you have, the dandelion probably told you more about itself than it did about your mother.

Observation. — On how tall a stalk is the ripe dandelion head? What is the shape of the head? What is its size? Of what is the head composed?

Where are the dandelion seeds? About how many seeds are there? What is the shape of the part of the flower stalk to which the seeds are fastened? What is its size? Notice the fringe just beneath it.

Pull a seed off from a head. What is the size of the seed? What is its shape? What grows from its top? Blow a seed away from you and notice the manner in which the seed floats through the air. With which end up does it alight? Of what use does the fluff seem to be to the seed?

Drawing and Composition. — Draw a picture of a ripe dandelion head, and another picture of a single seed. Then describe the same things in word pictures by writing a paragraph about each of them.

SUPPLEMENTARY WORK

Ripening Changes. — Cut a dandelion flower in two lengthwise and look for the same parts that are in a ripe head. Find the green seed and the white fluff. How near to the seed is the fluff in the yellow head? How near is it in a ripe head? When a dandelion flower begins to wither, it closes up, and the tongues of its green fringe shut together in a tight covering so that the head looks like an unopened bud. The seeds now ripen and send up slender stems which lift the fluff up like umbrellas, and push the dried flowers out so that they fall away. Then the head opens once more, and its seeds are blown away.

Wind-carried Seeds. — If you blow a ripe dandelion head to pieces, how far will a seed travel? If a seed had no fluffy tuft, would the plants spread as they do? Why do dandelions spring up on lawns after all the old plants have been killed?

Why do dandelions, milkweeds, thistles, and other plants spring up on heaps of soil soon after it is thrown out of cellars and wells? Do you think the seeds had lain buried beneath the ground or were they brought to the heap after the soil was thrown up? Have you seen grass and weeds growing on the roofs of old houses? How did the plants get there?

DANDELION HEADS

Notice the seeds in a milkweed pod. What is the shape of a seed? What is the difference between the fluff on a milkweed seed and the fluff on a dandelion seed? If milkweeds are plentiful, you may sometimes see their seeds floating high up in the air.

Pull a ripe cat-tail to pieces. Each tiny bunch of floss on a cat-tail is attached to a seed. How many seeds do you suppose each cat-tail sends out? Give one reason why cat-tails are plentiful in muddy swamps.

What other seeds do you know that have fluffy wings?

Cotton is the fluff that is fast to the seeds of the cotton plant, like the fluff on milkweed seeds.

VI. SPIDER WEBS

Material. — Some webs of the kind that look like wheels (orb webs). Look for orb webs stretched between the limbs of bushes or on fences or over windows. Catch the threads on a slate frame or on a hoop held against them. Also catch a spider on another web of the same kind by holding a box on one side of it, and the cover on the other, and bringing the two together quickly. Put the spiders in bottles for examination.

Observation. — In what directions do the threads of the web run? Are the threads spun around the center in circles, or in spirals? Are any of the threads stuck together? Are any broken?

Touch one of the lines that run around the center. Is it sticky? Does it stretch? Now try one of the straight lines in the same way. What is the difference between the two lines? By which set of lines are insects caught?

How large are the spiders that make the webs? What is their color? How many legs has a spider? Notice the divisions of a spider's body. Are they the same as the divisions of a fly's body?

Drawing. — Draw a picture of the spider web. If any of the threads sag, be sure that you draw them sagging in the right direction.

Composition. — Write a paragraph telling how the threads of the spider web are arranged, a second

paragraph describing the threads, and a third paragraph about the spider that made the web.

SUPPLEMENTARY WORK

How an Orb Web is spun. — When an orb-web spider spins its web, it first makes the straight lines that form the spokes of the wheel. Then it starts at the center with the same

ORB WEB

kind of lines and stretches threads round and round the web from spoke to spoke as far apart as it can reach. At the outer edge of the web it turns back and uses this first set of spiral lines to walk on while it lays down a spiral of sticky lines near together, destroying the first set as it works toward the center. Late in an autumn afternoon look on bushes and weeds for a spider spinning its web.

How a Falling Spider catches Itself. — Gently brush a small spider off from a book or pencil. Does it fall to the ground? How does it catch itself? Does it hang by its head, or by the hind part of its body? With what part of its body does it spin its thread? How does it pull itself up again?

How a Spider hunts. — A web is a spider's hunting net which it spreads for insects. Some of the threads are sticky and cling to the insects which touch them. As an insect struggles to get free it becomes entangled in other threads, for the sticky threads stretch. If the threads did not stretch, what would be likely to happen when a large fly stuck fast in a web?

Web Bridges and Balloons. — Have you ever felt spider webs on your face as you walked along a path? When some kinds of spiders wish to travel, they crawl up a post or tree and spin lines so light that the wind holds them up. The lines catch in neighboring trees, and then the spiders have suspension bridges on which they can travel. Sometimes a spider will cut his line loose and float away on it for a long distance as on a balloon.

Place a small bottle in a dish of water, and in the bottle stand a stick or long lead pencil. Place a spider on the stick. The water will prevent the spider from crawling away. Watch the spider as he spins a thread, and escapes by means of it.

Spider Web Cloth. — Twist some spider webs into a string. How strong a string can you make? Spider's thread is a kind of silk, and has been woven into cloth of great thinness and beauty.

Kinds of Spider Webs. — The common house spiders build webs that are a tangle of threads running in every direction. These webs are called cobwebs.

In the morning you may often see flat spider webs spread out on the grass, looking like saucers of pearls as they are filled with shining dewdrops. Examine one of these webs and notice the tube in which the spider lives. Notice also that the tube has a back door out of which the spider escapes when you try to catch it.

Digging Spiders. — Some kinds of spiders do not build webs, but catch their prey by pouncing upon it as a cat catches a mouse. Several kinds of spiders live in holes which they dig in the ground and line with a smooth layer of their silk. Some kinds leave the holes open, some cover them with trap-doors, and others build boxes of sticks and leaves around the entrances. If you find a smooth hole about the size of your finger going straight into the ground, it is probably the home of a large, gray-haired spider.

A Spider's Eggs. — On cobwebs in dwelling houses you may sometimes find brown, pea-shaped balls. These are nests of spiders' eggs. The eggs do not hatch out caterpillars, but fully formed spiders. Before the young spiders leave the nest they often eat one another until only a few are left.

Under stones and boards and the bark of trees you may sometimes find patches of silk about the size of a finger nail. These, too, are probably the nests of spiders. You may sometimes mistake them for the cocoons of caterpillars.

Daddy Longlegs. — On low bushes you may sometimes see small spiderlike creatures with enormously long legs. These are *daddy longlegs*, or *harvestmen*. They can not harm an animal or plant. They spin no webs, but live by pouncing on small insects, mainly plant lice. How many legs has a daddy longlegs? When it walks, how high above its feet does it carry its body?

VII. GOLDEN-ROD

Material. — Golden-rod flowers brought by the pupils themselves.

Observation. — How tall is the stalk of golden-rod that you are studying? How many branches has it? How far from the top does it begin to branch? What is the shape of the flowering part of the golden-rod? Are the flowers along only one side of the branch, or along both sides? Do the flowers stand straight up or hang down from the stalk? What is the odor of the flowers?

Pick one of the small flowers from a spray of golden-rod blossoms. What is its shape? How large is it? Tear it apart carefully. Of how many florets is it composed? What is the shape of one of the florets? Compare it with a dandelion floret.

Drawing. — Draw a picture of a small spray of golden-rod flowers. First, draw the main stem and its principal branches with light lines. Then draw the flowers all along the tops of the branches. Each flower in a spray is like an urn or vase on a slender stem. Draw the leaves below the flowers, and, lastly, go over the drawing and make the lines heavier.

Composition. — Describe a single one of the golden-rod plants that you have studied. There are so many kinds of golden-rod that you could not write a description to fit them all exactly. Write about a single plant so that any one going across a field would know that kind of golden-rod if he should see it.

SUPPLEMENTARY WORK

Kinds of Golden-rod. — During an afternoon's walk you can often find half a dozen kinds of golden-rod. Some are tall, and some have short stems. Some bear their flowers in flat heads, and others bear theirs in drooping plumes. Some have broad, flat leaves, and others have leaves almost as narrow and pointed as pine needles. See how many kinds you can find. Look for a white kind in or near the woods. Where do you find the most of the flat-headed kind? Where do the tallest kinds grow?

GOLDEN-ROD

Insect Visitors. — Watch a blossoming golden-rod in a field or wood for a few minutes. How many kinds of insects visit it? Do you see an insect about an inch in length with hard black wings crossed with yellow bands? The larva of this insect does great damage to locust trees, for it lives in tunnels which it bores through the wood. It is called a *locust-tree borer*. Do you see any bees on the golden-rod? Do you see any flies that

look like bees? A bee has four wings. How many wings has a fly?

Golden-rod in a Flower Garden. — Dig up some golden-rod roots in the spring and set them by a fence, or at the corner of an outbuilding. If you move the roots carefully, they will grow and produce a beautiful clump of flowers year after year.

Golden-rod grows either from seed or from its old roots which live through the winter and send up new shoots in the spring. Examine the roots of a plant. Can you find any sign of last year's stalk? Has it under ground the beginnings of next year's stalk?

GOLDEN-ROD

The National Flower. — The lily is the national flower of France, and the thistle of Scotland. Why would the golden-rod be a good choice for the national flower of the United States? Do you prefer some other flower? Which one?

Golden-rod Seeds. — After golden-rod flowers wither the head still keeps its shape, but then it looks gray and fluffy. Pluck a ripe head. Where are the seeds? How large is a seed? What is on the top of each seed? Of what use to the seed is the tuft? How long do golden-rod seeds cling to the stalk?

Bird Seeds. — You may often see birds picking the seeds from the naked stalks of bitter weed, or *ragweed*, as it is often called. The seeds of this plant are not in the tassels on the ends of the branches. Look at a plant carefully and note the location and size of the seeds.

Along fence rows and in newly cleared ground the low stalks

of wild sunflowers often grow and produce a harvest of seeds for the birds.

On a sunny day, when the ground is deeply covered with snow, watch the birch trees and see what birds come to eat the seeds. What other plants do you know that furnish seeds to the birds in winter?

Asters. — The most common fall flowers are golden-rods and asters. Nearly all the fall flowers that are shaped like field daisies are asters. Asters are white or blue or purple, but there is also a yellow flower called a *golden aster* that looks like a real aster. Some asters grow on tall, branching stalks as high as your head, and others are only a few inches high. Some have large and showy blossoms, and others have flowers smaller than a finger nail; but all kinds are alike in that each flower, like a golden-rod or dandelion, is made up of a number of florets.

VIII. GOLDEN-ROD GALL

Material. — Golden-rod galls brought by the pupils. They are round or spindle-shaped swellings on golden-rod stalks. Look for them in clumps of golden-rod.

Observation. — How large is the golden-rod gall? What is its shape? Has it leaves on its side? Has it an opening? Is there anything in the opening?

Split a gall in two lengthwise. How thick is it? How large is the room inside? Do you find any signs that an insect has lived there? Do you find the insect itself? Is it a caterpillar, a pupa, or a full-grown insect?

Drawing and Composition. — Describe the golden-rod gall with pictures and with written words. Make a picture and a paragraph about the outside of the gall, and another picture and paragraph about its inside.

SUPPLEMENTARY WORK

How a Gall is made. — When the golden-rod was young, an insect pricked a hole in its stalk, and there laid an egg which hatched a grub or caterpillar. Then the stalk grew faster at that point than at any other, and so formed a knob around the grub. The grub ate out the inside of the knob for food, and lived in the room that it made.

If the gall is a round one, the insect inside is a young fly. The fly will probably remain in the gall all winter and come out in the spring. Save some of the galls in a covered jar and see what kind of a fly comes out. Keep them in the cellar where they will not dry up too much. If the gall is long and spindle-shaped, a moth will probably go from it in the fall, leaving an empty pupa case sticking out from a hole in its side. Was the pupa case half-way out of any of the galls that you found?

