NATURE
STUDY
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ONE HUNDRED LESSONS

IN

NATURE STUDY

AROUND MY SCHOOL.

BY

FRANK OWEN PAYNE, M.Sc.

" Flower in the crannied wall,
I pluck you out of the crannies;—
Hold you here, root and all, in my hand,
Little flower—but if I could understand
What you are, root and all, and all in all,
I should know what God and man is."

—*Tennyson.*

NEW YORK AND CHICAGO:

E. L. KELLOGG & COMPANY.

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DEDICATION.

TO

My Teachers,

WHOSE EXAMPLE HAS INSPIRED HUNDREDS OF PUPILS LIKE
MYSELF TO BETTER EFFORTS, AND WHOSE SUPERIOR
TEACHING STILL REMAINS IN MEMORY TO GUIDE
ME OVER DARK PLACES IN MY WORK,
THIS LITTLE BOOK
IS AFFECTIONATELY
DEDICATED.

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PREFACE.

THIS little book is not intended to be in any sense a treatise on nature study. It does not pretend to be anything more than a collection of one hundred suggestive lessons on natural objects, such as have been given in the public school at Chatham, New Jersey, during the past two years.

It will be observed that these lessons are not classified in any iron-clad order, nor are they arranged with any reference to scientific sequence. This apparent absence of classification is introduced for a purpose, i. e., it fulfils more truly the natural method of acquiring knowledge. The author has found during many years' experience that when nature study is fitted into rigid rules as to *what, when, how*, etc., it becomes very soon little else than *so many pages of some text-book* in the teacher's hands. In nature study there should be the utmost liberty of choice given to the teacher and pupil, one condition only being required, namely, that *a certain definite period be given regularly* to the study of some natural object or phenomenon.

Comenius said: "Knowledge of things near at hand should be acquired first, then that of those farther off." Taking this maxim as a keynote, the author has endeavored to present only such lessons as can be given in any school outside of large cities: Beginning (1) with things which can be studied in the school-house and grounds, selected by teacher and pupils; proceeding (2) to things farther away from the school.

The illustrations are, with one or two exceptions, the

work of the writer's pupils. It may be added that not more than ten or fifteen minutes was given nature study twice a week in most grades ; in one grade one lesson per week of thirty minutes' duration was given.

Thus it is clear that this subject need not usurp the place of the time-honored branches. Rightly used it becomes a basis for much of the language- and number-work, and is made in every sense an integral part of our school-work. It may be added that, in the writer's opinion, this work should be given regularly and systematically.

INTRODUCTION.

A FEW general principles must be observed by teachers to render lessons on nature successful.

1. It is a cardinal principle that those things should be studied which are nearest and easiest to obtain.

2. It is equally true that, so far as possible, the nature study should fit the season. Spring supplies an endless wealth of growing seeds, bursting buds, and opening flowers. Flowers and insects are very abundant in autumn, and these are naturally the best things to work with. Winter offers some opposition to study in the open air, hence dependence must be placed on materials that have been collected before the landscape is covered with its mantle of snow; the school is then left to work on minerals, dried fruits, preserved insects, the snow itself, and such other things as may be at hand.

3. It is suggested, then, that during the autumn, while the pupils are at work upon things easily found, collections of things which will keep be made for use when the snow prevents outdoor expeditions. Any ditch or gravel-pit is full of pebbles of various kinds, and often as many as twenty or thirty different kinds of stones may be found in the space of a few feet. The city teacher is no less blessed in this respect than the country teacher, for wherever a new building is in process of erection the sand has to be screened, and the piles of gravel may be laid under contribution for stores of minerals. A stock of seeds and nuts, grains and dried seed-pods, should always be laid in.

If the following lessons do not appear to possess any

logical connection, it is hoped that they will be found to possess at least *pedagogical adaptation*.

The aims of the writer are three : 1. Psychological, i.e., training the seeing, judging, discriminating, and classifying powers. 2. Informational, i.e., the acquisition of knowledge. 3. To furnish a basis in nature for work in language, numbers, drawing, etc.

Each lesson gives the pupil increased power to make observations for himself, and his mind is broadened at every step.

Suggestions.—1. The teacher should bring something appropriate for a lesson into the school-room. The pupils often bring in the very thing desired.

2. The teacher must show interest in the thing. The teacher's interest is sure to awaken that of the pupil. Enthusiasm is contagious.

3. Talk about the object under consideration. Ask about it. Lead the children to name its properties, etc. This may be done at any time before, during, or after school. Some of the most delightful lessons I have ever heard have been given in little talks at recess or noon.

4. Inquire where other things of the same kind may be found, and ask pupils to get such for you.

5. *Prepare yourself* before giving the lesson ; you should know beforehand just what you desire pupils to discover. The object must be closely examined.

6. Never make a nature lesson a set task. Make it rather a period of relaxation and recreation from the severer lessons.

7. Select the best specimen to put away in a school collection. This starts a school museum, to which many interesting curiosities will in time drift.

8. Label each specimen with the name of the giver. This will stimulate children, and so the material for lessons will become practically inexhaustible.

9. Ignore no object which the pupil brings. If there be more objects than can be used in lessons, lay them aside for the present ; they will come in play when snow lies on the ground.

In conclusion I quote from a paper by Geo. L. Clapp, of Boston, entitled "Real and Sham Observation by Pupils," printed in *Education*, January, 1892 :

"There is no lack of material in the form of leaves, seeds, fruits, vegetables, stones, shells, insects, etc., but there is a lack of understanding as to how they are to be used in *educating* the children, not simply in *informing* them. The observation lesson is confounded with, or made the occasion for, an information lesson, or a language lesson ; and there too frequently the work ends." After illustrating how this may be the writer adds : "In the study of nature the habit of investigating must be formed. In the case of primary children the work must not be heavily saddled with language. The letter killeth the spirit. A language lesson may be given on the observation lesson with the greatest advantage, but at another time." "The pupil must examine his own specimens and express in his own words what he has discovered by his own senses. From his own object he will get the best description *for him*." "A prime object of nature is to get pupils to rely on *their own* powers, and it is the teacher's duty to furnish proper opportunities and guidance when necessary."

TABLE OF CONTENTS.

	PAGE
PREFACE.....	3
INTRODUCTION.....	5
CHAPTER I.—PRELIMINARY LESSONS.....	II-13
CHAPTER II.—LESSONS ON LEAVES, PLANTS, AND FRUITS....	14-42
<i>A. Fruits:</i> The Apple—The Orange—True Berries—Stone Fruits—Nuts—The Poppy—The Milkweed—The Pod—The Key-fruit—The Cone.....	14-20
<i>General Observation on the Study of Fruits</i>	20-24
<i>B. Lessons on Seeds:</i> The Seed-coat—Advanced Scheme for Seed Study—Growth from Seeds—Subsequent Work.....	24-31
<i>C. Some Lessons on Propagation—On Size and Comparison</i>	31-35
<i>D. Flowers:</i> The Daisy—The Gentian—Other Botanical Lessons.....	35-42
CHAPTER III.—LESSONS ON ANIMALS.....	43-100
<i>Fishes:</i> The Crayfish—The Turtle.....	43-45
<i>Birds:</i> The Canary—The Chick—The Robin—The Duck—The Hawk—Clothing and Shelter—A Feather—Hair, Wool, and Fur—Nests of Birds.....	45-51
<i>The Hen's Egg:</i> Raw—Hard Boiled—Experiments.....	52-55
<i>Insects</i>	55, 56
<i>Hints as to the Order of Work</i>	56-58
<i>The Beetle</i>	58-62
<i>The Butterfly</i>	62-66
<i>A Talk About the Fly</i>	67, 68
<i>The Grasshopper</i>	68-70
<i>A Talk about the Walking-stick</i>	70-72
<i>The Cricket</i>	73, 74
<i>The Bee Family</i>	74-76
<i>Wasps</i>	76, 77
<i>Ants</i>	77
<i>Talk about the Dragon-fly</i>	78-81
<i>The Fish:</i> The Perch—The Pike—The Clam-shell—Suggestions to Teacher for Further Lessons.....	81-88
<i>Bones:</i> Some Easy and Useful Devices for Teaching Them—Feet of Fowls—Wings—Sheep's Fore Leg—Sutures and Bones of the Skull and Face—Lessons for Higher Grades.....	88-100
CHAPTER IV.—THE SCHOOL MUSEUM.....	101-105

	PAGE
CHAPTER V.—RAINY-DAY LESSONS.....	106-134
<i>Lessons on Water</i>	106-108
<i>Lessons on Teeth—Human Teeth—Carnivorous Teeth—Herbivorous Teeth—Fish's Teeth—Omnivorous Teeth—Gnawing Teeth.</i>	108-111
<i>The Exploration of a Rose</i>	111-113
<i>A Study of Celery</i>	113-118
<i>A Series of Four Lessons to Illustrate Fermentation and Distillation.</i>	119-124
<i>Ten Lessons on Common Objects: Charcoal—Sulphur—Iron—Iodine— Lime—Glass—Soap—Sugar—Rubber.</i>	125-130
<i>Suggestive Lessons on the Human Body: Parts of the Body—Joints— The Flesh and Blood</i>	131-134
CHAPTER VI.—LESSONS IN THE SCHOOL-YARD.....	135-153
<i>Lessons on a Rainy Day.</i>	135-138
<i>Temperature</i>	138-140
<i>The Leaf-bud</i>	140-143
<i>Tree-buds</i>	143, 144
<i>What can be Found under a Flat Stone</i>	144-146
<i>The Earthworm</i>	146-149
<i>The Garden-slug</i>	149-151
<i>The Snail</i>	151, 152
<i>The Millipede and Centipede</i>	152, 153
CHAPTER VII.—WALKS WITH THE CHILDREN.....	154-185
<i>A Walk in Early Spring: Quartz—Bark—Pine-needles—Pine-cones..</i>	155-158
<i>Second Walk in Early Spring: Young Maple—The Crayfish—Frog's Eggs</i>	158-162
<i>Third Walk: Trees</i>	162-177
<i>Fourth Walk: Farming—A Brook</i>	177-179
<i>Fifth Walk: A Hill</i>	180, 181
<i>Sixth Walk: The Ground—Minerals—Metals—Quarrying—Soil and Subsoil</i>	181-185
CHAPTER VIII.—COLLECTIONS DURING VACATION.....	186-192
CHAPTER IX.—DEVICES AND HELPS IN NATURE STUDY.	
BOOKS OF REFERENCE.....	193-201
<i>The Weather-chart</i>	193, 194
<i>The Weather-pole</i>	195-197
<i>Definition Cards</i>	197, 198
<i>Moisture of the Air</i>	198, 199
<i>A List of Books Helpful in Nature Study</i>	200, 201

LESSONS IN NATURE STUDY.

Chapter I.

PRELIMINARY LESSONS.

THINGS BROUGHT IN BY PUPILS.

Introductory.—Let the teacher bring to school a few objects, picked up haphazard—say, an ear of corn, a piece of leather, a chicken's foot. These things are taken, examined, and talked about. There should be no attempt at formal instruction, but the objects should be centres of observation, and pupils should be encouraged to talk about the thing under discussion. The teacher may remark that there is much to learn from all kinds of common things. She may suggest that to-morrow each pupil bring in whatever may be found, and that the class will then see what can be learned from it.

Let us suppose that the following things are brought in and placed upon the desk :

1. A Pebble.—Here is a small rounded stone. Can you tell me what such a stone is called? Are pebbles all alike? How do they differ in color and size? Describe this pebble. Why is it round? What made it round? Did you ever see a pebble rolling along where the water was flowing rapidly? If a stone were sharp and the water set it to rolling, what would become of its sharp edges? Do stones wear away very fast? Think how very old this little pebble must be to have become so smooth and round.