GOLDEN-ROD GALLS

Tufted Galls. — Sometimes you may see a golden-rod that grows a dense mass of leaves like a green chrysanthemum flower. These bunches of leaves are galls, and are inhabited by the grubs of small flies.

The Spiny Rose Gall. — On the twigs of wild rose bushes you may sometimes find clusters of balls like peas, covered with long, sharp spines. Keep some in a jar, and you will get black flies from them in the spring.

Other Galls. — On grape and blackberry vines galls often form red, bulging knobs. Inside of them are small larvas which become black flies in the fall or in the following spring.

On willow bushes you can often find two or three kinds of galls. One kind looks like a pine cone.

IX. BURDOCK

Material. — Burdock burs brought by the pupils.

Observation. — What is the shape of a burdock bur? What is its size? With what is it covered? About how many hooks are there on a bur? Does the point of a hook turn inward or outward? Pull off one of the hooks. What is the shape of the whole hook?

Cut a bur in two lengthwise. Where are the seeds? How many seeds are in a bur? How large is each seed? What is its shape? Has it any silk or fluff like a golden-rod or dandelion seed? What is there about a bur that helps the seeds to reach new soil?

Drawing. — Draw a bur cut in two lengthwise so as to show its hooked coverings and the seeds inside. Be sure to curve the hooks in the right direction. Draw also a stem to the bur, so as to show whether the bur grows on the side or on the end of a stem.

Composition. — Imagine some burdock burs to be gatherings of seed children going out to seek their fortunes. Describe the burs. Tell how the children ride away, what dangers they pass through, and how some at last find a good place where they can grow.

SUPPLEMENTARY WORK

Burdock Flowers. — After frosts have come and most of the burs are dry and brown, you can often find small plants that are still in flower. Examine a green bur. Where is its flower? What is the color of its blossom? How many florets has it?

BURDOCK FLOWERS

What is the shape of a floret? Find the withered florets on a ripe bur. Compare the hooks on a green bur with the hooks on a ripe bur. On which are the hooks turned outward the most?

Burdock Seeds stealing Rides. — Have you seen burdock burs clinging to a person's clothes, or to an animal's hair? Give a reason why burdocks are common around houses and barns, and are seldom seen in the woods and meadows. Burdocks are among the few plants that spring up on vacant lots in the midst of large cities. Why is this?

Other Seeds that steal Rides. — In the fall, when you have come from a walk in the fields, have you found seeds clinging to your clothes? Among them did you find a flat seed with two barbed horns that held tightly to the cloth? These seeds are called *pitchforks*, or *stick-tights*. Notice on what kind of plants they grow, so that you may keep away from them.

Another kind of seed that will be likely to get on your clothes is flat and rough, and is called *hound's-tongue*. It is harder to brush off than pitchforks, for it clings flatwise. The clinging habit of the seeds is troublesome to us. How is it helpful to the plants?

Birds as Seed Carriers. — Birds aid in the spread of plants and trees by carrying their seeds away. Wild cherries are often planted along fences in this way. What other seeds do you know that are often planted by birds?

Weed Seeds and Man. — Many of our most common weeds, such as wild mustard, shepherd's purse, corn cockle, and white daisy have been brought here from Europe. Some sprang from seeds that were mixed with seed grain; some came with the hay and bedding of animals, and some in the packing around goods. Do you know weeds that have been brought to your town in any of these ways?

Have you seen clumps of lily of the valley, motherwort, tansy, or catnip growing where there is no sign of a house? These are all dooryard plants, and wherever you see them you may be pretty sure that a house once stood near by. They spread but little, except when planted by man, but once rooted they grow in the same place year after year, long after houses and fences and even fruit trees have disappeared.

X. NEST OF A PAPER WASP

Material. — The nest of a paper building wasp (hornet), hung in a prominent place in the schoolroom. Cut away one half of the nest so as to show its inside. After the leaves are off the trees the nests can be found on low limbs of trees, and in clumps of bushes and golden-rods. During the summer a hornet's nest is like a camp of bad-tempered savages, but in the fall the whole hornet family move out and leave the nest to us if we care to take it.

Observation. — What is the size of the hornet's nest? What is its shape? What is its color? Lift it. How heavy does it feel? Of what is it made? How many layers are in its walls? How thick is one of its layers? Where is its doorway?

What is the inside arrangement of the nest? How many stories has it? Compare it with a beehive. Of what is the comb made? How are the combs held in place? Do their cells stand upright or hang downward? What is the color of the lining of the cells? Open one of the cells that are closed. What do you find inside?

Drawing. — Draw a picture of a hornet's nest as it appears when its front is cut away. First, draw the outside of the nest with several broken lines to show its layers. Then draw the comb by making the cells in rows one above another. Also show how the combs are joined together.

Composition. — Write a description of the hornet's nest. Make a paragraph about the outer covering of the nest, a second paragraph about the comb, and a third paragraph about what you find in the comb.

SUPPLEMENTARY WORK

Wasp Paper. — Hornets make their nests from wood which they gnaw from weather-beaten trees and buildings. They chew the wood to a pulp, and spread it out in sheets which dry and become paper. If you see a hornet alight on a board, watch to see what it does.

PART OF HORNET'S NEST

Young Wasps. — The little cells in the combs of hornets' nests are not filled with honey, but are used to hold baby hornets. The larvas that hatch from the mother hornet's eggs are grubs without legs. They hang in the cells head downward, being held in by a sticky substance. There they are fed by the old wasps on insects and honey.

You may have seen hornets buzzing around your kitchen on a hot summer's day. They were probably catching flies for food.

When a larva is fully grown, it spins a white cocoon around the sides and over the top of its cell, and passes its pupal state

tightly shut up inside. About a month after the egg is laid the winged insect comes forth as a large black wasp with bands of white or yellow across its body. The cell is then used to rear another larva.

What is the thin white lining that projects a little way from each empty cell? See if you can tear the white lining as easily as you can tear the paper of the nest.

How Hornets' Nests are built. — Each hornet's nest is begun in spring by a single mother wasp, and at first is about the size of a black walnut. The wasp children are nearly all workers, with a few drones and queens. Thus the nest of hornets is much like a hive of bees. The young all remain at home and help the mother hornet to care for her other young. As the family grows the hornets make the house larger and larger. How large was the largest hornet's nest that you have seen? Did you ever find a large hornet's nest early in summer? Why not? What becomes of the empty nests in fall? In the fall, when frost comes, all the wasps die except a few mother wasps who pass the winter in some sheltered spot. In an empty nest you may find a few dead wasps, which may be either old ones or young ones too weak to fly away.

One kind of wasp builds a paper comb for its young, but puts no covering over it. You may often see these combs hanging by single stems from the rafters or eaves of a barn.

A kind of wasp commonly called a *yellow jacket* looks much like a honeybee, and stings worse than a hornet. It makes a light brown nest much like a hornet's nest, but builds it in a hole in the ground and makes the paper out of rotten wood. If you find a nest, mark the spot, and at the beginning of cold weather dig it up and examine it.

XI. NEST OF A MUD WASP

Material. — Nests of mud wasps brought by the pupils. They can be found on piazza ceilings, and under the roofs of attics, barns, and outbuildings.

Observation. — What is the size of the mud wasp's nest? What is its shape? What is its color? Of what is it made? How many cells are in it? How are the cells arranged? Do you find their doors?

Break open one of the cells. How thick are its walls? How large is the cell? What is its shape?

Do you find a young wasp in an opened cell? Is it a larva, a pupa, or a winged wasp? In the cells you may also find the bodies or remains of insects on which the young wasps fed. What kind of insects were they?

Drawing. — Draw a picture of the mud wasp's nest. Draw the outline of the whole nest with heavy lines. Then with lighter lines draw such parts of the separate cells as you can readily see, for the cells do not always show plainly on the outside of the nest.

Composition. — Write a description of the mud wasp's nest that you examined. Make a paragraph about the appearance of the whole nest, another paragraph about its cells, and a third paragraph about what you find in the cells.

SUPPLEMENTARY WORK

What are in Mud Wasps' Nests. — The cells of a mud wasp's nest are homes for baby wasps. As soon as a mother completes a cell she lays an egg in it, fills the cell with spiders, and closes the door with a lump of mud. A legless larva hatches out and lives on the spiders until it is fully grown. Then it lies quiet in the pupal state for a while, until its wings have grown. At last it gnaws its way out and flies off, never to return to the nest. You may have seen wasps come into your kitchen and fly around as if they were looking for something. If you let them alone, they will not sting you, but will catch spiders to put into their nests.

Mud Wasp's Nest

How Wasps build their Nests. — Where have you seen the nests of mud wasps? Were they all of one color? Could you tell where the wasps got their mud? You may sometimes find an unused or half-finished cell on a nest. Give a reason why the cell is unfinished. Notice if there are any unused balls of mud on the next nest that you see.

In warm weather wasps may often be seen getting mud around pumps and kitchen drains. Watch one roll a ball of mud with its fore feet, seize it with its jaws, and fly away. How long does it take a wasp to roll a lump as big as it can carry? Notice what a wasp does with its wings while it is working with the mud.

What a Wasp is like. — Wasps pass the winter sleeping in sheltered places. In late fall or early spring you may often see them on sunny windows in the attic or barn. Has a wasp the same number of wings as a house fly? Has it the same number of legs? Has its body the same divisions?

Wasp's Nest on an Apple Leaf

You may know the common mud-building wasp by its long slender waist.

Kinds of Wasps. — There are many kinds of mud-building wasps. One kind makes a nest like a jug about as large as the end of your little finger. These nests are usually fastened to twigs of trees, or to the stalks of golden-rods. In each nest the mother wasp lays a single egg and then fills the nest with live caterpillars which will furnish food for the grub that hatches from the egg.

Another kind of wasp that builds on twigs and plant stems makes a nest about the size and shape of a hen's egg. The cells look like pencil holes drilled irregularly through the nest.

Another kind of wasp makes long holes in small sumac and

elder limbs by eating out the pith. Then it divides the hole into cells by cross walls of mud or chips, and lays an egg in each. Look for these nests in dead sumac or elder twigs. Some of the nests that you may find may belong to a kind of bee. If the nest contains pollen and honey it is probably a bee's nest, but if it contains spiders and other insects it is a wasp's nest.

WASP'S NEST ON A TWIG

Sometimes you may find nests lined with leaves and divided by leafy partitions into cells. These are the nests of leaf-cutting bees.

Digger Wasp. — In the sidewalk or hard lawn you may sometimes find heaps of dirt beside deep holes about the size of a little finger. These holes are dug by digger wasps to be the homes for their young. In each hole a wasp will put a living cicada which it has stung and paralyzed. On the cicada it will lay an egg. The wasp that hatches out will use the cicada for food, and when full grown will dig its way out of the hole and fly away. These are among the largest of all wasps.

XII. BIRD'S NEST

Material. — The nest of a Baltimore oriole (hangbird) placed where the pupils can easily examine it. If an oriole's nest can not be found, use a vireo's nest, or the nest of some other bird.

Observation. — What is the shape of the nest that you are studying? What is its size? What is its color? To what part of a branch is it fastened? How is it fastened?

Of what stuff is the nest made? What different kinds of things were used in making it? How are the pieces of stuff held together?

Drawing. — Draw a picture of the nest. First, draw the limb and the outline of the nest. Then draw short crooked lines all over the nest to show the kind of stuff of which it is made. Make the lines lighter toward the middle of the nest to show its rounded shape.

Composition. — Suppose yourself to be a baby bird. Write a paragraph describing your nest, another paragraph describing the stuff of which it is made, and a third paragraph telling why you should think your cradle to be the best one in the world.

SUPPLEMENTARY WORK

Orioles. — Among the common birds around our homes none are more beautiful, or sing sweeter songs, or help man more

than Baltimore orioles. While the trees are in blossom they dress themselves in the brightest gold and fill the air with music as they hunt among the opening buds for caterpillars and other enemies of the trees. During the labor of weaving their nests and rearing their young they neglect their dress and song, and by the end of July their feathers are a rusty brown and their voices are silent. But all through the summer they pay the farmer good rent for the use of his trees, for they are fond of hairy caterpillars, and eat great numbers of the kind that spin webs and strip the leaves from orchard trees. Have you seen a web nest torn to pieces and filled with dead caterpillars? An oriole had probably been there for breakfast. When food is plentiful it will often suck the juices from caterpillars and leave their skins. Cuckoos also are fond of these web worms.