2. A Snail-shell.—Here is a house. Is it not a very

pretty one? Can you tell me what lived in this house? Can a snail creep out of his shell? His shell is coiled up. How many turns are there in this snail-shell? Did you ever see a snail moving along with his house on his back?

3. A Cherry.—Here are some cherries. Are they not very beautiful? Describe this cherry. How large is it? Is it sour or sweet, dry or juicy, hard or mellow, ripe or unripe? Mary may tell me how many seeds a cherry has. What do we call cherry-seeds? Can you tell me some other fruit which has pits?

4. A Baking-powder Can.—What have we here! What is its shape? Can you tell me some other object like it in shape? The waste-basket, a stovepipe, a silk hat. Of what is this can made? Is it pure tin? How do you know that the tin is only a thin layer over iron? What holds the tin together? Did you ever see a tinner solder? How does he do it?

5. Leaves.—Harriet has just brought in a large number of leaves. What kind of leaves are these? How many parts has a leaf? Can you tell me a plant which has larger leaves? What happens to leaves in autumn? Whence do they come in spring? We shall study more about leaves by and by.

6. A Piece of Slag.—Here is a piece of slag. Can you tell me what makes these holes all through it? How does this prove that slag was once melted?

7. A Bird's Egg.—See what a beautiful little egg! Can you tell me to what bird it belongs? How thin it is! It must have fallen from the nest when the wind blew.

8. A Nest.—See this nest! It is made almost wholly of horse-hair. It is a hair-bird's nest. Do you know the other name for the hair-bird? Oh, yes, it is a chippy. Could you make so fine a nest with your fingers? What does the bird use in making a nest? Is it not wonderful that she can make such a beautiful nest with only her bill and claws?

9. A Piece of Wood.—What kind of wood is this? Find

the grain. Is it a hard or soft wood? Smell it. Cut it. Some day we will learn more about wood.

10. A Living Cricket.—Here we have a cricket. We will set this bottle on the window-sill and see how the cricket moves about. Does the cricket like light? Oh, no, he prefers darkness. We may hear this cricket chirp for us.

Such talks may be indulged in from time to time until pupils begin to realize that nothing is unworthy their study. Ignore nothing. Manage to find food for talk in everything brought in.

Having gradually introduced nature study in this way, suggest that the study of things about the school-house be taken up.

Chapter XX.

LESSONS ON LEAVES, PLANTS, AND FRUITS.

A. FRUITS.

I. *The Apple.*

The apple is a type of core fruits. Apples are so common that they are admirable as objects for lessons. Another advantage in using the apple is that it is to be had all the year round.

The First Lesson.—Attend first to the external description, shape, size, color, texture of the skin, stem-end, blow-end, etc.

In the winter apples often feel quite greasy, due to the presence of a sort of oil or wax in the rind. The stem has a woody texture. The blow-end has the remains of last spring's blossom. The various kinds of apples have obvious differences. If, in getting your supply for the lesson, you ask the children to bring each one an apple, there will often be found to be a great variety on hand.

Second Lesson.—Half of the pupils may cut their apples from top to bottom exactly through the centre of the core. The other half of the class may cut theirs exactly through the centre from side to side. This will present the inside of the apple in two sections. Now have each pupil give one half his own apple to a pupil who has cut his in the opposite direction. Each child will now have two half-apples, one cut up and down, and the other from right to left, through the centre.

Study each section ; the thickness of skin, color, texture,

taste, and juiciness of the outer ring of flesh ; also the same features of the meat around the core. Compare these two kinds of meat. Study the core itself, its seed-cavities (carpels) with their shiny, horny walls.

Examine the position of the seed ; where it is attached to the cell, and how. Remove the seeds and examine them. Find their coats and seed-leaves. Find the germ. What of its position and size ? Quarter the apple and remove the core. See how easily the core separates from the outer flesh of the apple. Make drawings of the apple in its various positions ; of the sections ; of the seeds, etc.

Describe fully all you have done with the apple, illustrating your description with the drawings. Have the children talk with farmers about various kinds of apples and their culture, and bring into the class the information. Assign to different pupils different topics relative to this subject, and let them state their knowledge completely. Tell them how all our fine apples have been produced from the wild crab-apple by cultivation.

II. *The Orange.*

The orange is not native all over the country. As it is so common an article of food, it may be taken as the subject of a lesson.

This is a kind of berry. Operate on it as you did on the apple. Notice how different it is, both inside and out. The stem-end, with its little disk, which comes out ; the absence of a blow-end ; the numerous oil-glands in the skin ; the ease with which the skin peels off ; its white inside ; the sections into which the orange splits up, and the position of seeds at the centre—all are so different from the apple as to awaken interest when these distinctions are brought out. It is well to have lemons, limes, bananas, and grape fruit to present at the same time by way of contrast. In this connection it is well to devote some time to talk on the places where these fruits grow. Pictures of

orange-groves, orange-flowers, etc., are valuable aids to such lessons.

III. *True Berries.*

The orange differs from true berries in having a thick separable skin and few seeds. Gooseberries, cranberries, grapes, currants, and tomatoes are true berries, and, in their season, are excellent for study.

The cranberry is a most interesting fruit for winter study. In this fruit each child should have five or six to work on. They should be studied in the same manner as were the foregoing, but the seeds are too small to claim more than a passing notice at present. Cranberry culture is a good subject for a composition. In Maine, Massachusetts, New Jersey, Wisconsin, and Michigan the cranberry is a very important article of export, and thousands of men, boys, and girls earn their living by picking these berries for shipment. Thousands of barrels of them are shipped every year to Europe from this country.

Tomatoes are so large as to be easily studied as typical berries, *i.e.*, fleshy fruit having seeds scattered through them.

IV. *Stone Fruits.*

Peaches, cherries, plums, and prunes, in their season, are best, but dried prunes and apricots are better than none. The country teacher may have recourse to the so-called "berries" on the dogwood in the late fall. It is better to study everything in its season. There is enough in this season without resorting to dried fruits for material. If you desire to give a course of nature studies on fruits, save stone fruits till spring, when the first cherries are brought in to the teacher.

These cannot be cut through. The stone resists the knife, but the flesh can be carefully cut away and examined, as was done before. The seed in this case should be ex-

amined with care ; its outside appearance noted—whether wrinkled, as in the peach, or smooth, as in the cherry.

Crack the pit and examine the seed inside. Some stone-fruit seeds have a third skin around them.

V. *Nuts.*

Here are things which are always brought to the school. The hickory-fruit with its thick, soft, woody outside splitting away from the white-shelled nut within; the butternut with its thin brown papery covering and its very rough shell; the triangular beechnut and the spherical hazel in their flower-like burs; the horse-chestnut with its bur and large scar—are all excellent objects for winter study.

It is well to study the interior not merely by cracking the nuts, but also by sawing through with a butcher's saw. This will show beautifully how intricate is the interior of some nutshells.

City teachers can study English walnuts, cocoanuts, pecans, filberts, Brazil-nuts, etc., in a similar manner.

VI. *The Poppy (a dry fruit).*

This is always a most delightful fruit to observe. Its elegant shape is a good object to draw. The cap on the top is pretty, and the row of openings around it like a row of windows up under the eaves of a circular tower are curious. The top should be removed carefully, and then is disclosed a series of partitions radiating from the centre.

Here are myriads of little black or dark-brown seeds. These seeds are perfect spheres. Here is a good opportunity to teach plan in nature. The little windows remain shut until the seeds are ripe. Then the windows open, and out come the seeds. Taste of the seeds. Are they good? Tell the children of the milky juice of the poppy-plant. Tell them about the opium which is made from the juice; of its culture in the far East, and of the danger of using anything which contains opium.

VII. *The Milkweed.*

Here is another dry fruit. Its shape, warty surface, jointed stem, should be first observed. Then its shining interior, its great mass of flat brown seeds with their silky appendage, should be examined and discussed. Why does nature want the seeds to fly away? What would happen were the seeds all to fall down upon the ground in one place? Can you pull off the silk from the seeds? Does it come off easily?

Pull some silk. Is it strong? Would it weave into cloth well? Is it brittle or not? Examine some silk with a glass.

VIII. *The Pod.*

For this lesson it is well to have as many kinds of pods (legumes) as possible. Beans, pease, locust, honey-locust, peanut, are commonest. Some of these can be studied fresh from the gardens, while others hang on the trees all winter, and are available at any time.

These are also easily drawn and described. The curious way in which seeds are attached to one side by means of short curved stems (funicles) and the little hollows where the seeds nestle down closely are all worthy of note. The use of some of these for food will be worth mention. Another thing not to be overlooked is the fact that the halves of almost all pods (legumes) tend to split apart along a definite line. This is brought out in shelling peas, and also in cracking peanuts in the hand. The two halves are called *valves*.

IX. *The Key-fruit.*

So much has been written on the maple that it is hardly necessary to outline a lesson on this fruit, but the keys of the elm, box-elders, ash, and ailanthus are far less known, and so they may occupy a few words here. It is well to select one of these fruits, and give a rather full

treatment of it first. Then take up the others, bringing out first similarities, later differences. The maple-seed is at the end of the key. This puts the wing on one side. The maple-keys are always in pairs. Stand on a chair and drop one. See it whirl around? Why? This retards its falling, so that any wind may carry it farther, because it remains in the air longer. Again, stand on a chair and drop a maple-key and a bean. Which strikes the floor first? Note how the ailanthus seed is near the middle of the wing. See how the wing is twisted. Drop this, and see how this twisting makes the seed to loiter on the downward journey. Perform same experiments with other kinds of keys. Let each child handle and draw each kind. What a delicate membranous wing the elm has. How stiff is the wing of the ash. Are all maple-keys alike? Do all fall at the same time? How many seeds are in each key-fruit? Other differences will suggest other questions.

X. *The Cone.*

Cones are complicated, and a great deal of study may be put upon them. It is only the most peculiar features which need be taken up with primary or ungraded pupils. Here we have a compound fruit, wholly unlike any of the foregoing. Call attention to the fact that it is really a branch with many closely compact leaves upon it. Cut the cone from top to bottom through the axis. Examine the attachment of these wooden leaves. Observe also that these leaves are put on in a spiral arrangement. Examine the leaves. Are they thick or thin? Hard or soft? Smooth or rough? Compare the edge with the other parts of the cone-scales in thickness. Are they armed with a spine or not? Does the spine break off easily, or is it closely united to the leaf? Is there resin on the cone? Break off a leaf. Note the two hollows on its upper surface. What are these for? Can you find any seeds in the cone? See how they lie in the hollows. Note

the wings on these seeds. Can the wing be separated from the seed? Here we have a seed which is naked in the hollows on the upper side of a cone-leaf (scale). When ripe it loosens, drops out, flies away.

Dip a cone in water. What effect? Examine cones of different trees; also young and old cones from the same tree. When young, they remain closed up tight. A short branch of a pine-tree will often show as many as four or five different crops of cones. Such a branch, where possible, should be brought into the class.

Cones differ greatly in size, shape, and the form, etc., of their scales (leaves). The author's public school has made a collection of twelve different kinds of cones.

GENERAL OBSERVATION ON THE STUDY OF FRUITS.

As fast as dry fruits are studied they should be mounted upon a large stiff card. This is useful as a chart. It also helps to ornament the room. By being before the children's eyes they become more thoroughly familiar with the various forms. The teacher should always be on the outlook for dry fruits. In the fall a walk in the woods is sure to be productive of a quantity of dry pods of various things. These, put away, can be brought out when snow lies upon the ground. Children, once started collecting, will keep the class-room abundantly supplied.