ORIOLE'S NEST

Oriole's Nest. — How many orioles' nests can you see on your way to school? In what part of a tree is an oriole's nest usually found? How is it protected from thieves of all kinds? Can you see an oriole's nest easily in summer? Is it of any advantage to the bird that this is so? Can you see the nest easily in winter? Where do orioles go in winter? When they return in spring, do they use their old nests? Watch an old nest and see if it is used.

VIREO'S NEST

Vireo's Nest. — A number of different kinds of yellow or olive-green birds are commonly called *yellow birds.* Many of them build soft, downy nests in the forks of the smallest limbs on shade trees and swamp bushes. One kind, the vireo, builds a hanging nest that is shaped like a teacup. It often covers the outside of the nest with spiders' webs. What is the difference between a vireo's nest and an oriole's nest?

Nest of a Chipping Sparrow. — Chipping sparrows often build their nests in apple trees and in arbors by our doors. They make the nests out of grass roots, and line them with horse hair. Are the nests woven as firmly as an oriole's nest? Are they built in as safe places?

A Robin's Nest. — A robin builds its nest out of large spears of grass and lines it first with mud and then with soft grass. How does the robin make the inside of the nest smooth before the soft grass is added? You can find out by watching a robin build a nest in spring. In what part of a tree does a robin build its nest? Look at several robins' nests and see if they are built equally well.

Have you ever heard the robins sing at daybreak? They are among the first of the birds to waken, and they sing in a loud chorus as if to call the rest.

Nest of the English Sparrow. — Where have you seen English sparrows building their nests? Of what were they making them? How large are their nests? Have you seen one made out of an old robin's nest? At what time of the year do English sparrows build their nests? Have you seen them building in winter? Do they lay eggs in winter?

A Bird Census. — In winter is the best time to begin the study of birds' nests. Then the leaves are off the trees, and the nests can easily be found. Then, too, the birds are through with them, and no harm is done if we take them.

What kind of nests can you see along your street? By counting the nests you can get some idea how many birds lived near you during the last summer.

On your way to school count the birds' nests that you find. What kind of nest do you see the most often? How many kinds do you find? How many birds do you suppose were raised in them? Besides the nests that you see, there are probably other nests hidden in hollow trees and in barns and outbuildings.

Protection for Birds. — Birds protect our fruit and grain from insects, and enliven us with their songs. What have you done to help them? Did you ever put pieces of hair and string where they could get them for their nests? Have you made houses for them? Have you put water where they can drink and bathe? Have you given them food and water in winter? Have you helped to preserve the bushes where they nest, and the wild berries and seeds on which they feed? Have you always tried to be friendly with the birds so that they would be glad to live near you?

XIII. TREE TRUNK

Material. — Sticks of oak, chestnut, pine, or other stove wood prepared by some of the boys. Leave the bark on. Cut the wood in short lengths, split them in half, and smooth the ends and sides to show the grain of the wood. A little oil or varnish will bring out the grain marks more clearly.

Observation. — What is the name of the wood that you are studying? What is the color of the wood? What is the color of the circles on the end of the stick? How many circles are there? How are they arranged? How far apart are they? Is the wood between the circles solid, or does it contain fine holes? In what direction do the holes run? Each circle marks a year's growth of wood. How old is the stick?

Are there any lines on the split side of the stick? Which way do they run? Have they anything to do with the circles on the end of the stick?

How thick is the bark on the wood? Is it smooth or rough? Does the outer part peel off easily? How closely is the bark fastened to the wood?

Drawing. — Draw a picture of the end of the stick of wood. Show the bark and the marks on the wood.

Composition. — Write a description of the stick of wood. In the first paragraph tell about the circles on the end of the stick, in the second paragraph about the markings on its side, and in the third paragraph about the bark.

SUPPLEMENTARY WORK

How a Tree grows. — Have you seen a tree growing with its center rotten and hollow? In growing, does a tree need to use the center of its trunk?

End of a Stick of Black Oak

Have you seen great flakes of bark peeling off from a growing tree? In order to grow does a tree need to use the outer part of its bark?

All new growth goes on where the bark and wood join. Each year the tree forms a new layer of wood over all the old

wood, and lines the old bark with a new layer of bark. The wood that grows in the spring is lighter in color and softer than that grown later in the season. So each year's growth makes a double ring, — a thick, light-colored part and a thinner and darker part. By counting the rings you can tell the age of the tree.

Apple Twigs split to show course of Sap

Which part of the wood has the larger pores, that grown early or that grown late in the season?

When the inner part of the ring of bark grows larger, what happens to the outer part? Why is old bark rough and cracked on its outside? Why is bark on young branches smoother than bark on older ones?

Where Sap flows in a Tree. — Sap is the blood of a tree and contains everything that changes into wood, leaves, and bark. From the soil through the roots the plant gets some of its water, and also its ashes, or what is left after wood is burned. From the air, through the leaves, the sap gets its *charcoal* or *carbon*. When wood is burned, the most of the carbon passes back to the air.

All through the summer the sap passes back and forth between the roots and leaves. In going toward the leaves it passes through the pores, or open tubes in the wood. Did you see these pores in the specimen of wood that you studied? Wood is mostly bundles of thick-walled tubes, but it often takes sharp eyes to see their openings.

Does sap go up through all the wood? Find out by putting the cut end of an apple twig in water colored with ink. Let it stand for a day or two. Then split it open lengthwise and see in what part of the wood the ink has risen.

In going from the leaves toward the roots sap passes through the inner parts of the bark.

How a Tree repairs its Wounds. — Look at the place where a limb has been sawed from a tree. Which part of the wound is the bark covering the more rapidly, the upper or the lower?

You may have seen bark trying to cover the stump of a limb that was broken off at some distance from the trunk. Often the wood decays before the bark can cover it, and then the whole inside of the trunk is in danger of becoming rotten. In pruning a tree, always saw off a limb with a smooth cut close to the trunk.

Have you seen a swelling on a tree where a tight band has been put around it? Is the swelling above or below the band? The sap in the bark can not readily flow past the band. Thus the wood at the band holds back some of the food belonging to the other parts of the tree, and so that place grows more rapidly than the rest of the trunk.

Sap and Heart Wood. — After a few years the tubes in the wood of a tree become filled up so that the older wood is firmer and stronger than the young wood. In a large tree the center of the trunk is darker in color, and harder than the outer part. The center is called *heart wood*, and makes better lumber than the outer or *sap wood*.

Grain Marks on Wood. — In some kinds of wood the marks made by each year's growth show more plainly than they do

in other woods. When wood is sawed the circles are cut across and appear as grain marks on the boards. In order to show the grain marks, wood used for furniture, ceilings, and floors is often oiled or polished instead of being painted.

Does the wood on your desk show any grain marks? Are there any grain marks on the floor or on the walls of the schoolroom? By these marks you can tell what kind of wood you have. Of what wood is your desk made? How many kinds of wood can you see in the schoolroom?

Split a knotty stick of wood lengthwise through a knot. Notice how the grain marks on the trunk curve and run up the branch. Why is this? Has the wood from a small branch layers and grain marks like wood from the trunk of a tree?

What are the knots in a board?

Borers. — In the middle of sticks of firewood there are often tunnels about the size of a leadpencil, or smaller. These tunnels are usually made by white, black-headed grubs or borers. The borers gnaw tunnels through the wood and use some of the chips for food. When full grown they change to winged insects, chiefly beetles. These insects lay eggs which hatch out the boring grubs.

Borers can usually be found in decaying limbs, but many kinds live in growing trees and spoil the wood with their tunnels. Look for their tunnels in the sawed locust posts of a fence. (See page 45.) Borers often do great damage to fruit trees. Their tunnels are usually near the ground and can be found by means of the sawdust pushed out by the borers. Almost the only way to kill them is by running a wire up the tunnels.

XIV. COCOONS

Material. — Cocoons, especially those of the Cecropia, Polyphemus, and Promethea moths. Cut one open, and place it where all the class can examine it. Look for cocoons on shrubs, under the bark of trees, and in protected places on fences and houses.

Observation. — To what is the cocoon that you are studying fastened? What is its size? What is its shape? What is its color? Is it firm or soft? Are its threads tightly or loosely woven? Was there anything besides silk used in making the cocoon?

Examine a cocoon that has been cut open. How thick are its sides? In how many layers are its sides made? How does the inner surface of the cocoon feel to the touch?

In the cocoon that was cut open, what is the size of the pupa? What is its color? What is its shape? How can you tell the head of its body from the tail?

Drawing. — Draw a picture of the cocoon. If there are any fluffy threads on the cocoon, draw them with a sharp pencil in light lines.

Composition. — Write a description of the cocoon. Make the paragraphs on the subjects called forth by the observation questions.

SUPPLEMENTARY WORK

How to keep Cocoons. — Keep the cocoons so that you can see what kind of moths come from them. The best way is to leave them where you found them until spring. If you bring them home, remember that they are used to cold weather and to rain. So put them in a cool place, and wet them once a month. When warm weather comes again, put them in a box with mosquito netting tacked over the top, and watch for the moths to appear.

What comes from Cocoons. — From the large, firm cocoons that you will be likely to get there will probably come some one of four kinds of large moths. If a cocoon is large in the middle, and tapers to each end like a spindle, there will come a very large, reddish gray moth, the *cecropia.*

Cecropia Moth and Cocoon

If the cocoon is nearly egg-shaped, the moth will probably be either a yellowish gray one, the *polyphemus,* or a light green one with a long tail on each hind wing, the *luna* moth.

If the cocoon is like a long bag, and is covered with a folded leaf, there will probably appear a smaller black or reddish moth, the *promethea.* If a naked twig bears something that looks like a single folded leaf, look to see if it is a cocoon. Notice how these cocoons are fastened to the twigs.

The fuzzy caterpillars that spin webs in the fall and eat the leaves from shade trees make cocoons out of their own hair and a little loosely woven silk. The cocoons are small in size,

and are made under loose bark and in corners of fences and buildings. In the spring small white or spotted moths come from them.

Keep any other kind of cocoons that you find and see what moths come from them. Also collect butterfly pupas and keep them in the same way that you keep the cocoons.

Tussock Moth and Cocoon

Ways of passing the Winter. — In the fall most insects die, but the next summer there are as many as ever. From what does each year's insect host spring?

What starts a new brood of house flies? What starts a new brood of mosquitoes? What starts a new brood of wasps? What starts a new brood of bees? What starts a new brood of ants?

Almost the first butterfly that you see in spring is one that has lived through the winter. It is black, with yellow bordered wings; it is called the *mourning cloak* butterfly.

Tussock Moth. — Among some kinds of insects none at all live through the winter, but the next year's brood is hatched from eggs that are laid before the insects die in the fall.

On the trunks and smaller limbs of elms and other trees from fall to spring you may often find small white or ash-colored cocoons with a bunch of eggs on each. These are the cocoons of the *tussock moth.* The moth comes out in the fall and lays her eggs on the cocoon, where they remain all winter and hatch out in the spring. The caterpillar is white and

hairy, with bald patches of red on its back, and with long pencils of hair at each end of its body. These caterpillars often do great damage to shade and fruit trees by eating their leaves. The trees are most easily protected from them by brushing the cocoons from the limbs and burning them before the eggs hatch.

Woolly Bear Caterpillars. — A few kinds of caterpillars do not change to pupas in the fall, but curl themselves up in some protected spot for the winter and undergo their changes in the next spring. Have you seen a brown-haired caterpillar hurrying over the frozen ground or snow? This is the *woolly bear* caterpillar. It will live through the winter, and change to a gray moth in the spring.

Spider Nests. — Sometimes you may find what you suppose is a cocoon, and get from it a great number of young spiders instead of a moth. Some spider nests look like cocoons, but they are usually made of softer and finer silk than cocoons, and the eggs can often be seen inside.