An example is given of pupil's descriptive papers. When a leaf, flower, or seed has been thoroughly studied, the pupil should place his knowledge on paper.

The Apple.

(Description by Doretta N. Wagner, age twelve. Drawing by Charles Miller.)

The apple is a delicious fruit, and I do not wonder that Adam and Eve were tempted. The apple I have is about the size of an orange or breadfruit. It is something the shape of

a tomato. Its skin is smooth and tough. The one I have is of a beautiful color, being shaded with pink, green, yellow, and

FIG. 1.—APPLE AND SECTIONS.

brown. Its stem is an inch in length. It is made of woody fibres, and is very strong, so as to hold the weight of the apple.

The little dried-up blossom at the bottom consists of five parts. It is filled with little stamens, which look like little dark-brown threads.

Its flesh is cream-color. Its taste is tart, and my apple is very juicy. Some apples are mealy. When cut across, its core looks like a starflower. In each petal there is a seed. When cut lengthways toward the centre, it is tough. In the centre these are covered with a tough substance that looks like fish-scales. It is enclosed by a heart-shaped mark.

The seed is pear-shaped. Its outside skin is dark brown and shiny. The inside skin is light brown and is tough. Inside this skin it is perfectly white. Inside of that is a germ. There are many kinds of apples. The Baldwin is a sour apple and keeps well for winter. The russet is also a sour apple, but it is of another color. The Baldwin is dark red; the russet is brown. The crab-apple is a bitter apple, used only for preserves and jelly. The bellflower, the Canfield and Greening are other apples. They are also very useful for cooking, raw dried, cider, and pies.

The Orange.

(Description by Ray Atteridge. Drawing by Chester Bellows.)

The shape of the orange is that of an oblate spheroid. It is about the size of a baseball. The orange has a different smell from other fruits. The orange-skin is thick. It looks porous. The outside is the part that has the flavor. The orange-skin is formed of two parts—the inside is white, the outside is an

FIG. 2.—SECTIONS OF ORANGE.

orange color. The part of the orange which is good for food is the juicy part. When the orange is cut across, there are segments, and each little segment is protected from the other by a thin skin.

The flesh of the orange is mostly a yellowish juice. It looks like the muscles of the arm or the leg. The seeds are near the

centre. They point toward the core. The seed has two skins. One end of the seed is sharp and the other is blunt. The outer skin is white and tough, and does not fit close to the seed. The inside skin is a brownish color and slippery. It fits close to the seed. It is the thinner of the two. The skin is spongy. It is larger than that of an apple-seed. The germ is at the sharp end of the seed. The seed is like a little bean. There are two parts to it. When under the glass, it looks like the heart of a cabbage.

Oranges grow in warm climates. Some of the places are Florida, California, and West Indies. The Florida oranges are the best, but this year the oranges of Florida are no good, for they are all frozen. They use the orange for flavoring different things. The orange is nice to eat in the hand or on the table. We like oranges the best in the winter-time. They grow on a tree, not on a bush.

The Cranberry.

(Description and drawing by Rollo S. Smith.)

The cranberry grows in New Jersey, Delaware, and Massachusetts. It is grown in marshy land, and a river or a brook is always found near, so they can flood it to keep the plants from getting frost-bitten. The cranberry is something the shape of an egg, and is about the size of a sparrow's egg. The color of the skin is of a light red at the blossom-end, but it gradually grows darker toward the stem-end. Here it is a very dark

FIG. 3.—CRANBERRY AND SECTIONS.

red. The skin is very smooth, and does not separate from the fruit very easily. When cooked it separates very easily.

The flesh is of a cream-white color. The texture of the flesh is not very tough, and it is full of little pores. The flesh tastes very sour, and has an insipid taste beside. The cross-section looks like a full moon and a four-leaf clover in the middle of it.

Each cavity has four little seeds in it. There are four of these cavities, which make the leaflets of the four-leaf clover. The vertical section is blong, and each section contains two cavities, which are full of seeds that point to the stem-end. There is a very tough kind of cord, that goes from end to end, that separates the two cavities. This cord is of a red color. The seeds are all attached to the cord that passes through the middle of the vertical section. The big ends of the seeds are

where they are attached. The seeds, when under the magnifying glass, look like bitter-sweet berries, and are about the shape of an orange-seed. The seeds are fastened together by a kind of red substance that looks like red sticky jelly.

All the children whose work is here shown were pupils in the Chatham (N. J.) public school.

B. LESSONS ON SEEDS.

I. *The Seed-coat.*

Preparation.—The teacher should first collect several kinds of seeds. Large ones are best, as beans, pease, squash, watermelon, pumpkin, hickory-nuts, chestnuts, walnuts, peach-pits, etc., etc. Distribute two or three beans to each pupil, having soaked them overnight to soften them. Give each child a pin with which to dissect his bean.

The Lesson.—Children, we will learn something about this seed. What is it? Its shape? Size? Color? Scar where it was fastened to pod. Is it rough or smooth? Hard or soft? Draw its shape on your slates. Take a pin and stick it just under the skin of the bean, so as not to injure the bean inside. Be careful not to hurt the bean, for there is a little baby bean-plant inside. The little bean-plant is asleep. Do not stick the pin into the baby. Peel off the skin. We will call it the coat for the baby inside. See if this bean has more than *one* coat. How does the "overcoat" differ from the "undercoat"? How many parts has the bean? Pick them apart and see if you can find the baby.

Other Seeds.

Do the same with pease, squash, melon, etc., until you bring out the fact that the seeds of these plants have *two* coats.

Call these an overcoat (testa) and an undercoat (tegmen). If a seed proves to have a third coat, tell them that

some seeds have more than two coats, but that most seeds have two only. Thus the following table can be made by the pupils :

SEEDS.

Name.	Scar.	Outer Coat.	Inner Coat.
Bean.	small on side near end.	smooth, white, tough.	thin, delicate, tender.
Pea.	small round side.	green, smooth, tough.	thin, veiny, tender.
Peach.	rough, at the end.	hard, a shell, wrinkled.	thin, brown, wrinkled.
Apple.	at end, small.	smooth, brown.	thin.
Orange.	at the end, rather large.	roughish, white, tough.	cream, tender.
Horse-chestnut.	very large, gray.	brown, smooth, horny.	brown, very thin, close to seed.

II. *Advanced Scheme for Seed Study.*

Name.	Position.	Testa.	Tegumen.	Embryo.	Cotyledons.	Radicle.
Maize.	anatropal.	tough, flexible, yellow.	thin, white, delicate.	monocotyledonous, white.	one.	white.
Pumpkin.	anatropal.	hard, yellowish, tough.	thin, white.	dicotyledonous.	fleshy, starchy.	small.
Orange.	anatropal.	tough, thick.	thin, brown, tough.	polycotyledonous.	7, various in shape.	small, 2-parted.

Later such seeds as sunflower, thistle, milkweed, maple, acorn, and ailanthus may be studied.

Encourage the children to collect small boxes full of seeds. I have seen small boxes, $2 \times 2 \times 1$ inch, used, and very interesting collection of seeds thus formed. Late in the fall, when the seed collection is complete, give a language lesson as follows: Let the class write about seeds, answering these questions based on their observations:

How does a peach-pit differ from a plum-pit? Which is larger, a plum- or cherry-pit? Name seeds that have wings, down, silk. Name a seed with a very large scar. Other questions will suggest themselves.

The seeds collected may often be of use for observation lessons on growth by sowing on wet cotton in early spring. I have seen children work for weeks on seeds, deeply interested in finding these facts, and unconsciously developing their senses to an extent that is truly wonderful.

III. *Growth from Seeds.*

Procure some lima beans; have enough to supply each child. Soak them overnight. Then plant them on a mat of wet cotton. Cover lightly with another wet mat and place in a tumbler on a sunny window-sill.

In a day or two employ them in a lesson. Tell the children that there is a little door in the seed-coat. Tell them that if they watch for it they will soon see the baby put his little foot out of the door.

This will create enthusiasm, and observations will be made almost every hour of the day. In a short time their watching will be rewarded, and then each stage of development will be observed and recorded. Let drawings be made every third day. Other seeds sown in like manner always awaken great interest among the children. Mixed bird-seed gives most interesting results. Older pupils may examine root-fibres, etc., with a small magnifying glass and see the root-hairs.

The following is an outline of observations on the bean, together with language and number lessons based upon

them. They are submitted as samples of first-year pupils' work, during February and March, 1894, in Chatham (N. J.) public school, lowest primary classes, Miss M. Alice Gulick, teacher. The drawings are made by the *pupils*; *not one* has been *doctored*. They have been copied by tracing, and then

FIG. 4.

inked line for line. The children range from six to eight years of age. Lessons are given in the following order :

I. **The Scar (hilum).**—This is where the seed grew to the pod. The scar is interesting to observe. It varies so in size. The children are given many kinds of seeds just to observe the scars. Beans, pease, almonds, chestnuts,

horse-chestnuts, corn, and other large seeds show great diversity in size, shape, and position of the scar.

II. **The Little Gate.**—Tell the children that inside the seed is a little baby plant, and that there is a little gate or door where it can come out when it gets big enough.

FIG. 4a.

Then the little opening (micropyle) just below the scar on the bean is pointed out, and the children are told to find the little gate on other seeds. This will be hard to do in some seeds, for the little gate is sometimes merely a pore that can only be found with a needle-point. It is worth the search, however, for it will bring out the fact that

the little gate and the scar occupy very different positions on the seeds of different kinds of plants.

III. The Overcoat.—Tell the pupils that the little baby plant (germ) must have a coat to keep it warm. Soak the seeds and carefully cut away the outer seed-coat (overcoat). The children should do the same with a pin. Get them to describe the outer coat (testa). Such words as smooth, rough, thin, thick, white, brown, wrinkled, ridged, etc., will come up and furnish excellent language drill.

IV. But tell them that kind Mother Nature gave the little baby plant two coats, and ask them to find the undercoat. Tell them that the baby is sleeping and they must be careful so as not to wake it up. They will thus find the *inner coat* (tegmen) and then the baby itself is exposed.

V. The Baby.—Direct the pupils to separate the seed-leaves and see the little baby lying there between. 1. Point out the pointed portion; it is the baby's *foot* (radicle). 2. Point out the two little leaves (plumule). This is the baby's *head*. Then taking some fresh seeds, plant them on wet cotton in tumblers so that the growth may be observed. No drawings of the inside were made because of its small size, but the children were encouraged to *tell* all they knew of the coats and other parts of the seed.

VI. Growth.—Figures 1 and 2 of Fig. 4 were traced around, and special attention was called to the little gate, so that the children became eager to watch the *little baby* creep out through the gate. Drawings were made every two or three days. Errors were carefully noted, as, for example, when a little six-year-old drew the roots in figure 6, making them turn upward, and when an eight-year-old put parallel veins on cut 9.

IV. Subsequent Work.

Corn was planted Jan. 28, and observations lasted through the first week of March. Then pease were planted, and by the time they had been studied young maples, acorns, horse-

chestnuts, etc., were sprouting outside, and from their study a *valuable fund of knowledge, an increased power of observation*, and a more hearty appreciation of *nature's plan* and *God's providence* were awakened in those children's minds.

The following sentences are culled here and there from the work of some forty children ranging from six to eight years of age:

"See the bean in the glass. The seeds are in the water. The bean is wet in the glass. The bean was planted on wet cotton in the glass. There are roots in the glass. The leaves come from the stem. The little baby plant in the seed is called a germ. We planted the seed on wet cotton. There are roots on the bean and the corn and the pea. The stem grows up from the seed. We can plant seed in the ground. The seed has two skins. We like to eat beans when they are cooked. The rootlets run from the large root. The roots are white. Can you see the stem of the pea?"

The foregoing will show about what to expect. The teacher should always say: "Now, children, look at your sentences and see if they are begun correctly." This fixes *capitalization*. In like manner attend to *punctuation*. Accept no slovenly work. This fixes *habits of neatness* and helps the *penmanship*. *Drawing* of everything studied is advisable, since it is one of the best means of delineation.

A few problems in number are added:

1. There are 5 corn-sprouts in one glass and 3 in another; how many in both?
2. I had 4 peas in one glass; how many in three such glasses?
3. The bean-plant has 3 leaflets on each leaf, and a bean-plant has 6 leaves; how many leaflets on the plant?

Have pupils write the story of a seed. How it grew in a fruit or pod; how it fell upon the ground; how the water and light and heat of the sun wakened it up; and how it grew to be a fine plant. This exercise may be varied by having the seed tell its own story.

Exercises of this kind must be copied neatly and laid away for future use as supplementary reading. Material of this character is far superior to a great deal which we find in so-called supplementary readers ; it is about things the pupil has seen.

C. SOME LESSONS ON PROPAGATION.

I. Here is a branch cut from an ivy-plant. Let us examine it closely. Do you see any roots upon it? Let us place the lower end of the stem into a bottle of water. We will set it in the north window and see it put forth roots. Here is a piece of nasturtium, and also a piece of oleander. We will also put them into bottles of water and see their roots form.

Observe them each day, and by and by the tender, white, threadlike roots will be seen to appear. The nasturtium will probably be the first to throw out roots, then the ivy, and last the oleander. When the roots appear, examine under a magnifying glass and discover the little root-hairs by which the plant absorbs moisture and nutriment from the soil.

Before the roots appear examine from time to time to see the *callus* or scar where the roots first appear. This callus comes at the end of the slip where it was cut off, and when it comes you may be very sure that roots will speedily follow. When the roots have made their appearance, and when you have given them all the study you can, put the new plants in good earth and set in a sunny window. The foregoing illustrates one important way of propagating plants.

II. Here is a piece of geranium stem. Let us plant it in the soil. First we will cut off the large leaves and we will cut the stem off smooth with a sharp knife. Look at it closely and see how fresh and green the stem looks where I have cut it.

We will take this clean sharp sand and sift it to get out all the pebbles. Now we will put it in this pot and make it damp. Let us push this pencil down into the soft damp sand and so make a hole. Now put in your geranium slip and crowd the sand up around it. Where shall we put it? Why put it in a north window? Why not let it have sunlight from the first? When it has been planted for a week, carefully remove it by tipping the pot upside down and examine the geranium stem for a *callus*. Signs of healing over will probably be observed, and a roughish ridge will be seen on the edge where bark and wood join. This is a *callus*. If the stem has begun to rot, it is because the sand has been kept too wet. The sand should be *damp*, not *wet*. If no callus has appeared yet, carefully bury again and wait another week. The callus and the roots are bound soon to appear, and they may be examined as with nasturtium, ivy, and oleander.

III. Procure a plant of periwinkle (myrtle) having rather long branches. Plant it in a pot, and fix another pot full of good earth, but having no plant in it. Place the pot of earth beside the one containing the periwinkle and lay one of the long branches across the pot of earth. Place a stone upon the branch, and water the pot of earth whenever you water the periwinkle vine. Now and then gently lift the stone and observe the vine. After a time roots will appear and a new plant will thus be formed. The branch may be severed after a while and the new plant will then carry on a separate existence. In the above experiment have pupils make careful note of when the stone is first placed and how long it takes to root the branch.

IV. Make the foregoing experiment with another branch, only before placing the stone cut off a small slice of the bark from the periwinkle vine on the *upper side only*. Do not take off the bark all around; that would cause the death of the branch. It will be found that roots will start much sooner around the wound than they will on a stem which has not been so treated. These experiments will

bring out much valuable information regarding how nature tries to repair any injury; how new plants may be formed from old ones, etc.

In all such work a diary should be kept to record observations.

ON SIZE AND COMPARISON. MEASUREMENTS.

Many teachers give their pupils some drill on form and size. Some teach measurements. One of the earliest faculties to develop is comparison, and the following lesson is designed to furnish drill in comparison and measurements. Each child has a ruler.

THE LESSON.

Who can tell me what kind of tree this is? Yes, it is an oak-tree. Did you ever notice how large some oak-leaves are? Let us see who can find the largest oak-leaf. Here is a very small one. See who can find the smallest also.

Get the biggest and the littlest you can find, and then we will all sit down here and measure them.

Mary, how long is your leaf? Who has a longer one? Measure from the top to the end of the stem of the leaf. Does the stem of the leaf belong to it? Yes, because it comes off with the leaf.

[When you have had the children measure their leaves, have them put the figures on slate or paper. Be sure the brighter ones help the duller, and so facilitate matters.]

Now let us see who has widest place. Measure farther down, Willie? You are too far down, Jessie. Hold the leaf flat, Mary.

Now you may measure the smallest leaves. When this has been done, the results of both observations may be written upon the board. A sort of table may be made, as follows :

SIZES OF LEAVES.

Name.	Largest.		Smallest.	
	Long.	Wide.	Long.	Wide.
White oak....	4 $\frac{1}{2}$ in.	3 $\frac{1}{2}$ in.	1 $\frac{1}{4}$ in.	$\frac{1}{2}$ in.
Maple.....	3 $\frac{1}{2}$	5 $\frac{1}{8}$	2 $\frac{1}{8}$	2 $\frac{1}{2}$
Plantain.....	6	1 $\frac{3}{4}$	5 $\frac{1}{2}$	$\frac{3}{4}$
Grass.....	13	$\frac{1}{8}$	4	$\frac{8}{16}$

Should the teacher think best, the children may add columns on distance around, measuring as near as may be the margin of each leaf.

That is rather too much to ask unless the margin is very regular. It is well to have one or two margins measured. Few people realize the distance around any object. This scheme will furnish instructive work for two or three lessons. Don't push any observation lesson until the child feels it to be a task. When interest begins to wane, drop it and turn the attention elsewhere.

Another drill in observation of size and measurement of handy forms is to have each child procure a piece of string not less than three yards long. Take the yardstick and appoint them two and two to measure the circumference of several trees about two feet from the ground. Let them use the string, and then by applying it to the yardstick they can tell the distance around any tree in the yard. This is eminently practical work, and will benefit the pupil in many ways.

I have found children fifteen years old who did not know how to use a measure, and who had no conception of distance, yet *they knew the tables by heart*. Out on such methods! One fifteen minutes spent in measuring any object is better in the practical results than any table *learned by heart* to-day, forgotten to-morrow.

Another most interesting lesson on measurement is to take some place beneath the trees in early autumn when the leaves lie around upon the ground. Measure a square yard on the ground and have the leaves counted which lie in the space. The number will astonish most pupils.

Then if it takes a certain number to cover a square yard, how many will be required to cover the ground under the tree?

Such problems, assigned to be solved at home, will add much to the interest in number-work.

D. FLOWERS.

I. *The Daisy.*

Bring into the school-room a large bunch of daisies, or, better, ask the children to bring you some at recess. The daisy is so common that it is easily obtained. Any common flower will do quite as well. When ready, give each child ten flowers.

Lay the flowers on your desks, children. Mary, where did you get your daisies? Arthur, where did yours come from? Anna, do daisies grow in sunny or shady places? Willie, did you find yours in rich or barren soil? Martha, do daisies grow in dry or damp places?

Having obtained correct replies to the above, ask some one to tell where daisies grow, putting the above facts into one or two sentences.

Jennie, what color is the daisy? Yes, it has a yellow center with white flowers around it. What does the daisy look like? Yes, the centre looks like a button or a ball, the whole flower like a star. What shall we call these white flowers around the yellow centre? Let us call them *rays*, because they make the daisy look like a star.

We will call the yellow centre the *disk*. Now take one daisy from your desks, children. Count the rays on the one you have taken up. I will write the numbers on the board, and you may write them on your slates. Now you may tell me, one at a time, how many rays there are on your daisy.

Mary, 31.

Jessie, 29.

Willie, 34.

Hannah, 35, etc., etc.

This will disclose the fact that these flowers differ in the number of their rays. Now, if the teacher wishes to suspend the nature-work and take up number-work, he may proceed. Mary had a daisy with 31 rays; how many rays would there be in 5 daisies? etc., etc. Willie's daisy had 34 rays; how many were there on $\frac{1}{2}$ his daisy? Children of higher classes may be required to add the numbers and divide by the number of flowers, thus finding the average number of rays to a flower. Expedients will readily suggest themselves to any wide-awake teacher. This flower will furnish material for number-work, language-work, busy-work, and almost every kind of work done by children during the first four years of school.

Read to the children Burns' *Poem to a Daisy*; sketch a cluster of them on the board. Cultivate the eye, the heart, with those humble instruments thrown with such lavish profusion around your school-house.

At another time make a comparison between the white daisy and the yellow one (*Rudbeckia*) as to form, size, soil, color, number of rays, etc. Have conventional designs for wall-paper, tiles, oilcloths, dress goods, etc., etc., made from this flower or any other handy one.

The Daisy.	Jennie Miller.
Location	Mr. Mun's field.
Soil.....	Dry, rich, sandy.
Height of plant.....	2 ft. 6 $\frac{1}{2}$ in.
Number of flowers examined.....	10.
Color of rays.....	White.
Number of rays.....	34.
Average number, 10 flowers.....	32.
Remarks.....	Strong smell.
Date	June 3, 1894.

Although number lessons and language lessons may be built upon the nature lessons, yet the nature lesson should be given as such, not as an introduction to any other line

of school-work. Nature study, for *its own sake*, should have a place in the school.

II. THE GENTIAN (*Figs. 5 and 6*).

Gentians are so common, so conspicuous, and so beautiful that, coming as they do so late in autumn, they are among the most appropriate flowers to study at that time of the year. At least one whole plant should be obtained when possible, so that all its parts may be seen. I would not advise the digging of roots enough for a whole class, for such an act as that would soon drive these beautiful blossoms from our forests. One root is enough, but each child should have at least one flower to examine for himself, and the one with roots should be passed from one to another, and each child may see the plant *in toto*. I would not advise the teacher to procure the plants for a class. Have the children procure their own if possible. This is so that they may observe the locality, soil, and surroundings of the plant. Having supplied each child with a specimen, time should be given to allow all an opportunity to observe their specimens. Perfect silence should reign while each looks at his plant.

FIG. 5.

Oral Lesson.—Having given time for silent, independent observation, get each pupil to tell all he sees. Question to get him to see what he has not yet observed. Ignore those features which the child cannot see, i.e., is not ready to see.

Illustration.—The untrained child will probably not be able to see more than that the flower is blue, and perhaps that the petals are fringed (fringed gentian), or that the flower is closed (closed gentian).

It will then be the teacher's place to ask questions like the following: Are there many or few roots? Their color and size? Are they branching or simple? What is the position of the stem? Its shape? Break it; is it solid or hollow? Its height? Its surface (rough or smooth)? Its color? Does it bend readily (flexible or brittle)? How are the leaves placed on the stem? Are they few or many? Large or small? etc. Their shape, size, color, and general appearance? Are all leaves alike? Compare the lower with the upper leaves. Are the flowers alone or in clusters? Are they single or double? How many sepals (green outer flower-leaves)? Describe the petals as you did the leaves. Draw a petal. Cut open a flower. Are petals separate or united? Count the stamens. To what do they grow? Are they between or opposite the petals? How many pistils? Draw the pistil. Cut it crosswise and draw the section? What do you find inside the large part of the pistil (ovary)? When these (ovules) ripen into seeds, how will they get out of the pod? Where are the seeds attached to the ovary?