Silkworms. — The silk that is spun and woven into cloth is made from the cocoon of the silkworm. The caterpillars are kept in boxes and fed on mulberry leaves. Each cocoon is made of a single thread that can be easily unwound. The silk from the cocoon of any other kind of a caterpillar might be used to make cloth if it could be unwound.

XV. ICE

Material. — When the weather is freezing cold, place some cups and bottles of water outside of a window on the sill. Tip them frequently so as to see the first ice that forms.

Observation. — Look at the freezing cup of water. On what part of the surface does the first ice form? How many pieces of ice form at one time? What is the size of the first bits of ice that you see? What is their shape? Is the ice the same in all the cups?

Just before the cup is frozen over pour off the water. Do you find any particles of ice on the sides of the first bits of ice that formed? Is the under surface of the ice smooth? What do you find on the under surface? Is the upper surface of the ice perfectly level, or does it show tiny ridges? How are the ridges made?

Look at the freezing bottle of water. Where does the first ice appear in the bottle? What is the shape of the ice? How far into the water do the first pieces of ice reach?

Drawing. — Draw a picture of the first particles of ice that you saw on the freezing cup of water. Draw a picture of the first ice that formed in the bottle of water.

Composition. — Write a composition telling how water freezes and how the ice looks. In the first paragraph describe the bits of ice that first form in the cup, in the second paragraph describe the ice when it has become a sheet, and in the third paragraph tell how the water froze in the bottle.

Ice Needles in a Bottle of Water

SUPPLEMENTARY WORK

Ice Needles. — In a pond ice forms in the same way as it does in a cup or bottle. At first it is in scattered needles, but when a great number of needles have formed, the ice is in one sheet, or block. Look at a thin scum of ice on some water just before the sheet is complete. Are the openings between the needles round, or long and narrow? Are the edges of the openings smooth, or are they like saw teeth? What makes the saw teeth? Look for needles and combs of ice on the sides and bottom of a pail of freezing water.

Notice the frost on a window on a very cold day. Do you see any ice needles there? The needles are often arranged in beautiful shapes. What ice forms have you seen? The ice is made from the steam or watery vapor in the air. Why are kitchen windows often covered with ice when the windows of the sitting room have little?

Put a wet board where the water on it will freeze. Does the ice form an even coating, or is some of the ice in the form of needles? Are any of the needles arranged in stars or rosettes?

When it clears off cold after a fog or light rain, you may often see ice figures on a stone sidewalk.

UNDER SIDE OF NEWLY FORMED ICE

Bubbles in Ice. — Have you seen lines of bubbles in ice? Are they crisscrossed in every direction, or in straight lines side by side? Do they run lengthwise of the ice, or up and down? The bubbles are made by the air that was dissolved in the water. In frozen water the air is driven from the water and held between the needles of ice. In which direction can you split ice the more readily, across the lines of bubbles or lengthwise of them?

After a warm rain melting may take place around each bubble until the ice is full of holes, and readily crumbles to needles. Notice this on a skating pond after a thaw.

Will ice bend? How thick must ice on a pond be to bear a man?

Why Ice bursts Bottles. — When water freezes, it swells so that ten quarts of water become eleven quarts of ice. Thus ice is lighter than water, and so it floats. Why does not a pond freeze solid?

Place a bottle of water outside of the window where it will freeze solid. Does the bottle break? Does the ice rise up in the center and form a hump? What makes it do so?

Icicles. — In the afternoon when it becomes cold after snow has been melting all day on a roof, the water dripping from

the eaves often freezes in long spears. How can it be warm enough to melt the snow on the roof, and at the same time be cold enough to freeze the water at the edge of the roof? How large was the largest icicle that you have seen?

Frost on Windowpane

Caddis Worms. — When you are out skating, look through the ice into the water below. What kinds of grass do you see? What kinds of fish are there? Do you see any turtles? As you look through the ice do you see what look like rough sticks about the size of the end of your little finger moving

slowly among the grasses? These are cases which caddis worms build as covers for their bodies, and in which they live.

ICE ON A SIDEWALK

You may often see a head and legs sticking out of the end of each case. The worms finally change to winged insects.

XVI. SNOWFLAKE

Material. — Give this lesson during a cold snowstorm when the flakes are small and uniform in shape. Allow the pupils a short recess in order to examine the flakes out of doors, or in a freezing cold room where the snow will not melt. Use a magnifying glass if possible. Have the pupils take pencil and paper and make rough sketches of the flakes while they are observing them. Let them do their writing and their careful drawing on returning to the schoolroom.

Observation. — How large are the snowflakes that you observe? Are they all much alike? Are any shaped like stars? How many points have the perfect stars? Do all the stars look alike? Are their rays smooth, or are they covered with frost work?

Do any of the stars show signs of having melted? What part of a star melts first? In which are the stars the more perfect, in the large or in the small flakes?

Are any of the flakes shaped like wheels? How many rays or spokes has each wheel?

What other shapes of flakes do you find?

Drawing and Composition. — Write a composition about the snowstorm that you watched. Tell about the weather, the shape of the flakes, how the flakes came down, and how things looked under the snow. Illustrate your work with a picture of a single snow-

flake, and with a drawing showing how some fence, or tree, or building looked under the snow.

SUPPLEMENTARY WORK

How Snowflakes get their Shape. — Snow is made up of ice crystals. The ice comes from water that has frozen in the

SNOWFLAKES (Magnified)

clouds. Each flake starts with six needles that are arranged like a six-pointed star. Then smaller needles branch out from the sides of the first needles. If the cross needles fill all the space between the points, the star becomes a six-sided wheel. Afterward tiny needles may form all over the star, making it a most beautiful object to look at. Not every flake will be a perfect wheel or star, for many are broken by the wind.

ROAD IN A SNOWSTORM

During the course of the winter see how many shapes of flakes you can find.

If the air is warm, some of the points of the stars may melt, and then the flakes stick

together to form large ones. So in large flakes you can make out no regular form. You will usually find the most perfect flakes at the beginning of a cold storm. Why is this?

Road after a Snowstorm

Snow Writings.—Sometimes animals and birds leave writings in the snow. If you find their tracks, see how much they tell you about the creature that made them.

What tracks did you find on your way to school? Was the trackmaker going fast or slow? Was it walking, trotting, galloping, or hopping? What is the difference between a dog's track and a cat's track? In which do you see the prints of the toenails?

At each leap a rabbit carries its hind legs outside of, and ahead of its fore legs. So the two prints of its hind legs are in front, and a little distance apart, while behind them are the tracks of its fore legs near together.

Rabbit Tracks

Make a dog run over the snow. At each leap does it put its hind feet between its fore feet or outside of them? Do its hind feet strike the ground behind or in front of the tracks of its fore feet?

Look at the tracks of a galloping horse. Are the tracks arranged like a dog's tracks?

Snowbirds. — What birds have you seen near the house after a snowstorm? Hang a piece of suet in a tree for the birds to eat. What birds do you see eating it? Scatter some crumbs on the snow. What birds come for them? Among our winter visitors is a small slate-colored bird with a light gray breast, — the *junco*, or *snowbird*. Another is a small gray and white bird with a black hood on its head, — the *chickadee*. Both of these birds and many more will be likely to come to your door after a snowstorm if you coax them with food. Do not forget to give them drink also.

MOUSE TRACKS

Have you seen birds eating the seeds on weed stalks that stand up above the snow? On what kinds of weeds were they feeding? Have you seen birds eating the seeds of golden-rod or birch? (See p. 46.)

What birds spend the winter with you? Make a list of all that you can see. What birds do you see in winter that you do not see in summer?

(82) A Frosty Morning

XVII. FROST

Material. — Have the pupils bring pieces of board or other things covered with frost. Meet the pupils out of doors before school, and call their attention to the forms of frost on the shady side of the schoolhouse. Use a magnifying glass if possible. While the pupils are looking recall to them how water freezes and how snowflakes look.

Observation. — On what do you find frost? Is there any on the bare ground? On what does it show the most plainly? How does the frost look at a distance?

Is the frost in a white coating like paint, in grains like flour, in needles like ice, or in stars and wheels like snow? Look for flat particles of frost. How many straight sides has one of the particles? Do you find any frost stars, any rosettes or other figures?

Do the frost particles stand on end or lie flat on their sides? What is the shape of the particles that glitter in the sunlight? Does frost on the grass glitter as much as frost on a board or fence? Do you find a reason for this?

Drawing and Composition. — Write a description of the frost that you observed. Illustrate your work with pictures of some of the frost shapes that you saw.

SUPPLEMENTARY WORK

What Frost is. — Frost is not frozen dewdrops, for dew would freeze in solid balls. It does not fall from the air like snow, for then it would cover everything alike, and would not cling closely to things. It is made from vapor that becomes ice when it touches anything freezing cold. Are the particles of frost like needles of ice? Are they like snowflakes?

Shapes of Frost. — Look at frost on different days. Have its particles the same shape every day? Does the frost on a board look like the frost on the grass? You may have seen rosettes of frost on a tin roof. Are these rosettes like the rosettes of ice that form on a wet board?

When it becomes cold while a fog is in the air, the trees and weeds are often coated with a delicate white frost so that each twig seems covered with downy feathers. This feathery frost often forms on bushes that overhang a running stream. What is the shape of its separate particles?

Plants in Frosty Weather. — How does freezing affect most leaves and flowers?

What kinds of garden vegetables are not harmed by frost? What kinds of green leaves can you find in the middle of winter on the school grounds? What kind can you find in gardens and fields? How does a catnip plant look in winter? Does wheat keep green through the winter? Do turnips that have been left in the ground keep green tops? Does lawn grass show any living part above ground in winter?

In winter you may often see mullein plants with green leaves spread out in rosettes on the ground. Notice the thickness of these winter leaves. They contain food ready made for new shoots to use on the first warm days of spring, and next summer all that will be left of them will be dried skins. What other rosettes of leaves have you seen in winter?

Notice a dandelion plant in winter. How large are its winter leaves?

XVIII. PINE TREE

Material. — Some young pine trees placed where the pupils can examine them at their leisure.

Observation. — What kind of pine is the one you are studying? Is its main stem split into branches, or does it go straight up through the tree? Are the branches scattered without any order up and down the stem, or do they grow in groups? How many circles of branches are on the tree? How far apart are the circles? How many branches are in each circle? Are there any branches except in the circles? How are the small branches arranged on the large branches?

How many buds are on the top of the main stem? How many buds are on the end of each branch? Do you find buds anywhere else? Are the buds arranged like the branches?

How old is the tree? Does the number of its circles of branches agree with the number of circles on the cut end of the wood?

Drawing and Composition. — Make two pictures to show the arrangement of the branches on the pine tree. Make one picture with lines in a drawing, and the other with words in a composition. First picture

the circles of branches on the main stem, then the small branches on the sides of the large branches, and then the buds.

SUPPLEMENTARY WORK

History of a Pine Tree. — You can easily read the story of a young pine's growth for ten years or more. Get some year-old pines, some that are two years of age, and some that are older.

PITCH PINE, SIX YEARS OLD

First year. — A year-old seedling pine is a single straight stem. On its top it has two or three buds pointing outward, and an upright bud in the center of the circle. These buds will grow into branches during the second year.

Second year. — Each bud grows into a stem that looks like a year-old seedling. From the upright bud another length grows on the central stem, and the other buds become a circle of branches. Each stem of the new growth bears buds like those on the top of the first year's growth.

Third year. — In the third year, and in each year afterward,

the central stem grows a new length and forms a new circle of side branches. Also each side branch grows and branches in the same way as if it were the main stem.

In a pine tree, the part above any circle of branches looks nearly as the whole tree did when it was the age of that part. In a large tree, count down five circles of branches from the top, and see if the part above the lowest circle is not a perfect five-year-old tree. By counting the circles of branches you can tell the age of a pine tree. In the oldest tree there are always some parts that are only a year old. What parts are they?

In spruce and fir trees the branches grow even more regularly than in the pine.