The foregoing questions may be multiplied indefinitely. The teacher should at least bring out the following facts:

The roots are many, fibrous, white. *The stem* is smooth, green, erect, rarely branching. *The flowers* are usually three or four in number, four-parted, blue, with "satiny" fringed petals. *The stamens* are equal in number to the petals. *The pistil* is large, having two stigmas at the top.

The flowers growing in shade are always paler than

those growing in the open sunshine. The gentian favors rich moist soil, but never wet soil. The stem and root have a strong bitter taste.

Various sketches, such as the accompanying drawings (Figs. V and VI) may be made: No. 1, entire plant; 2, the pistil; 3, same cut crosswise; 4, a seed highly magnified showing its loose coat; 5, the flower cut open to show alternation of stamens and form of petals; 6, plan of the flower, parts being respectively sepals, petals, stamens, and pistils.

FIG. 6.

Never draw the thing for a pupil. Let him draw *what he sees*. Only after the child has done his *best by himself* would I let him see the printed or blackboard form. It is the *artist* who paints from the *living subject*. He who enlarges a photograph is not necessarily an artist, hence the foregoing directions.

Written Lesson.—The written lesson may follow the oral one immediately, but it is better to take the following day for the written lesson. Before writing it is well to have a brief review of the gentian from memory. This is almost necessary in a primary school, but with larger pupils no oral review is needed.

When all are ready with paper and pens, the order may be given to write, as neatly as possible, a description of the gentian. This description should be illustrated with drawings, either from memory or after the sketches from the plant itself.

Before taking up the written work the teacher should say: "Begin and end your sentences properly." "Look to your capitals and punctuation." "Be careful with your penmanship."

Suggestions.—Each plant may be pressed between some thoroughly dried newspapers. Use a board and about six bricks as a weight to press them. When thoroughly dry, mount the plant on Bristol-board cut same size as the written exercises, and bind the whole together with a ribbon or a brass clip. This makes an attractive exhibit, and also a souvenir of work done in school. No work should be accepted until it has been done neatly. Misspelled words should be marked for the pupil to copy and study.

This beautiful flower is also easily made into designs for drawing, and since its leaves are in twos and the parts of its flowers in fours, there is likewise an opportunity to use it with lowest primary classes in number-work.

Having studied the fringed gentian carefully, bring in the various beautiful poems about it. Bryant, Lowell, Whittier, and others have celebrated its beauties in song. These selections are excellent for supplementary reading.

The following flowers are offered as good subjects for similar lessons in autumn: the bellflower, goldenrod, aster, sunflower, lady's-tresses, chickweed, and closed gentian.

In conclusion the following scheme for Friday afternoon programmes is offered: select a flower as the subject for the afternoon. Let the school-room be decorated with this flower where it can be found in abundance. Let the blackboards be ornamented with drawings of the plant from nature, with conventional designs of tiles and borders having this flower for a unit. This may be easily done with

such flowers as the daisy, dandelion, periwinkle, violet, azalea, anemone, gentian, goldenrod, aster, rose, etc. When the flower is not abundant, there may be at least a bouquet on the teacher's desk. The programme may consist of selections from the poets relative to the flower to be honored, interspersed with musical selections, and three or four of the best written exercises of the children. The result of such a programme can not fail to inspire both teachers and pupils with a deeper love for nature. The children will know the flowers and love them. They will be able to describe them and tell where they grow and how they live. They will know what poets have said about them, and knowing one plant intimately will enable them to learn others more readily.

OTHER BOTANICAL LESSONS.

Roots form excellent material for nature lessons. These are especially good, because they may be had at all seasons. Thus in summer the plantain with its numerous long white fibrous roots, the violets with their matted fibrous roots, the short tap-roots of many weeds and vegetables (cabbage, onion, etc.) are easily obtained and studied. But in winter beets, carrots, parsnips, and sweet potatoes are to be had. Turnips and carrots are also easily drawn and colored, and all roots furnish materials for clay or papier-maché modelling.

Branching.—Modes of branching may naturally follow lessons on buds. They may be deferred until the following lessons on trees are taken up. Budding, branching, and trees themselves are so closely related that it is always advisable to treat them at or near the same time.

Leaves.—So much has been published on leaves that it has not seemed advisable to the writer to outline any special lessons upon them in this book. Every teacher should have Miss Youmans' *First Book in Botany* as a guide to all elementary lessons on plant-forms. The use of leaves as elementary units of design is admirable.

Flowers.—Aside from two or three flowers, the writer has omitted lessons upon these fascinating objects of nature for the reason that all the leading school-papers as well as many books give much space to the subject of flowers. With flowers, as with leaves, their use as units of design and objects for conventional drawing cannot be too highly commended.

Chapter XXX.

LESSONS ON ANIMALS.

FISHES.

The Crayfish.

Shortly after ice breaks up in early spring go to some pond or stream with a dip-net made of thin cloth fastened to a wire hoop. A little effort will secure a liberal supply of larvæ of frogs and other creatures. Crayfish will nearly always be found, and usually there will be seen numerous eggs fastened to the swimmerets under the long abdomen. Place your material in a large shallow tin pan of water and take to school. Here the complete change from egg to crayfish may be observed by the children. It is interesting if each child can have a bowl of water of his own to observe, but I have found one large vessel of water quite sufficient for observations of an entire room. If you fail of securing eggs, you can at least have observations made upon the adult. These observations should at least bring out the following facts: 1. Its body is jointed. 2. It has ten jointed legs. 3. It has long antennæ. 4. Its eyes are on stalks, like those of the snail. 5. It can move either forward or backward, but it prefers a backward motion. 6. In moving it turns the tail under and darts quickly backward. 7. It uses the tail for swimming. 8. The jaws move from side to side. 9. The first pair of feet is enlarged into huge claws. 10. The body is covered with limy scales (crusts). 11. Under the large side-plates are the gills. 12. The cray-fishes shed their scales (moult) from time to

time. They have to do this in order to grow. 13. Note how it acts when teased. At first it attempts to escape, then it defends itself with its claws.

Read to the children about the crayfish ; how it burrows in the earth in summer, bringing much dirt to the surface, and digging wells to find water in dry seasons. Tell that in this manner they are a great benefit to plants, but that they often do much damage by making holes in levees along the Southern rivers.

Older pupils may dissect crayfishes when dead and mount the parts upon card for more special study. If they desire to prepare some crayfishes for permanent collection, first soak them in a solution of glycerine, alcohol, and arsenic for several days ; then remove, rinse, and dry before mounting. The same solution is good for preparing worms, caterpillars, etc.

The Turtle.

Some common kind of turtle is most desirable. If possible, the turtle should be brought into school and kept there several days before the lesson is given. In addition to a living turtle it is well to have one or more preserved turtles, turtle eggs, skulls, etc., and some ornaments made of tortoise-shell.

Where does the turtle live ? Do all turtles live in water ? Do they always live in water ? What do we call creatures which live partly on land and partly in the water ? Amphibians. Does a turtle breathe by lungs or gills ? Give reason for your opinion. Can you find its nostrils ? Examine its beak. Has it any teeth ? Why not ? Is its blood warm or cold ? Examine the shell. Of how many scales is it composed ? Observe the breast-bone. See what bright eyes he has. Why does he not run away when teased ? What does he do ? Some turtles have a soft shell like leather ; others can shut up their shells like a box. Tortoise-shell is very valuable for ornaments. Eggs and flesh of turtles are very good for food.

A turtle may be preserved by making an incision in the soft side between the front and back shells and placing him in a solution of alcohol, glycerine, and arsenic. The solution will penetrate the body and keep it from decomposition.

BIRDS.

The Canary.

Let a pupil bring a bird-cage to school. This cage should contain one or more birds. Hang it where the birds may be seen from time to time, so that their mode of life may be observed. Describe the canary; its round head, full throat, slender legs, long toe-nails. What is its color? Are all canaries colored so? How many toes has the canary? Do they all start from the same point on the leg? How does it sit upon a perch? What takes the place of a heel? Are all toes of equal length? Examine the bill. How does its shape compare with the bill of a chick? Examine the eyes, their position in the head, the *three eyelids*, and the way each moves. Examine the scales upon the legs. Are these scales alike in front and behind? What does the canary eat? How does it crack a seed? How does it drink? Watch the bird for five minutes or less and then recount what it has done in that time. Give the bird a bathing-dish of fresh water. Watch it bathe. A lesson in cleanliness. When possible it is well to have a large family cage and let a bird raise her young where day by day they may be seen and conversed about. (I would not advise the bringing of any but canaries into the school-room, as other birds pine in confinement.)

The Chick.

A friend of mine once borrowed a small "coop" containing a hen and thirteen young chicks and kept them a day in her school. Such a plan may succeed very well, but children must, in such cases, be cautioned not to handle the feathery babies.

Describe the young chicks ; their shape, color, covering, and manner of running. Notice how they eat and "peep." See how they run to their mother whenever she gives a certain call. See how anxious the old hen appears when her chicks venture too far from her. If young, you may still find the little hard point adhering to their bills with which they broke out of the shell. See how small and round their little wings are. Feed them some wet meal or moist bread-crumbs. How greedily they eat it. Compare the hen with the canary, as regards bill, feet, legs, feathers, eyes and eyelids, food, size, use, etc. Hens belong to a great family of birds called scratchers, because they scratch for their food.

It is well to bring into school on some other day a dressed fowl and show to the children the various parts of the body.

The Robin.

This bird comes so early in the year that his arrival is always hailed with joy. How does a robin go along on the ground? Hops. Why does he go hopping along in the grass? What does he eat? Did you never see a robin hopping along with a long worm in his mouth? What else do robins eat? Did you ever find the cherries on the tree all pecked full of holes? Who did it? What sharp sight the robin must have to see worms away down on the ground. Compare his bill with those of the canary and the chick. Describe the robin and her eggs. When the robins sing, we feel that spring is close at hand. Sometimes when they sing in a peculiar way we say they are calling for rain ; but when the cat gets the young robins we hear them giving their piteous cry of alarm. They build their nests in trees, and make them of hair, sticks, grasses, and mud. When they go south in the fall, they gather in large flocks.

The robin is a good subject for teaching patience, tenderness, jollity, and self-denial, for it exhibits all these traits in the care of its young and its merry song in the

spring. Robins give us often much trouble by stealing fruit, but their song and blithe manner recompense for all their failings.

The Duck.

Describe the body of the duck. Compare it with the chicken in shape. Notice the way in which the legs are attached, i.e., so far back as to make walking awkward. Such walking is called waddling. Does this position of the legs aid or detract from the duck's ability to swim? Why? What advantage is there in the broad flat bill? Study the plumage closely. See how much more down the duck has than the hen. Examine the feet. How many toes? How many project forward? How do the feet differ from those of the hen and canary? Is this web thick or thin? Does it unite all toes? With what is it covered? How do the web-scales differ from those on the leg? Why does nature give birds scales on their feet and legs instead of feathers? Compare ducks' eggs with those of hens', canaries', and robins'. Hunt for the oil-gland just above the tail. How does a bird dress its feathers? Why? What noise do ducks make? Bring out the fact that the duck is suited to its environment just as is the chick. The duck could not swim if its feet were like those of the hen, and the hen could not pick if her bill were shovel-like, as the duck's is. Nature thus suits all things to their surroundings.

The Hawk.

This bird should be described in a manner similar to the preceding. Care should be taken to point out those characteristics which make hawks, owls, etc., different from the birds previously studied.

Some of these characteristics are found in the hooked bill and talons (claws), fitted for tearing food and characteristic of flesh-eating birds. The large bright eye, the haughty pose, the vigorous manner of motion, all show a near relationship to the eagle, owl, and vulture. Describe

how the hawk steals chickens and other birds. Tell how you have seen very small birds, like robins, sparrows, and bluebirds, attack a hawk which had robbed them of their young. Describe the sport of hawking in the Middle Ages.

Clothing and Shelter.

Note to the Teacher.—The autumn is a good time to take up a series of lessons on clothing and shelter. Then it is that nature begins to plan for the protection of her children. Such a series of lessons may well begin with a talk by the teacher in which allusion is made to the fact that all things are preparing for their long sleep. As in a preceding lesson, twigs should be shown on which the winter buds are already forming with their various means of bud protection. Attention should be called to the fact that birds are not moulting now, and horses, cattle, cats, and dogs are not shedding their hair, but are getting fine thick coats for winter wear.

Propose then to study the clothing of various animals, and request pupils to bring in all manner of things which serve as clothing, shelter, or protection for animals or men. This will include feathers, scales, hair, fur, wool, textiles such as cotton, hemp, flax, and silk, and all manner of nests of birds and insects. The fall and winter are good for such collections, since the nests are mostly deserted then and there is no cruelty in getting them at such a time.

A Feather.

Children, can you tell me any one who has chickens? Can I get some of you to bring me some nice clean feathers? (These questions will usually result in supplying the teacher with an abundant quantity of all kinds of feathers.) Select similar feathers, say those from the tail or wing of the chicken. Give one to each child and tell him to examine it carefully. How long is the feather? How wide is it? Is it alike on both sides? What are soft fine feathers

called? Here is a piece of swan's down. Can you find any down on this feather? Where is it? Yes, there is a little down on the feather just below the wide part. Who can tell the name of the stem of the feather? Yes, it is the quill. What is a quill like (finger-nail, horn)? Can you see through quill? What shall we call anything that

we can see through? We call the wide part of a feather the *vane*. Is the vane alike on both sides? Which side is wider? What makes the parts of the vane (barbs) stick together? Can you not see the little hooks that hold them together? Tear the vane apart. Does it tear easily? Can you bend the quill? Can you cut it? Is it solid or hollow? Is there any hole in it? Yes, there is a small hole at the lower end. Can you find another hole in the quill? Yes, there is another hole among the down just below the beginning of the vane. Josie, what do we use feathers for? What kind do we put in pillows? What kinds on our hats and bonnets? Of what use are feathers to birds?

FIG. 7.—FEATHER SHOWING PARTS.

We call a young feather just about to grow a pin-feather.

Will feathers burn? When they burn, what happens? They melt and burn with a very bad smell. How do ostrich feathers differ from those of the hen? Why does nature give the hen such thick stiff feathers, and the ostrich such light thin loose ones? Hold a hen feather up

before one eye and look at the sun. What do you see? Why does the light show all these rainbow colors? It is because in passing through the feather the ray is broken up. Squint the eyes and look at the sun. Do you not see the same colors? Why? Get a chicken's head and see how many kinds of feathers grow on it. Examine the ear

FIG. 8.—PARTS OF FEATHER ENLARGED.

nostril, sides of mouth. Did you ever watch a bird dress her feathers? How does she do it? Watch a chicken, a canary, or any other bird dress her feathers and describe just how she does it. Under the microscope the accompanying drawings of the parts of a feather were made by a pupil. Now let us see how many kinds of feathers we can get for our museum,

Hair, Wool, and Fur.

To study these things it is necessary to have samples of different kinds of fur. Pieces taken from the trimmings of cast-off wraps, carriage robes, etc., are useful. These should be examined and compared as regards, fineness, length, thickness, value, color, etc. Compositions on these things form an excellent exercise. Accounts of the animal which furnishes each kind, how caught, and something of his habits and the land where he lives, will come in as a part. Hairs should be pulled from the head and examined with a glass. The root or bulb and the delicate barbs should be noticed. The similarity to feathers is also noteworthy.

Scales of fishes are very interesting. The way they are fastened to the fish, their size and shape, are worth study. Are all scales on the same fish alike? Are the scales of all fishes alike in shape? In thickness? Scales on the legs of fowls. Their points of similarity and difference from those of fishes. The scales of turtle-shell. Their form, number, and peculiarities.

Nests of Birds.

The materials used? The way they are woven? Evidence of design in their construction? Where found? How obtained? Easily got or hard to reach? Compare these nests one with another. Are all robins' nests alike? In what respects do they differ? Can you account for these differences in material used? Tell the fable of how the thorn bush plucked a little tuft of wool from a little lamb. The lamb at first complained to the thorn bush, but when the thorn told him that it was done to give the bird something warm with which to line her nest, the little lamb told the thorn to pluck as much as she wanted, etc. The moral is of mutual dependence and helpfulness.

Other kinds of nests, such as those of the paper-wasp, mud-wasp, bee, are full of material. Spiders' webs, snakes' holes, ant-hills, and the hollow in the tree where the squirrel sleeps will be good themes to conclude the series,

THE HEN'S EGG.

I. *Raw.*

Hold up before your class a fresh egg. What is this? How do you know? What is its shape? Its color? Did you ever see a larger egg? What kind was it? Are all eggs white, like this one? Name a bird that has speckled eggs, blue eggs, etc.?

What kinds of hens lay brown eggs? Describe the shell. What shape is it? Is it rough or smooth? Examine carefully the surface of the egg. Hold it to your eye and close the other eye. What do you see? Place the lips at the

FIG. 9.—HEN'S EGG, FRESH.

large end of the egg. Hold them there a moment. Is it warm or cold? Place the small end of the egg to your lips. Is this end warmer or colder than the large end? Put the egg in clear water. Will it sink or float? Put it in strong brine. Will it sink or float now? Why? Fill the vessel half with strong brine, then carefully add a quantity of fresh water so as not to mix it with the brine. Why does the egg sink in the water until it reaches the brine, and float in the middle of the glass?

Now we will break the egg. We must do it carefully, so as not to break the inside parts of the egg. I will crack the shell so, and put the egg into this saucer. Now come and look at this egg, and see what we can find inside it; but first let us see what is still in the shell. How many layers

has it? Does it line the shell all around? What do you find at the large end? Is this space empty or full? (We will talk of that again soon.) What color is this thin skin that lines the egg-shell? Can you get it out of the shell? Now let us look in the saucer and see the parts of the egg. What is this thin watery part called? Which part of the white is thicker than this watery part? What do we call this beautiful yellow ball in the centre of the white? Can you see the thin silken sack that covers the yolk? See these milky-looking twisted cords that grow to the yolk on each side. What else do you see on the yolk? See if you can look closely and find a lighter spot. What shape is this spot? Did you ever see the little round spot before? Is it always on top, or beneath? To-morrow we will see what is inside of the yolk.

II. *Hard Boiled.*

Yesterday we had a fresh egg. Let us see how many remember what we learned. What color was the shell, the yolk, the white? What comes next to the shell inside? Where is the air-bubble? How many parts has the white? Which part is nearest to the yellow part? What is this yellow part called? Why does not the yellow part run out and mix with the white? What holds the yolk in the shell? Which part of the yoke is always on the upper side?

Here is another egg. It is hard boiled. We will crack the shell and take it off. When anything cracks and breaks easily, like an egg-shell, what do we say of it? Name some other brittle things. Now I have tapped it all over with my ruler until the shell is full of cracks. Now we will pick the pieces of the shell off. Where is the lining of the shell now? Where is the air-bubble? Is the lining tough or tender? Was it tougher or tenderer yesterday? What did boiling the egg do to the lining of the shell? Where is the white? How has boiling changed the white? Now let us cut down through the white carefully, so as not

to cut the yolk. Can you find the thin sack that covered the yolk and kept the yellow from coming out when the egg was raw? Look carefully. Yes, here is some on the yolk, and there is part of it on the white in the little round hole where the yolk lay. Only see how thin it is! Now can we find the little spot which we found yesterday on the upper side of the yolk?

Yes, Charlie, you found it first. Now we will try to find how this yolk looks inside. I will cut it right through the centre of the little round spot with this sharp knife. Now see how the egg-yolk is made up inside. What is in the centre? Which part of the yolk is boiled hardest? Which part is still soft? See the layers around the soft middle. What shape are they (vase-shaped)? What has boiling done to the yolk? What can we say heat does to an egg? It changes the white —, and the yolk —. Did you ever see mamma break an egg into a hot pan on the stove? What happened?

III. *Experiments.*

If I beat the white of the egg with a fork, what will happen?

I put this fresh egg in some vinegar yesterday, and left it until to-day; what has it done? Where has the shell gone?

Here is some alcohol. I will put some on this little piece of white of egg. What does it do to it? Little boys and girls have brains something like white of egg, and when they drink whiskey, or wine, or beer, or cider it does this same thing to their brains. We do not want to have our brains cooked with this nasty alcohol, do we? Then we must let all kinds of drinks alone, so as to save our brains from being spoiled by them. Take a piece of this lining out of a fresh raw-egg shell, wet it and put it on your hand, with the inside of the lining down on the hand. Press it down and wait a few minutes. What is it doing now?

What makes it stick to your skin, Mary? Does it hurt, Sadie? Wet the hand and it will come off again.

Place the egg in vinegar or other acid for a day, and the shell will be dissolved.

INSECTS.

The beginning of the fall term is the best time to begin the study of living insects. So many insects are getting

FIG. 10.—OBSERVATION BOX.

ready for their winter sleep that, if they are collected in September, many of their transformations may be watched, and a deep interest will thus be awakened as the pupils find each day that some new change has taken place.

Begin, then, by collecting a few insects, no matter what. Caterpillars are preferable to butterflies, as they have all their changes to go through. To study living insects it is necessary to have some sort of "observation box; those

used for the shipment of honey are very good." But the most approved device of this kind is made by taking common inch boards from six to eight inches wide, and making a box as in Fig. 10. This box should be just long enough to sit upon the window-sill. The bottom and sides consist of board. The ends, also of board, should extend up to eighteen or twenty-four inches above the sides, and plates of glass should fit in as in an aquarium. A fine wire-gauze top should be put on. This prevents the escape of insects and permits a free circulation of air.

Having completed the "observation box," fasten it securely to the window-sill, and then begin to populate it. Every insect caught should be given its own proper food. This is easily done when the collector is careful to bring in a spray of the plant on which it is found. Place the spray in a bottle of water, and set the bottle down in the box. Fresh sprays must be supplied as the old ones wither. Water larvæ may be placed in dishes of water and also set into the box, where their changes may be watched with interest. Grubs dug from the earth may be placed in soil in a can, or the whole box may be filled with mould for their benefit. Thus every condition—light, darkness, air, water, etc.—can be supplied for the study of these creatures.

Having placed your "observation box" on the window-sill, and having peopled it with whatever is *most convenient*, begin a series of systematic observations on one or more of the inhabitants of the box. A good way is to assign some one insect to each pupil, or let two or three pupils observe one. Let them report each day what has happened.

HINTS AS TO THE ORDER OF WORK.

Each pupil will have a notebook, and proceed to :

1. Draw the insect in different positions.
2. Draw the insect in different parts—viz., head, tail, legs, etc.
3. Note his food.

4. Manner of eating (how the jaws work).
5. Manner of motion and locomotion.
6. Rate of eating, etc.
7. Changes in action.
8. Note all changes with dates until death.

Example.—*Asterias* butterfly (caterpillar).

1st Observation.—Describe it with drawing.

2d Observation.—Acts sluggish.

3d Observation.—No change.