Why Many Pine Limbs die. — After a pine has grown in a regular way for four or five years, its branches begin to crowd one another. Then some of them die from want of space, sunlight, and food, and some more are killed by winds and insects. So no tree grows exactly after its plan. Yet even an old tree plainly shows its plan of growth on the ends of its branches, while numbers of dead twigs on its trunk and larger branches show when and how it tried to follow its model. Why are there more dead branches on a forest pine than on a pine tree that has grown in a field?

Where a Tree grows in Length. — If you drive a nail into the trunk of a growing tree, will it be lifted farther and farther from the ground as the tree grows taller? By the end of each year each length of new wood is hard and fully formed, and can not be made longer. So the limbs always keep the same distance apart, and no limb or piece of old wood is lifted up from the ground. The limbs seem to be lifted up because the lower ones die. A tree grows taller only because new lengths of wood grow on the outer ends of the old wood.

Why are the branches farther apart on an old tree than on a young one? Why are the upper branches nearer together than the lower ones? Why can you not see the remains of any dead branches low down on the trunk?

XIX. PINE LEAVES

Material. — Leafy branches from several kinds of pine trees.

Observation. — From what kind of pine were the leaves that you are studying taken? What is the shape of one of the leaves? How many inches long is it? What is its color? What is its odor? What is its taste? How many leaves grow together in a group? Is there a wrapping around the base of each group of leaves? How far up on the leaves does the wrapping extend? What is the wrapping like?

Has a pine twig more or fewer leaves than an apple twig of the same size? Do pine leaves grow nearer together or farther apart than apple leaves? On what part of last year's growth of wood do you find leaves?

Are there any leaves on two-year-old pine wood? Are there any on three-year-old wood? How old are pine leaves when they fall? What kind of scars do they leave on the bark?

Drawing. — Draw a picture of pine leaves in their natural size, showing how they grow together in groups. Draw the wrapping if there is any.

Draw a picture of a pine twig, showing how the leaves are arranged on it.

Composition. — Write a description of the pine leaves that you observed. In the first paragraph describe the single leaves, in the second, tell how the leaves are arranged on the branch, and in the third, tell about the falling of the leaves.

SUPPLEMENTARY WORK

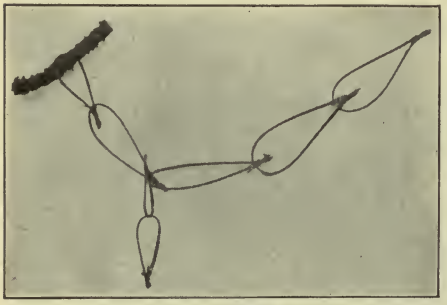
Age of Leaves. — In pines and in most other trees the leaves are of the same age as the wood on which they grow, for new

Blossoming Twig of Pitch Pine

leaves seldom form on old wood. New pine wood is almost covered with leaves, but the older limbs are bare. What are the ages of the oldest leaves on white pine, on pitch pine, on spruce, and on cedar?

In the fall the winds blow dry and brown leaves from every evergreen tree. What is the age of the wood from which most of the leaves are shed in white pine? What is the age of the wood from which most of the leaves are shed in pitch pine? What is the age of the wood from which most of the leaves are shed in spruce?

Pitch Pine and White Pine Leaves. — While all kinds of pine look much alike, there are many differences in their leaves, their bark, and their manner of growth. Compare a white pine with a pitch pine. Which has the softer leaves? In which is the greater scar left by the fallen leaves? In which does the new wood have the smoother bark? What other differences do you see between the two trees?



Chain of Pitch Pine Leaves

It is easy to make a watch chain out of pitch pine leaves. Pull out two of the leaves from a cluster. Bend the third leaf double, and tuck its outer end into the sheath or wrapping on the base of the leaf. Then you have a link. Can you make a chain out of white pine leaves?

Other Evergreen Trees. — In arbor vitæ the smallest twigs are almost covered with scalelike leaves that overlap like shingles on a roof. How old are the leaves when they fall?

How many kinds of evergreens do you see on your way to school? What is the most common kind in your woods? What kinds are grown on the lawns of your town?

Besides pines and pinelike trees, what other evergreens grow in your woods?

XX. PINE CONE

Material. — Pine cones that are ripe, but not yet open. Cut off a few scales from the bottom of each cone, so that the other scales can be easily removed.

Months before a pine tree ripens one set of seeds, it blossoms and starts another crop; and until the seeds are ready to grow, it keeps them safely locked within scaly cones where only a squirrel or a crossbill could steal them.

Observation. — On what kind of pine did the cone that you are studying grow? What is the length of the cone? What is its diameter? What is its color? Is it smooth or rough? What markings do you find on its surface?

Pick a cone to pieces. Of what is it composed? How are the scales arranged in a cone? In removing them, at which end did you have to begin? What is the size of a scale? What is its shape? What marking do you find on its upper end?

How many seeds are under each scale? What is the size of a pine seed? What is its shape? What is its color? What arrangement has a pine seed for being carried away after the cone opens?

Drawing and Composition. — Describe the fruit of a pine tree. Make a picture and also a paragraph about each of the following topics: —

The whole cone.
A scale from the cone.
A seed.

SUPPLEMENTARY WORK

Pine Flowers. — A pine tree bears blossoms, but its flowers are not showy. One kind of flower is a cluster of small tassels or balls that give off a yellow dust, or *pollen*, when the twig is shaken. Look for these flowers on the sides of the newest shoots in late spring.

Another kind of flower is the young cone. It may often be found on the same twig with the tassels. At first the young cones are soft, and purple or yellow in color. They must get pollen dust from the tassel flowers before they can grow and produce seed. This dust is brought to them by the wind. The cones grow through two summers and ripen their seeds in the fall, a year and a half after they begin to grow. During the following winter they open and set the seeds free.

Spruce Cone and Seed

Pine Seeds. — Lying flat under the scales are the winged seeds. Until the seeds are ripe, the scales are pressed tightly together. Put a few unopened cones on a shelf where they will dry. In a few days

they will open with sharp clicks, and the seeds will begin to drop out. Wet a cone that has opened; it will close up and open again when it becomes dry once more.

Pine seeds are light, and, owing to their wings, are readily blown about by the wind. So young pines spring up many rods away from the parent tree.

YOUNG CEDARS AROUND PARENT TREE

Cones on Other Evergreens. — All kinds of pine, spruce, fir, hemlock, cypress, and arbor vitæ bear their seeds in cones. What is the difference between the cones on a pitch pine and those on a white pine? Could you tell the cone of a white pine from the cone of a Norway spruce? What is the difference between a hemlock cone and a pine cone? How large is the cone on an arbor vitæ? How large are the seeds of an arbor vitæ?

How do cedars bear their seeds? What is the difference between cedar seeds and pine seeds?

Do you know a cone-bearing tree that sheds all its leaves in the fall?

XXI. APPLE BRANCH

Material. — Some whiplike shoots that grow along the larger limbs of apple trees. Choose those shoots that have branches on their sides.

Observation. — Notice the apple twig just above its highest branches. Do you find the appearance of a joint? (The joint stands between the growths of two seasons.) What marks do you find on the bark at the joint? Do you find other joints on the branch? How old is this branch? How long is the part that grew during the last summer?

On the wood that grew during the last season how many buds do you find? How are they arranged on the stem? How far apart are they? What is the size of a bud? What is its shape? Do you find any buds on two-year-old wood?

Below each bud is the scar left by a fallen leaf. What is the shape of a scar? Do you find leaf scars anywhere except under a bud? How many leaves did the branch bear during the last season?

How many branches do you find on two-year-old wood? How long is the largest of those branches? How long is the smallest? On what part of the last season's growth do you find the longest branches, on the half the nearer to the tree, or on the half the farther away?

Drawing. — Draw a picture of the apple twig so as to show how it grew during the last two years. Draw its joint, its buds, its leaf scars, and its side branches.

Composition. — Write a description of the last two years' growth of the apple twig. Make the first paragraph about its joint, the second about its buds, the third about its leaf scars, and the fourth about its side branches.

SUPPLEMENTARY WORK

Joints. — An apple branch grows in yearly lengths which are marked by joints. By counting the joints you can tell the age of the branch. After several years the joints disappear because of the growth of the wood and bark. See for how many years you can trace the joints back from the tip end of a large branch of an apple tree.

Buds. — When a newly grown stem is only a few weeks old, it prepares all the buds that will ever appear on that part of the stem. Like a pine, it places a bud on the tip of each branch, but instead of placing the other buds around the end bud as a pine does, it scatters them over the whole length of the shoot, placing one above each leaf. What is the difference between the buds on the side of an apple branch and those on its end?

Carefully peel a bud and a little bark from the wood of a twig. Do you find any mark on the wood under the bud?

Usually, only those buds at or near the outer end of a shoot open and grow. The rest stand still unless the end of the limb should be broken off. Then the buds on the part that is left may grow, even if they have waited four or five years for the chance. Look for the unopened buds on a large apple branch. How old are the oldest buds that you find? What

THREE-YEAR-OLD APPLE BRANCH

is the difference between the buds on the older wood and those on the newest wood?

Branches. — From each opening bud there grow a woody shoot and a number of leaves. From the bud on the end of the twig another length grows on the stem, and from the buds on the side of the stem there grow branches. Each bud that grows usually opens in the spring after it was formed. So side branches are usually one year younger than the stems on which they grow.

If all the shoots that start should keep on growing, the tree would soon become a solid mass of branches; but only a few grow to much size. Why is this?

Even though only a few branches grow large, an apple tree usually has too many limbs. For this reason farmers prune their trees by cutting out the inner limbs so that the leafy parts are like a shell over a hollow center. Then the branches that are left will get more food and sunlight, and will be the more likely to bear good fruit.

On the sides of the large branches you may often see

short, rough twigs. These are stunted branches that grow hardly the width of a joint in a year.

If the whole top of an apple tree is cut off, new shoots will spring from the trunk even where there are no buds, and the bark is thick and dry. Along the upper side of large branches whiplike shoots often spring up. These shoots take food that should go to the fruit, and so the farmer keeps them cut off.

Why an Apple Tree grows crooked. — A year-old apple seedling is a single straight stem with a bud on its tip. For three or four years it usually grows with a central straight stem like a pine. It would keep on growing so, if the bud on the tip of the stem always grew to be a strong shoot. But sometimes the bud becomes an apple instead of a shoot. Sometimes the bud is broken off, and sometimes it is injured by insects. Then the tree has to grow by means of its side branches, and so grows crooked.

How is a pine bud protected so that it seldom fails to grow?

Leaf Marks. — On many trees the scars left by the fallen leaves show much more plainly than on an apple tree. Look at the scars on a horse chestnut, hickory, or ailantus tree. How are they different from the scars on an apple branch? The scars are shaped like the base of a leaf stem, and in no two kinds of trees are they quite alike.

XXII. APPLE FRUIT SPUR

Material. — Apple branches from the ends of fruit-bearing limbs.

Observation. — On the apple twig do you find short, swollen lengths that look as if something had been broken from their ends? These are spurs on which apples grew. How many spurs do you find? Look at one of the largest spurs. What is its length? How much larger around is it than the stem on which it grows? Has it a shoot on its side?

How many round scars do you find on the tip of the spur? From each scar an apple fell. How many apples tried to grow on the twig last summer?

Notice the buds on the ends of the side branches of the twig. Are some of them much larger than others? The large ones are probably blossom buds. How many blossoms would the twig probably have put forth next spring?

Drawing. — Draw a picture of an apple fruit spur. Show the scars on its end, the shoot on its side, and the blossom bud, if there is one.

Composition. — Write a history of the fruit spur. Describe the spur and tell what you can about the apples that it bore. Tell what you think would have grown from it next year if it had not been cut off.

SUPPLEMENTARY WORK

How Fruit Spurs grow. — From each apple blossom bud there grows a fruit spur which bears from three to five blossoms on its end, and leaves on its side. The spur reaches the length of about an inch by the time the blossoms open, and then it grows no more in length but becomes larger around than other shoots. All further lengthening of the branch beyond the place where the apple grew goes on by means of a shoot from the side of the spur. The spur itself always looks as if it had been broken off.