4th Observation.—Attached hind foot to roof of box.

5th Observation.—Spins a collar or loop to fasten his head in.

6th Observation.—Rests head in loop and goes to sleep.

7th Observation.—Begins to change color.

8th Observation.—Begins to change form also.

9th Observation.—Assumes a grayish color and a more angular form.

10th Observation.—No change.

11th Observation.—Splits down the back.

12th Observation.—Emerges from shell, a beautiful black butterfly.

These should be accompanied by dates, and thus the life-history of the creature can be determined.

Last fall, while we were studying the metamorphosis of a certain caterpillar confined in a cigar-box, a most interesting duel was observed between two caterpillars of the same kind. Both were about ready to go into the pupa state. One had gone up to the top of the box, and was just beginning to fasten his hind foot firmly to the ceiling; the other, not seeing him, also crawled in the same direction. By the time that No. 2 had reached No. 1 the latter had begun to spin his collar. No. 2 crawled on, and chanced to crawl over No. 1. Then a fight began. No. 1 struck at No. 2 with his head, for he was fastened by his feet to the roof. No. 2 returned the thrust, and each ran out a pair of branching yellow horns, with which they fought until No. 2 fell to the floor, while No. 1, who became dislodged from

the loop, went to spinning himself another, and after he had become a chrysalis his former loop hung useless beside him. No. 2 went elsewhere, and hung himself up for his long sleep. The children made much of this, and many language lessons were built upon it.

The Beetle.

In stocking the observation case with such living things as the children will collect from every locality the question will often be what to accept and what to reject. Often

FIG. 11.—*a*, A BEETLE; *b*, A GRUB.

more than one box seems necessary, but as this is apt to lead to confusion, it is recommended to have only one.

Every locality should be laid under contribution. Stones should be overturned, bark of dead trees removed, and whenever any creature of the insect world is seen he should be taken, with something of his environment, when possible. To explain: A caterpillar should be taken with the branch on which he is feeding; rotten wood with the beetle found in it, etc.

One such "bug-box" contained a bottle of water having some sort of larvæ, a baking-powder box of vegetable mould in which were some white grubs, another full of meal containing "meal-worms," and numerous twigs bearing caterpillars. If these twigs are found in early September, they should be often renewed, and be set in bottles of water to prevent their wilting. Later in the season the caterpillars will not eat so much, and late in September and October no food need be given them, as they are usually ready to form their pupas then.

It is not possible to give the exact names of the insects which will be found. No two cases would be inhabited by the same denizens, but it is reasonable to assume that there will be members of the great families of insects, viz.: 1, *straight-winged*; 2, *net-winged*; 3, *two-winged*; 4, *scaly winged*; 5, *shell-winged*; 6, *half-winged*; and 7, *membrane-winged*. These families may be represented respectively by 1, grasshoppers; 2, dragon-flies; 3, flies; 4, butterflies; 5, beetles; 6, bugs; and 7, bees. On this assumption I shall outline lessons on these typical insects.

Suppose, then, that there is among the insects a grub. The earth will be watched day by day. A pupil will keep count of the days and note when he comes out; also his size, shape, color, and actions.

Suppose it to be a beetle,—for beetles are plentiful enough,—then questions like the following may be asked:

How many parts has the body? Which part is largest? How many legs? Are the legs alike? To which part are the legs fastened? How many joints in each leg? What kind of feet has the beetle? How many wings? How do the outer differ from the inner wings? What is a baby beetle? Grub. Do you see this beetle's feelers? Some beetles have horns on their heads. Let us try to get different kinds of beetles. Let us watch them every day and see how they live.

(*Note*.—Beetles are often called bugs, but they are not real bugs).

Language Lesson.—The following sentences are selected from language lessons and number lessons on the beetle.

The beetle is black. His wings are shining. This beetle is smooth. This little beetle eats potato-leaves. That large beetle eats rotten wood. The beetle has rough legs. His legs have seven joints. His toes are like little hooks. His fore legs are shorter. Do you see the little black eyes? There are knobs on his feelers. The feelers are like a little string of beads. The wings are hard like a shell. The outside wings are stiff, but the inside wings are thin. There are fine wings under the shell. Three legs are on each side. The legs grow to the middle part. Beetles have a head, and a chest, and a big body. A baby beetle is called a grub. I saw a big white grub. The grub was in the dirt. The boy dug up a fat grub. This red beetle has black spots. That brown beetle is a "June bug." I saw a yellow and black beetle with long feelers. Beetles do not sting. Does this beetle eat dirt? Do beetles bite boys and girls? Beetles do not sting or bite us. We should not hurt these beetles. John found three beetles under a big flat stone. I saw a big brown beetle on the vine.

The list of sentences to be made upon the beetle might be increased almost indefinitely. These are samples taken at random from the children's work.

Number Lesson.—1. There are 6 legs on my beetle.

2. $3 \text{ legs} + 3 \text{ legs} = 6 \text{ legs}.$

3. $2 \text{ wings} + 2 \text{ wings} = 4 \text{ wings}.$

4. One beetle has 6 legs; how many legs have 3 beetles?

5 beetles? 6 beetles?

5. $4 \text{ wings} - 1 \text{ wing} = 3 \text{ wings}.$

6. A beetle lost 1 leg; how many had he left?

7. There are 7 joints in 1 leg; how many joints in all 6 legs?

8. $9 \text{ beetles} + 5 \text{ beetles} - 2 \text{ beetles} = ?$

9. A mother beetle had 12 little beetles, 3 flew away; how many were left?

10. A man told a boy that he would give him a cent for

every 10 potato-beetles he would catch. The boy caught 30 beetles. How many cents did the man give him? How many beetles must he catch to earn 50 cents.

General Suggestion.—1. In catching insects note their locality, food, etc.

2. Study them alive, (*a*) their form, size, color, etc.; (*b*) their motions and locomotion; (*c*) food and manner of eating; (*d*) changes, etc.; (*e*) draw back, front, side, and end views; (*f*) draw various organs enlarged.

3. Call attention to all these, and encourage the children to talk about them, and write about them.

4. Make observations the basis of number lessons from 1 to 6.

5. Finally, when the life-history is as complete as possible, kill the insect with a drop of naphtha or benzine, and mount him for future use.

We know far too little about insects, as regards their life-history. Intelligent people often betray the profoundest ignorance of the life-history of the commonest insects. It is time to turn attention into this channel. It will broaden the mind; it will cultivate the heart; it will enrich the memory; it will furnish an exhaustless fund of material for language and number lessons.

The teacher should have a box prepared to receive a collection of insects. This will become a part of the school museum. To kill an insect put a drop of gasoline or naphtha upon it. It will die at once. This does away with the cruel method of transfixing with a pin. To prepare a bug-case, take any shallow wooden box,—one with a sliding top is preferable,—line it with paper, and slide a pane of glass into the top instead of the board top which belongs there. As fast as the insects are killed pin them to the bottom of the box. A small pill-box full of naphthaline powder or crystals placed in this box will keep out dust-lice and moths.

At first all insects may be put into one box, but as the collection grows it is well to have a separate box for each

family of insects. Boxes especially prepared to receive collections may be had at trifling expense from any dealer in scientific supplies.

The Butterfly.

Note to the Teacher.—Among the insects collected will be numerous caterpillars. The beetle in the last lesson

Parts of a butterfly.

FIG. 12.

may be followed by any insect desired, but caterpillars are interesting, as they are beginning to seek places where they

may build, or at least where they may hide, their cocoons during their long sleep.

Among the commonest caterpillars is the one here figured (Fig. 12a). It is a green caterpillar, beautifully marked with black bands and orange-yellow dots. Having procured some of these beautiful caterpillars, place them in the "bug-case" and wait results. If obtained late in the fall, the observer will not have to wait long. While waiting the

FIG. 12a.

teacher may perform this experiment before the children: Select one and tickle him with a feather or other soft body. If this is persevered in, he will become angry and thrust out a pair of branching horns (?), and he will strike at the annoying thing spitefully.

The changes are better told in the accompanying illustrations than in words. It will cover a long time from the time the green larva is placed in the "bug-box" until he emerges from his chrysalis (Fig. 12a, e) a beautiful

butterfly This is a black butterfly with blue and yellow spots on the wings. Note, also, the beautiful orange-red dot at the inner edge of the hind wings. If he can be caught in the act of spinning his collar, there will be no end of interest among the children. The children should also draw the whole and parts of all insects studied, as in Figs. 1, 2, 3, 4, etc. Even the mutilated insects found in street-lamp globes and emptied out every day will supply teachers in city schools with abundant material for work of this kind. Of course, Figs. 4 and 5 can hardly be drawn by children from nature unless you have a glass, but these may be drawn by the teacher on the board to show the children how the wonderful compound eyes are made, and how the beautiful scales are attached to the wings.

THE LESSON.

1. The Caterpillar.—How long is this caterpillar? How wide is it? How is its body made up? Of how many rings? How is each ring marked? What colors has this larva? Have all the rings black bands with dots? Which have not? Which ring has hairs upon it? How many hairs? How many feet has this caterpillar? How many feet on each joint? Do all joints bear feet? How do the feet on the middle joints differ from those on the front joints? How many feet on the last joint? Does the hind foot look like the front or the middle feet?

2. The Chrysalis.—What holds the pupa to the stick? How did this collar come there? How did the small end of the pupa get fastened to the stick? How does the pupa differ in feeling from the caterpillar? How do they differ in color? In size? Is the pupa dead? Can it move? Has this animal lost any rings by changing into a pupa? Can you tell where the feet were?

3. The Imago.—How many parts has this butterfly? How many legs? How many wings? How many feelers? How do the hind wings differ from the fore wings? What color are the spots on the wings? Are all spots alike?

Which ones are yellow? Which blue? How many rows of spots on the front pair? On the back pair? How many rings in the abdomen? Notice the black dust on the wings. Look at it with a glass. See the long tongue. How long are the tails on the wings? Look at the little toes. Draw the head: 1, front view; 2, side view. Draw the scales. Are the scales all alike? Are they alike on all parts of the insect? Draw the front wings. See the veins running through them. Draw the hind wings.

CONTRAST.—How do butterflies differ from beetles? 1, front wings; 2, hind wings; 3, antennæ (horns or feelers); 4, legs; 5, size; 6, color; 7, manner of flying; 8, food; 9, the way they use their wings; 10, manner of creeping; 11, shape of the joints of their legs; 12, covering of wings.

COMPARISON.—Wherein are butterflies like beetles? 1, number of parts of body; 2, made of rings; 3, number of legs; 4, attachment of legs; 5, number of wings; 6, compound eyes.

By such a lesson as this the characteristics which belong to insects as such are brought out, and the distinctions between the shell-winged (coleoptera) and scaly-winged insects (lepidoptera) is also brought out in such a way that the child can easily see that these creatures, so different in some respects, are very similar in others. It is thus that real scientific work is done, and the child acquires scientific habits of thought, and at the same time he is developing material for language- and number-work.

Language Lesson.—This is a butterfly. The butterfly is black. A baby butterfly is a caterpillar. My butterfly came from a green caterpillar. The caterpillar had a green and black dress. There were yellow spots on the green dress. He ate green leaves then. The black dust came off his wings. He has two horns. The horns have knobs and little hooks on them. His eyes are very big. This butterfly has a long tongue. He eats honey with it.

Number Lesson.—1. 12 rings — 2 rings = 10 rings.

2. 2 wings + 2 wings = 4 wings.