YEAR-OLD FRUIT SPURS AND SIDE SHOOTS

Apple Scars. — Soon after the blossoms fall most of the young apples also fall, leaving scars which may be seen for some weeks. The older apples in falling leave scars which may be seen for months or years afterward. You can tell the scars left by the ripe apples by their very large size. Usually only one apple on each spur grows to much size, and only about one spur in ten ripens an apple. If every blossom produced a ripe apple, the limbs would break beneath their load.

Side Shoots. — Within a week or two after the blossoms fall the young spur usually sends out one or two side shoots. When do side shoots usually start on other branches?

A side shoot usually becomes only a short stub in its first summer's growth if an apple ripens; but if the apple falls early, the shoot may grow six inches or more, and after a few years may become a large limb.

Blossom Buds. — In the same year that a fruit spur ripens an apple, its side shoot usually makes no blossom bud. The next year the shoot usually grows in length and makes a blossom bud on its end, and in the following year forms an apple. Hence a branch seldom bears ripe apples more often than every second year. If all the branches bloom in one year, the tree will not bear apples the next year. When a tree bears every year, half of its branches blossom in one year and the other half in the next year.

Apple Branch with Fruit Spurs

The side shoot on a spur from which a green apple falls may form a blossom bud in the same year that the apple grew. Hence a second blossom may appear in the next year after the first one opens. Have any of the fruit spurs that you observe blossom buds on their side shoots? Did any of the spurs with blossom buds ripen apples last season?

Age of Fruit Spurs. — The age of fruit spurs and their branches may be read in the same way as the age of other shoots, if we remember that a side shoot, up to its first joint,

is of the same age as the spur on which it grows. Look at an apple twig and read its history. How many ripe apples has it borne? In what years did it bear them? How many green apples has it borne?

Notice an apple tree that has failed to bear fruit. Do you find fruit spurs on it? Does the tree need pruning? Have insects injured the tree? Is the soil poor?

Fruit Spurs on Other Trees. — Look at a pear branch. The joints, fruit spurs, and fruit scars are marked on it even more plainly than on an apple branch.

Do peach trees bear their fruit on the ends of their shoots or along the sides? On peach trees the fruit buds are usually in threes. The two outer buds become blossoms, and the middle one produces leaves. Are peaches borne on new wood or on last year's wood? Look at a peach tree in winter and notice the short, dead stems that bore peaches in summer.

XXIII. EARTHWORM

Material. — Earthworms in a box of damp soil. During the study period have each pupil place a worm on a piece of moist blotting paper. At the end of the lesson turn all the worms loose on mellow soil.

Observation. — How many inches long is the worm that you are studying? What is its shape? What is its color? How many joints has it? How is its head end different from its tail end? Does its back look different from its under side? Where is its mouth? Has it eyes?

Look for a vein on its back and another on its under side. Count the number of beats that the veins make in a minute. How many does your own pulse make?

How does a worm travel? Touch its head and see if it will travel backward.

Drawing and Composition. — Draw a picture of an earthworm, and then write a paragraph about the body of the worm, another paragraph about its pulse, and a third paragraph telling how it travels.

SUPPLEMENTARY WORK

Wormholes. — An earthworm lives in the earth, in a smooth tunnel which it makes by swallowing the soil and casting it out again.

If there is a cellar being dug near you, you can probably see wormholes in the firm earth on its sides. Are the holes straight or crooked? They are often close together, and reach to the bottom of the cellar, so that they look like the roots of trees.

Habits of Earthworms. — Put some earthworms in a box of damp soil and cover them with black paper or cloth, to keep out the light. Feed them with small bits of cabbage leaves or fat meat, and keep the ground moist, but not soaking wet.

EARTHWORM

Take the cover off from the box of worms without jarring the box. While you watch them, what do they do? Do they eat? Do they seem able to see anything? Clap your hands together. Do the worms seem to hear? Tap on the box. Do the worms seem to feel the jar?

An earthworm gets some food from the soil which it swallows, but at night it often lies stretched on the ground in search of bits of leaves and scraps of vegetables and meat for food. At daylight it stops the mouth of its tunnel with pieces of grass and leaves and lies quiet near the surface of the ground.

Watch a robin search for worms in the morning. How hard does the bird have to pull in order to get the worm out of the hole? Does a worm ever prove to be the stronger and get away?

An Earthworm's Work. — After a rainy day our paths and lawns are often almost covered with little heaps of dirt that earthworms have cast up from their holes. The earth thrown out during the summer is enough to cover the ground nearly a quarter of an inch deep. Thus worms plow the soil for the farmer and enrich it by burying grass and bones and everything else that lies on the ground. They loosen the soil to a greater depth than man can reach with his plow, and they open ways for plants to reach down many feet through soils too firm for their roots alone to pierce.

How Earthworms travel. — As you hold an earthworm with one hand and gently pass the thumb and forefinger of the other hand along its body, you may feel two rows of little spines. In order to feel them the more plainly, which way must you pass your fingers, toward its head or toward its tail? These spines are a kind of feet. A worm travels up and down its smooth tunnel by thrusting forward the front half of its body and holding by its spines while it draws up the hinder half.

An Earthworm's Blood. — If a large earthworm is kept warm and moist, you can plainly see the pulse beating in its blood tubes. In which vein does the blood flow toward the head, in the one on its back, or in the under one?

An earthworm breathes through its skin. If its skin becomes dry, the worm soon dies. Why?

XXIV. ONION

Material. — Onions cut in two lengthwise. If the halves are dried for a week, their layers may be more plainly traced.

Observation. — How thick are the outer wrappings of the onion? What is their color? How many roots has the onion? What is the shape of the roots? Do you see any green leaves on the outside of the onion?

How many layers do you see on the cut side of the onion? How thick is one of the layers? To what are the layers fastened? What is their color? Where are the leaves inside of the onion? Where is the stem to which they are fastened? What is the shape of the stem? Of what is the greater part of the onion composed, stem, leaves, or roots?

Drawing and Composition. — Draw a picture and write a description, first, of the outside of an onion, and second, of the inside of an onion that has been cut in two lengthwise.

SUPPLEMENTARY WORK

Seed Onions. — An onion plant blossoms and bears seed. If a seed is planted in the spring, a new onion forms during the summer. In the fall its leaves die, but the onion itself consists of new leaves and a flower stalk, wrapped into a ball called

a *bulb.* If the onion is set in the soil again in the following spring, the new top quickly lifts itself up from the bulb, before other plants can get a start. Cut an onion in two crosswise. The white layers are leaves stored full of food which the green or yellow leaves use in their growth. Does each of the white layers reach all the way around an onion? If the onion were set out again, what would the yellow center become?

Lily Bulb cut in Two Lengthwise

Let an onion bulb lie on the window sill for a few weeks and watch it as the new leaves grow out. Does the bulb grow larger or smaller? After its leaves have sprouted, is the onion good for food? When the tops reach their full size, how much of the bulb is left?

Top Onions. — Some kinds of onions produce small bulbs on the tops of their seed stalks. If one of these bulbs is set in the soil, it grows and becomes a large onion, and then sends up a shoot which will bear small bulbs instead of seeds. Some of the small "seed" onions that are sold for growing an early crop are raised in this way, but most of them are small ones that were raised from seed late in the fall, and were pulled up while they were still small.

Multiplier Onions. — One kind of onion, when it reaches its full size, breaks up into from two to five smaller bulbs. If

one of these small bulbs is set out, it will grow large and then will split itself up into smaller ones as the first onion did.

Lily Bulb. — A lily blossoms and bears seed. On the sides of the stalks of one kind, the tiger lily, are small black bulbs like the bulbs on top onions. But lilies commonly grow from underground bulbs like multiplier onions. Each lily bulb is like an onion. In its center it contains leaves and blossom buds. Early in the season the leaves spring up and the blossoms open, and then the tops may die; but growth still goes on, for the plants spend the rest of the summer in forming new bulbs and in storing them full of food for next year's growth. Thus a lily is sure of making a good growth for at least another year.

Get a Chinese lily and place it on some stones in a dish of water. In about a month it will produce as large leaves and blossoms as if it had been planted in the soil. Where does it get its plant food? Will new lilies grow from it next year? Each bulb has enough food stored away to form full-grown leaves and blossoms, but not enough to form new bulbs unless it gets new plant food from the soil.

Hyacinths. — Hyacinths are among the common flowering bulbs that are easily and quickly raised. Set out some hyacinth bulbs in flowerpots and watch them as they unfold their leaves and blossoms.

How many kinds of bulbs do you know?

Bulblike Parts of Plants. — A potato is not a bulb, but is the thickened part of an underground branch. Its "eyes" are buds. Put a potato in a shallow dish of water in a sunny window; it will turn green like any other branch, and its eyes will put forth leaves.

Is a turnip a bulb, a branch, or a root?

XXV. MAPLE SEED

Material. — Maple seeds, brought by the pupils if possible. Look for them on the ground around sugar maples or Norway maples.

Observation. — What is the size of this seed? What is its shape? What is its color? What markings do you see on it? Where is the part that sprouts? What is the size of that part? What is its shape?

Pick the shell from a seed. How many coverings are around the plant that is within? How thick is the inner covering? What is its color? How does it feel to the touch?

Unfold the seed plant. What is its color? How long a stem has it? How many leaves has it? How large is a leaf? How thick is it? How are the leaves packed away in a seed? Do you find a small bud between the leaves?

Drawing. — Draw a picture of a whole maple seed, and another picture of the seed plant as it looks when it is unfolded.

Composition. — Write a description of a maple seed, following these topics: —

The whole seed.
The seed coverings.
The seed plant.

SUPPLEMENTARY WORK

How Maple Seeds sprout. — Maple seeds usually sprout while they lie on the top of the ground, or are only lightly covered. Scatter a number of maple seeds on some soil in a box in the schoolroom, and keep the earth wet; or bring some sprouting seeds to school and plant them in the soil. The first leaves that appear are those that were already formed within the seed. Watch the plants as they unfold from their coverings, while their stems lengthen and grow downward into the soil. Then see how the tiny bud between the first leaves grows and becomes a second pair of leaves. How do the second pair of leaves differ from the first pair?

Seeds and Seedling of Silver Maple

The First Food of a Seedling Maple. — Watch the first pair of leaves on a growing seedling. As the plants grow, the leaves become thinner and thinner, for their substance goes to make the stem, roots, and second pair of leaves, until the roots can fix themselves in the soil. Finally only their yellow skins are left. Plant some maple seeds in sand. Then the seedlings can not get much food except from the seed leaves. See how large the plants will become.

Seeds sprouting under Parent Trees. — What kind of maples are growing along the sidewalks near your home? Look under and around them for their seeds. All through the year you

can usually find maple seeds and young maples along fences and hedgerows near the parent trees. The seeds of Norway maples and sugar maples ripen in the autumn, and, as they fall, are scattered by the wind. They lie on the ground all winter and sprout when they are soaked by the warm rains of spring. Their stems sometimes lengthen so fast in a single night that the whole seeds are lifted upright from the ground, before their coverings have fallen off. Then you may see the winged seeds standing upright around the parent tree, and swaying in the wind like dancing children.

Sprouting Seeds of Norway Maple

The seeds of silver maples ripen in early summer and sprout almost as soon as they fall.

What becomes of Seedlings. — A parent tree sows great numbers of its seeds over the surrounding soil, but although most of them may sprout, only a few that fall on the best places will become large trees. Weeds and grass will choke many before they get a start, and those that do grow will soon begin to crowd one another. In a clump of seedlings that have grown for three or four years a few trees will be large and strong, and between them will be many that are slender whips, and others still smaller that have been crowded to death. After twenty years only a few of the largest trees will be left. Their trunks will stand far apart, but their branches will meet in a canopy overhead.

Other Sprouting Tree Seeds. — In the spring look for young cherry trees sprouting from the pits of fallen fruit. What is the difference between maple seedlings and cherry seedlings?

In the fall look for sprouting oak seeds. Acorns lie on the ground and send their roots into the soil like maple seedlings.

Raising Trees. — When America was settled by white men a large part of the land was covered with valuable forests. Are many of the trees left near you? Do you know of any unused lots on which trees are springing up from seed? Have the young trees grown much since you can remember? A young white pine or wild cherry tree will grow about two feet in each year, and will become a good-sized shade tree before a boy becomes a man. Men plant tree seeds in order to raise a crop of trees for lumber, or shade, or ornament.

In the fall plant a row of peach pits in your garden. Care for the seedlings as you care for vegetables, and you will soon have valuable fruit trees to set in your yard.

Wild cherries, blackwalnuts, chestnuts, maples, and oaks are among the trees that may readily be raised from seed.

XXVI. SPROUTING BEAN

Material. — Some beans that have been soaked in warm water over night, and some sprouted beans. Plant some beans next to the glass in a tumbler of moist sawdust, so that they can be easily seen while they sprout. Wrap thick paper around the glass to keep out the light. Give the lesson when the beans are breaking through the surface of the soil.

Observation. — What part of a bean plant first appears above ground? When the upper end of a bean plant appears, how many leaves has it? How great a part of the bean that was planted comes up with the new plant? How large is the stem of the plant? What becomes of the outer skin of the bean?

Split open a fresh bean and find in it the first pair of leaves that will appear above ground. How great a part of the bean do the leaves form? Find the beginnings of a stem and of the second pair of leaves. In what part of the bean are they? How large are they? Does the stem point toward the hollow, or toward the back of the bean?

Drawing. — Draw a picture of the inside of a split bean. Make this picture large enough to show the young plant that is in the bean. Draw also a picture of a bean plant that has just come up.

Composition. — Write a paragraph describing a young bean plant, and another paragraph about the plant as it appears in an unsprouted bean.

SUPPLEMENTARY WORK

How a Bean comes up. — In every seed a young plant is wrapped up just as a plant is wrapped in a bulb. In only a few other seeds can the new plant be so plainly seen as in a bean.

When a bean sprouts, the growing stem lifts the whole bean above ground. How is the sprouted bean changed in color?

SPROUTING BEANS

What becomes of the first pair of leaves on a bean plant? How soon after the bean comes up do the second pair of leaves appear?

How Some Other Seeds come up. — Plant some peas as you did the beans. When the new pea plants appear do the seeds

rise above ground as the bean seeds did? What is the shape of the first pea leaves that appear?

Plant some kernels of corn. Where is the kernel after the young shoot has come up? What is the shape of the first shoot that appears above ground?

Keep some grains of corn in a moist sponge for a few days, and look at the young sprouts when they first appear. What is the shape of a corn sprout? What is its color? Does it grow toward the top of the kernel, or toward the small end? Does it split the kernel open or grow from its side?

Plant some onion seeds. You will see something interesting when the new shoots appear above ground.

Open the kernel of a peanut and see if you can find the stem and leaves of a young plant in it.

Direction of Growth. — Turn the tumbler in which a bean is growing on its side for a day or two. In which direction does the bean stalk now grow? Turn the tumbler upright again. What does the stem do now? In which direction does a stem always grow? In which direction does the root grow?

Which side up should you plant a bean so that the root end of the stem will not have to turn in order to grow downward? Does the position of planting a bean make any difference with its coming up?

Climbing Vines. — How does a bean vine climb a pole? Does it twine around a pole in the same direction in which the hands of a watch move, or in the opposite direction?

In which direction does a hop vine twine?

How does a pea vine climb a bush?

How does a grape vine support itself?

How does an ivy hold fast to a wall? How does the Virginia creeper cling?

XXVII. MAPLE BUD

Material. — Blossom buds from Norway maples or sugar maples. Choose those that are just bursting. Horse-chestnut buds may also be used.

Observation. — Look at a maple bud that is about to open. How large is it? What is its shape? What is its color? Has it changed since winter? What is the difference between a blossom bud and one that has leaves only? Which kind opens first?

How many scales are on the outside of a maple bud? How large is a scale? What is its color? How thick is it? How does its surface feel to the fingers?

Cut a bud in two lengthwise. Do you find any leaves in the bud? Do you find any blossoms? How are the leaves and blossoms packed away?

Drawing. — Draw a picture of an opening maple bud, and another of the inside of a bud that is cut in two lengthwise.

Composition. — Write a description of an opening maple bud, making a paragraph about each of these topics: —

The whole bud.
Its scales.
The parts inside the bud.

SUPPLEMENTARY WORK

Contents of Buds. — In every bud there are leaves and a stem, and in many there are blossoms also. These parts are wrapped

Blossom Buds of Norway Maple

in fuzzy or sticky scales, so that they are well protected from the wind and rain.

How Buds grow. — Watch a young shoot growing from a bud. When sap begins to flow in spring, the stem within the bud lengthens into a shoot. Within a few weeks the new shoot usually grows to be as long as it ever will be. At first

it is soft and watery, but during the latter half of summer it uses its food in hardening its wood and in forming buds for next season's growth.

Which tree blossoms the earlier in spring, the Norway maple or the silver maple? In the silver maple which appear first, leaves or blossoms?

BLOSSOM BUD OF NORWAY MAPLE EXPANDED

A Cabbage is a Bud. — A cabbage head is a giant bud on the top of a stalk. Look at the next cabbage that you have for dinner. Its central stem and leaves are like the stem and leaves of a maple bud, but it lacks a scaly covering. If a cabbage is allowed to grow, the stem within the head lengthens into a tall stalk which has the leaves of the head arranged a few inches apart along its whole length. This stem bears flowers and seeds.

What other garden vegetables grow in heads, or buds?

Age Marks. — When a bud opens, its scaly coverings fall and leave scars on the bark. The scars, instead of remaining close together, are drawn a little apart by the growth of the central stem, so that they form a ring about an eighth of an inch across. These rings are formed wherever a bud stood and show the beginning of each year's growth. (See p. 95.)

Buds are like Bulbs. — Buds and bulbs are much alike. In both, while this year's crop of shoots, leaves, and blossoms are

CABBAGE CUT IN TWO LENGTHWISE

growing, a new crop is started and wrapped in the bundles which we call *buds* and *bulbs*. In bulbs, the food for the spring growth is stored in the outer layers of the bulbs themselves. Buds have no store of food, but are fed by sap from the roots.

XXVIII. TADPOLE

Material. — Tadpoles kept in a shallow pan of water with a little sand and mud, and a water plant, so that they shall have a home like their pool. Look for them about the first of May along the edges of shallow pools and ponds. After three or four days it will be well to return them to their pool of water and get new ones, for they are not likely to thrive in a room.

Observation. — How large is a tadpole? What is its shape? What is its color? Is its under side colored like its back? How many eyes has it? Where are its eyes? What is the shape of its mouth? How long is its tail? What is the shape of its tail? Has the tadpole legs? How does it travel? Does it stay under water all the time?

Drawing and Composition. — Write a description of a tadpole, and tell what it did for ten minutes while you watched it. Illustrate your work with a picture of a tadpole.

SUPPLEMENTARY WORK

Eggs of Frogs and Toads. — Tadpoles hatch from eggs that are laid mostly by frogs and toads in shallow water early in spring. The eggs look like drops of gelatine with a large black spot inside of each. Toads usually lay their eggs in strings, and frogs lay theirs in bunches that look like handfuls of grayish jelly. Collect a few and watch them as they hatch. You can tell young toads from young frogs only by the blacker color of the toads.

The eggs may usually be found some time in April. The earlier warm weather comes, the earlier frogs and toads lay their eggs. You may mistake fishes' eggs for frogs' eggs. The eggs of fish are colorless or white; the eggs of toads and frogs are brown or black.

Stages in the Life of Tadpoles

Tadpoles. — Tadpoles seem to be the heads of toads without their bodies. Look up the word tadpole in the dictionary, and see from what two old words it comes.

A young tadpole breathes by gills, like a fish, but as it grows

older lungs begin to form. Why do the larger tadpoles come to the top of the water once in a while, and after a moment, wiggle back again? Why do they make you think of wigglers?

A Tadpole's Changes. — Before school closes for summer you may find tadpoles with legs sprouting from their bodies. Which sprout first, the hind legs or the fore legs?

Has a full-grown toad or frog a tail? A tadpole's tail does not drop off, but its substance is carried by the blood to feed the growing legs.

Some kinds of frog tadpoles remain tadpoles for over a year, and do not change to frogs until the next summer.

You may have seen a footpath or road covered with small toads after a rain. Great numbers of toad tadpoles are hatched in every pool. In June or July they become full-grown and leave the water. They lie in the shade on hot days, but after a rain they often swarm over our paths and roads.

FULL-GROWN FROG

What Toads eat. — A toad is a friend to the farmer, for it eats many harmful bugs and worms, and does no harm. Then, too, the toad eats mostly at night, when the bugs are feasting and while the birds are asleep.

Watch a toad some evening. If you are quiet and gentle, it may dart out its tongue and catch a fly.

Frogs and Toads in Winter. — When cold weather comes a frog goes down deep into the mud, and a toad buries itself in soft soil below frost. Both sleep through the winter, and in early spring come out as lively as ever. You may know when they have wakened, for they at once begin to use their voices.

Frog and Toad Voices. — Notice the different kinds of sounds that frogs and toads make. Many of the peeping sounds that come from swamps in spring are made by toads. The shrillest peep of all is made by a tree frog. The common green-backed frog makes a lower-pitched peep, or a croak.

On an evening in early spring listen to the sounds that come from a marsh. How many kinds of frog and toad voices do you hear? On what date did you hear the first one in spring? How late in summer have you heard them?

On summer evenings you may often hear toads peeping and tree toads trilling in orchards and meadows.

Tree Frogs. — Several kinds of frogs live in trees, but they are usually called tree toads. In the place of toenails the ends of their toes have flat suckers for climbing. The animals are mottled gray and black, and look so much like a bunch of moss that it is almost impossible to find one even though it may be plainly trilling its notes close by.

Salamanders. — In quiet pools and damp woods you may sometimes find black or brown creatures about four inches in length that look something like small alligators. These are *salamanders*, but are often wrongly called lizards. They lay their eggs in the water, and their young look like the tadpoles of frogs, and pass through the same stages of growth, except that the salamander tadpoles do not lose their tails when they get their legs.

XXIX. WATER STRIDER

Material. — Some water striders in a large dish of water, covered with a pane of glass, to prevent them from flying away. Catch them with a net made by sewing a bag of cheese cloth to a stout wire bent into a circle, and fastened to a pole. At the end of the lesson return them to their home.

Pins and sewing needles will also be needed.

Observation. — How large is a water strider? What is its shape? What is its color? Has it wings? What is the shape of its mouth parts? How many legs has a water strider? What is their shape?

What is the shape of the part of a water strider's leg that touches the water? Does the insect get its feet wet while it is walking on the water? How does the surface of the water look where a leg rests upon it? How much does a water strider disturb the water when it moves?

Carefully drop a small needle on the surface of a cup of water. Can you make the needle float? Try a pin also. How does the surface of the water next to the needle look? Does the water wet the needle? See if you can make a wet needle float. Does the water strider float as the needle does?

Drawing. — Draw a picture of a water strider as it looks when it is walking on the water.

Composition. — Write a paragraph on each of these topics : —

Description of a water strider.

The surface of the water around a water strider's legs.

A needle floating on water.

SUPPLEMENTARY WORK

How a Water Strider Acts. — If you see a long-legged insect walking on the water with only its feet touching the surface,

WATER STRIDER AND PIN FLOATING

you may know it to be a water strider. Can you catch it easily ? How fast can it travel ? What is one usually doing ?

Drop a fly on the water and see what the water strider does. Do you see a dent or dimple on the surface of the water under each foot of a water strider? The insect does not swim through the water, but walks on the top of it.

On a sunshiny day you may see a bright ring around the shadow of each foot of a water strider. What makes the ring?

Whirligig Beetles. — Wherever you see water striders you are likely to see crowds of small, black beetles, on the surface of the water, darting to and fro. They swim on the top of the water so fast that they appear to be whirling round and round. They can dive and fly as well as they can swim. Catch one, if you can, and look at its paddlelike feet.

Flying Insects under Water. — Sweep the grassy edge of a pond or pool with a scoop net. Among other interesting things you will be likely to get winged insects that live under water most of the time. One kind is a brown, flat insect, two inches or more in length, and is called a *giant water bug.* These bugs often fly around bright electric lights at night.

You may also catch two other kinds of smaller flying bugs. One swims on his back and is called a *back swimmer.* Another, the *water boatman*, keeps one pair of legs thrust out sidewise, and uses them as if they were oars. When under water, all these bugs carry, beneath their wings, a supply of air for breathing. This air under water gleams like silver.

Mosquito Destroyers. — Water striders and whirligig beetles live on other insects which they catch on the surface of the water. They are fond of wigglers, and catch great numbers of the malarial kind, for these wigglers float with their backs halfway out of water. The back swimmers and water boatmen catch all kinds of wigglers under water. Few mosquitoes can grow in pools where these four kinds of insects live.

XXX. DUCKWEED

Material. — Duckweed floating in a dish of water. Give this lesson while waiting to use a subject which, like the lesson on maple buds, must be given in the course of the few days during which the specimens are in the proper stage.

Observation. — How large is a duckweed plant? Has it a stem? How many leaves has it? How large is one of the leaves? What is its shape? What is its color? How are the leaves joined together?

How many roots has a duckweed plant? How large is a root? What is its shape? What is its color? Are the roots single or branched? To what part of the plant are they fastened? Are their lower ends fastened to anything?

Drawing and Composition. — Draw a picture and write a description of a duckweed plant.

SUPPLEMENTARY WORK

How a Duckweed Grows. — A duckweed plant consists of three or four small leaves which float on the water, and a few slender roots which hang loose in the water. The whole plant is smaller than a fingernail, but it is often so plentiful as to form a green covering on the water. Why do you not find it in the middle of an open pond?

Duckweeds increase in number by new leaves that grow from the edges of the old ones. Do you find any of the small new leaves on the plants that you observed?

DUCKWEED AND A SNAIL

Leaf Shapes of Water Plants. — Besides duckweed, what other plants have you seen growing with their leaves afloat on the top of the water? What is the shape of the leaves of pond lilies? What is the shape of most floating leaves?

Do you find any plants having some of their leaves floating on the water, and other leaves growing under water? How do these two sets of leaves differ in shape?

How stiff is the stem of a pond lily? Why does a pond lily not need a stiff stem? What is the stiffness of the stems of most plants that float on the water or grow beneath it? In what way might stiff stems be bad for the plants? How stiff

are the stems of most plants that grow in swiftly running water?

Pond Algæ.—Wherever you find duckweed growing, you will also be likely to see a green scum floating on the water and covering sticks and stones with waving tufts. This is a kind of *pond alga.* Take some in your hand, and see of what it is made. Do you see separate threads as fine as the finest silk? Examine some of the threads with a microscope. Do you see beautiful spirals of green running along each thread?

Snails.—Along with duckweed you are quite likely to find water snails clinging to leaves and sticks. You may know them by their spiral shells. Some will be as small as pin-heads, and you may see others as large as your thumb. They eat green leaves, and especially algæ.

XXXI. APPLE BLOSSOM

Material. — Apple twigs in blossom. Just before the blossoms appear review the lesson on apple fruit spurs.

Observation. — From a single apple bud how many blossoms grow? How long a shoot grows from it? How many leaves grow from it? Which come first, leaves or blossoms?

How large is an apple blossom? What is its color? Has it any odor? How many colored petals has it? What is the shape of a petal? What finally becomes of the petals?

How many pinlike stalks are within the ring of the petals? Are the stalks all alike, or do you find two kinds? What is the difference between the two kinds of stalks?

What is the shape of the part to which the petals are fastened? This part is called the *calyx*. What is the color of the calyx? How many points has the upper edge of the calyx? What becomes of the calyx after the petals fall?

Drawing. — Draw a picture of an apple blossom bud that has just opened. Draw a picture of a single blossom, showing all its parts.

Composition. — Write a description of an apple blossom. In the first paragraph name everything that grows from a blossom bud, in the second, describe the colored part of a blossom, in the third, describe the small stalks in the center of the blossom, and in the fourth, describe the calyx.

SUPPLEMENTARY WORK

Parts of an Apple Blossom. — In an apple blossom you can easily see three distinct parts.

First, there is a ring of beautiful white or pink petals. How long do they remain on the blossom? Do they leave a trace of themselves behind?

Apple Blossoms

Second, within the ring of petals are two sets of small stalks. Those that are tipped with yellow balls are *stamens.* How many stamens are there? How are they arranged? Touch a stamen. Does some dust fall from the ball? The dust is called *pollen.*

At the center of the blossom is another set of small stalks, each tipped with a flat sticky knob. These stalks are the upper ends of *pistils.* How many pistils are there? Some of the powder from a stamen must fall on a pistil or else the apple and its seed will not grow.

What becomes of the stamens and the stalks of the pistils

when the petals fall? Look for their remains on a ripe apple.

Third, the petals, the stamens, and the stalks of the pistils are borne on the upper edge of a green, urn-shaped *calyx*. The calyx becomes the real fruit of the apple tree, and contains seeds in its center.

Cut a blossom in two lengthwise with a sharp knife to show how its parts are arranged. To what part of the calyx are the petals joined? To what part are the stamens joined? To what part are the stalks of the pistils joined? Where are the beginnings of the seeds? Look at the blossom of a strawberry or blackberry and see if you can find parts similar to those on an apple blossom.

Bees. — Have you seen bees on apple blossoms? How many have you seen on a tree at once? What were they doing? When a bee crawls over a blossom, it gets some of the pollen on its hair, and rubs it on the next pistil that it touches. If it were not for the bees, we should not be likely to have many apples. Why?

Apples cut to show the Cores

What flowers besides apple blossoms have you seen bees visit? Look and see if you think that the bees help their blossoms to form their seeds. What other kinds of insects have you seen visiting flowers?

Apples. — From an apple-flower bud there grows a fruit spur which bears leaves and four or five blossoms. How long a time does it take a fruit spur to reach its full size? How old is a fruit spur when it puts forth a side shoot?

Only one apple in a cluster usually grows; the rest

drop off, leaving scars on the wood to show where they were.

The next time you eat an apple see if you can find the remains of the stamens and pistils, and of the starry fringe of the calyx. After you have eaten all the pulp compare the core with a bean pod.

Look at the red seed cases on a rosebush. How do they resemble apples?

Codlin Moth. — Most young apples that start to grow fall off because there is not room for all; but those that do grow meet with many enemies. The common worm that you find in wormy apples is a reddish caterpillar. This is a young *codlin moth.* The full-grown insect is a small gray moth. It lays its eggs in the top of an apple just as the blossoms are falling. The caterpillar eats its way into the apple, and about the middle of summer comes out, and makes a cocoon under the loose bark on a large branch. The best way to protect apples from this caterpillar is to spray the trees with poison just after the blossoms fall.

XXXII. OAK APPLE

Material. — Oak leaf galls of the kind that are commonly called *oak apples.* Look for them in June on the under side of the leaves on small red oaks or black oaks. Last year's dried galls that may be found among the fallen leaves may also be used.

Observation. — How large is an oak apple? What is its color? What is its shape? Is it heavy or light? What markings are on its surface? Are there any holes in it?

How thick is its outer shell? What do you find inside of the shell? What is at the center of the shell? What do you find inside of the inner kernel? Do you find signs of an insect anywhere in the gall?

Drawing and Composition. — Write a description of an oak apple. Illustrate your work with a picture of the outside of a gall, and another picture of the inside of one that is cut in two through its center.

SUPPLEMENTARY WORK

Gallflies. — About the time that your summer vacation begins oak apples will turn brown and dry. Collect some and keep them in a jar covered with muslin. In a short time a reddish fly may be expected from each gall.

In spring the full-grown flies lay eggs in the opening leaves. When an egg hatches, the leaf forms a gall around the young grub. Does a gall harm a leaf that it is on? Do you ever

find a gall on the upper side of a leaf? On what kind of oak have you seen the greatest number of galls? Do you find any on white oaks?

In June you have to look closely to find a gall, although it is fully grown. Why is this? In July you can easily find them. Why can you see them easily in July?

Oak Apples

While you looked for green galls did you find any last year's galls on the ground? Did you find anything inside of any of the old ones? How does the shell of a green oak apple taste? How does its inner spongy part taste?

Enemies of Gallflies. — Often, instead of a single red fly, you will get a number of small black flies from a gall. This is because another kind of fly often lays its eggs beside the gallfly's grub. When they hatch, the new worms eat the right-

ful owner of the gall and live in its house. If it were not for its enemies, galls might multiply and cover every oak leaf in a forest.

Other Kinds of Oak Galls. — On scrub oak and white oak twigs you may often see white spongy masses that are called *vinegar balls*, and are sometimes eaten for their sour taste. They are made up of tufts of fibers that grow from hard kernels. In each kernel there lives a young insect. Keep some of the vinegar balls in a jar to see the small black flies that come from them.

You may often find on oaks hard red galls, and also soft red galls that look like drops of gum. Look for grubs inside of them. What other kinds of oak galls do you find?

The galls on a kind of oak in Asia Minor are the gallnuts that are used in making black dyes and ink.

Swamp Apples. — On the twigs of swamp honeysuckles you may often see greenish white lumps like small apples. They look like galls, but are really a growth of something that is like a mold.

XXXIII. CLOTHES MOTH

Material. — The larvas of clothes moths in their cases, and some moth-eaten cloth. The moths may be found among old woolen clothes that have been lying undisturbed in a garret or barn.

Observation. — How large is a clothes moth? What is its color? What was the color of the cloth on which it was found?

What you see at the first look is only the case in which the clothes moth lives. Where is the opening to the inside of the case? Cut the case open carefully. How large is the caterpillar that you find? What is the color of the caterpillar?

Drawing and Composition. — Draw the picture of a clothes moth in its natural size. Write a description of a clothes-moth's case and of the caterpillar inside it.

SUPPLEMENTARY WORK

Full-grown Moths. — Keep some moths in a covered jar with pieces of woolen cloth for food. Watch the caterpillars as they come halfway out of their cases to eat. About June they will turn into small flying moths. These full-grown moths have narrow brown wings that stretch about three quarters of an inch across, and are bordered behind with fringes of fine hair. These flying insects lay eggs which hatch out the clothes-eating caterpillars.

The Moth's Case. — As soon as it is hatched the naked caterpillar makes a case for itself out of shreds of cloth fastened together with its own silk. As it grows it puts new pieces down the whole length and on the ends of its case.

Change the clothes moths in the jar to cloth of another color, so that you can see the patches as the moths add them to their old cases. Does a moth add new pieces to both ends of its case?

LIFE HISTORY OF A CLOTHES MOTH

Carpet Beetle. — Look under the edges of carpets and in boxes of old clothes for yellow grubs about a quarter of an inch in length, thinly covered with stiff black hairs. These are young *carpet beetles* or *buffalo moths.* They are becoming common, and are often doing more harm than clothes moths. Can you easily catch one, or hold it between your fingers after it is caught?

You may sometimes find the empty skins of carpet beetles, and perhaps you may see a winged insect inside a skin, for the grubs turn into hard-winged beetles and fly away. In color

these full-grown beetles are a mixture of black, white, and red, and look a great deal like small lady bugs. They live on mullein and other flowers, but in the spring they come into our houses to lay their eggs. Keep some of the grubs until they turn into winged beetles, so that you may know the full-grown insects when you see them.

Fish Moths. — In chests and boxes of clothes you may sometimes come upon shiny white insects that quickly run for cover. Their bodies are large in front and tapering behind, and are covered with silvery scales that may easily be rubbed off. They are called *fish moths* or *silver fish.* These insects often damage linen and cotton goods, especially those that have been starched.

Protection against Clothes-eating Insects. — Almost the only way to keep clothes free from moths is to clean them and pack them in tightly closed bags, or in tight boxes with paper pasted over all the cracks. Only the young insects do the damage, and if the old ones can not get in to lay eggs, the clothes are safe, for the young do not travel far.

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