3. 2×4 legs = 8 legs.
4. 8 legs + 6 legs = 14 legs.
5. If 1 caterpillar has 12 rings, how many rings will 3 caterpillars have?
6. If 1 ring has 6 spots, 10 rings will have how many spots?
7. If 1 butterfly had 4 wings and he lost 1, how many has he left?
8. How many legs has a butterfly?
9. How many more legs has a butterfly than a cat? A boy?
10. If 1 eye has 6 sides, how many sides will 13 eyes have?

Suggestions.—I have given only a few sample problems and sentences to illustrate the line of work to be followed with primary pupils.

It is a good plan to give all the language and number lessons on the days following insect study in some such way, and so review the insect previously studied.

Another excellent exercise in language is to write a skeleton on the board and have blanks filled in with the necessary words. I give an outline as follows, which may be varied indefinitely to suit pupils of every grade in language:

Mary saw a large green . . . on a stick. He had . . . rings, and all but two had . . . bands with . . . on them. Mary put the green . . . in a cigar-box and she watched him every day. After a while he began to act . . . He spun a . . . for his neck and fastened his foot so that he might rest. Then he became . . . and . . . After a great many days his shell was empty. There was a big black . . . in the box. I think that the . . . came out of the . . . This butterfly had . . . on his wings, and his . . . had knobs on the ends of them. His toes are little . . . He has . . . wings and . . . legs. His . . . is three-parted. A baby butterfly is called a . . . A caterpillar is not much like a grub. A beetle is not much like a . . . , but they are both . . .

A Talk about the Fly (House-fly).

The children should catch several flies. If possible, each child should have one or two.

Let us look at this little fly. How many wings has the fly? What color are the fly's wings? What shape are they? How many parts has a fly's body? We call the part next to the head the chest or thorax. We call the other part the abdomen. Ab-do-men is a big word. I will write it on the board. You may write it on your slates. Now, Nellie, you may tell us something about the fly. "The fly has three parts." That is very good indeed. Georgie, what else did we learn about the fly? "He has two wings." "The wings are clear." "There are fine marks on the wings," etc., etc., will easily come out.

On which part of the fly do the wings grow? On which part do the legs grow? How many legs has a fly? Now look carefully and see if you can find two little balls, one on each side, near the wings. Tell them that these little balls (balancers) are to keep him steady when he flies in the air. Call attention to his red eyes, and to his peculiar mouth, which can be easily seen in most flies. Get them to tell you all they can about flies; their habits, food, etc. Tell them that the fly lays her eggs on meat or other animal substance, and that the eggs hatch into maggots. These develop into flies. What animal is the enemy of flies? How does he catch them? Did you ever see a spider catch a fly?

Select one or two good specimens and pin them to a board, or, better, to the inner surface of a pasteboard box. Ask the children to see how many kinds of flies they can find to put in your collection, as house-fly, horse-fly, bee-fly, bot-fly, bottle-fly, etc., etc.

Bring out the fact that true flies have never more than *two* wings. What kind of food do flies like—sweet or sour, solid or liquid?

When are flies most common? What do we do to keep

them out of the house? How can we get flies to go out of the house of their own free will? By darkening the house and by leaving one light opening, as a window-blind partly open. Flies abhor darkness and fly toward the light-crack. They will soon pass out if it be a warm sunny day outside.

Are flies of any use to man? How? Take a piece of sticky fly-paper and when several flies have become entangled take a simple magnifying glass and examine carefully. If you find one which is gray in color, or one which has small bright scarlet specks on it, look at such a fly closely. The gray dust and scarlet specks will be found to be *lice* which live on the fly.

Did you ever find flies under a board or stone? Why do not flies live as crickets, ants, and beetles do? Nature has given different tastes and inclinations to insects, as she has to different races of men. Some prefer the dark, damp seclusion of the earth, others the sunny freedom of the atmosphere, but all work together for good in one way or another.

Repeat the *Spider and the Fly*. What is the parlor? The "winding staircase"? etc., etc.

The Grasshopper.

Henry has just brought me a fine grasshopper. He caught it in the yard. Are they easily caught? How do they move from place to place? Why do they move so? Let us place him under this tumbler and we will watch him. Can you tell me how I know that the grasshopper is an insect? Why so called? He has six legs. His body is three-parted."

Let us first study his head. Examine the eyes under this glass. Are they compound eyes, like those of the dragon-fly? Examine the feelers (antennæ). How are they built up? Look under the eyes and see him move the *lips*. See the small feelers on the lower lip. These are *palps*. How many parts has the chest (thorax)? To which part are the

fore legs attached? What are attached to the second part?

See how the hind wings and hind legs grow to the third part. How do the legs compare in size? What other insect that we have studied has such big stout hind legs? The cricket. Yes, the cricket has such legs. How do the wings of the cricket compare with those of the grasshopper in number, form, veining, size, and position when at rest?

FIG. 13. GRASSHOPPER.

How many rings make up the abdomen? Look closely at the egg-depositors (ovipositors) at the end of the abdomen. How do they compare with the leaflike bodies at the end of the dragon-fly? See the small holes on the side of the abdomen. They look like a row of buttons down his sides. These are breathing-holes (spiracles). See how his abdomen swells as he breathes. Let us give him a tender piece of cabbage and see if he will eat it.

How do they jump? How do they fly? Can they walk? Do they fly with fore or hind wings principally? Why?

What kind of insect shall we call this? Straight-winged. Yes, we will call the grasshopper a *straight-winged* insect.

Draw the head, front view, side view, top view. Draw each leg. Draw the wings. Draw the insect with wings spread. Draw him side view.

Write what you know about grasshoppers; where found, food, habits, and describe the insect as fully as possible.

Note to Teacher.—I would not kill and dissect any insects. Biology is too advanced for children; besides, it teaches a moral lesson to be kind to every living thing. I would not go so far, however, as to condemn the study of parts of dead insects. When it becomes necessary to kill such things, do it by the shortest and easiest method, viz., drop a few drops of naphtha, gasoline, or benzine on the insect and it will kill him instantly. I have seen a beetle transfixed with a pin to a door struggle and suffer for days, while the children looked on and got enjoyment from it. In all our dealings with animals and children we should constantly keep before us the fact that our lessons must have not merely an informational aim, but above all they should have an ethical aim; and when a child is constantly made familiar with the killing of living creatures his better nature cannot help being seriously affected by it.

A Talk about the Walking-stick.

I fancy when you look at this slender fellow you will say: "Here is a creature that looks like an insect so far as the legs and jointed body goes, but you told us that the bodies of insects are always divided into three parts, and this one has more than three parts to his body. Besides, this creature has no wings." Well, it does seem so at first sight, but if you will remember that the legs and wings are always attached to the thorax (chest or middle part) you will have no difficulty in seeing that this insect has also a three-parted body.

He is long-waisted—that is all. And his waist is made of three parts. These three parts have big names. Beginning at the head, they are called prothorax, mesothorax, and metathorax, but all we need to remember is that the thorax has three parts. In the insects we have studied these parts are not so easily seen, but in this family they are always easily found.

See what long feelers the walking-stick has! Compare these feelers with those of the katydid, grasshopper, and cricket. You see they all have long feelers. Look at these feelers with a glass. They are like a string of beads. Examine the mouth and the eyes; how they project from the head. Compare the neck with that of the dragon-fly. Compare the legs with those of his cousin, the grasshopper.

The walking-stick can creep along very fast, because his legs are so long and his body so slender.

Green ones may be seen among bushes in summer, and gray ones in barns, upon the ceiling and walls.

Sometimes they grow to be very large. One kind becomes over a foot long. The walking-sticks have many relations in warm countries.

The walking-sticks are harmless creatures, but they have many enemies. Nature has made them look so much like hay or twigs that they can thus hide, and no one can see them as they stand upon the limb of a tree.

One summer I saw hundreds of them in a barn. They were everywhere, but to any one who was not looking for them it would have been impossible to realize how many were there.

FIG. 14.

They were just the same color as the hay, and looked like it. They could only be seen when they began to move.

Suggestions.—Draw the walking-stick.

Write a careful description of it.

Write all you have learned of its life-history.

Compare it with the grasshopper and the katydid. Draw a contrast.

Compare and contrast the walking-stick with the butterfly, beetle, and dragon-fly.

Write an imaginary conversation between a walking stick and a grasshopper.

Write a story of a walking-stick who escaped from its enemies because of its ability to hide.

Questions.—If you were going to give a walking-stick one pair of wings, where ought they to be fastened on?

Where if you gave two pairs? Did you ever see an insect with wings on the first section of the thorax (prothorax)? What other wingless insects have you seen? Where were they? Why does nature give some insects wings and others none? If he had wings, what kind would they be? Yes, they would be straight like those of his cousins, the grasshopper and katydid. Make a list of winged and wingless insects you have seen.

A Child's Story.

A pretty green walking-stick lived in a bush. He was very lean and long, and he looked very hungry. He was not hungry, for he had plenty to eat, but he could not get fat. When he heard the birds coming, he just put his feet together and stood still. The birds could not see him, because he was green and looked just like a little stem.

JENNIE CARSON.

Measurements.—The walking-stick is four inches long. His legs are two inches long. All of his legs are twelve inches long. If his legs were placed end to end, they would reach a foot long. His body is twice as long as one leg. The feelers are three inches long. There are nine joints in the abdomen, and three in the thorax. If I add one for the head, there will be thirteen joints in his whole body.

The Cricket.

I will introduce you to the grasshopper's cousin. We found this little creature under the stone in the yard. What is its name? Describe it carefully. Are crickets easy to catch? How do they go? How do you catch them? Do they bite? Do they sting? Can they jump as far as a grasshopper can? See how nature has fitted them for jumping. Their hind legs are very much longer than their

FIG. 15.—*a*, YOUNG CRICKET; *b*, FULL-GROWN CRICKET.

fore legs. Are their wings like those of the grasshopper? They are shorter. Can crickets make a noise? We say that they chirp. This cricket is black. Let us put a living cricket under a glass and watch him. See how he moves his jaws.

Crickets feed on tender roots and leaves. Mole-crickets often do much harm to the roots of plants, because they eat them, and sometimes this kills the plants. Mole-crickets

have large claws, so that they can dig down into the earth just as a mole does. See the short stiff hairs on his hind legs. If you look closely, you will find on one of his wing-veins some short stiff hairs also. When he scrapes his leg across his wing, we hear the noise which we call chirping. Put the cricket into this dark box and perhaps he will chirp for us. Some say, "*Te-weet, te-weet*," some say, "*Katy-did, katy-did*."

The crickets, katydids, grasshoppers, and walking-sticks, all belong to the same family, because their wings are straight. They are straight-winged insects. We will call them cousins.

Let us write down what we have learned about the cricket.

Sometimes crickets live about houses. In old houses they often live around the fireplace. Did you ever hear the story of *Old Dame Hicket*?

"Old Dame Hicket
Had a wonderful cricket
That lived in a hole by the fender,
And when he came out
He would dance all about
On his hind legs, so tall and so slender.

"This pleased the old dame,
So she gave him a name,
Little Peter it was, you must know;
And she fed him with crumbs
'Twixt her fingers and thumbs,
Then into his hole he would go."

Was this a true story? Draw the cricket as you think he looked in this story.

The poem *To an Insect*, by Oliver Wendell Holmes, and Dickens' *Cricket on the Hearth*, may be read to the class.

The Bee Family.

To-day we will study a new family of insects. These are busy little creatures, always working. They are great build-

ers, too. They are bees, and are cousins to the wasps, hornets, and ants. Do you see how their bodies are divided? They are very different from the beetles and dragon-flies, and yet they have many features in common with them.

Their bodies are jointed—how many parts? Three: head, thorax, and abdomen. See the long slender neck

FIG. 16.

which joins the thorax of the wasp to his abdomen. How many wings has the bee? How do the fore wings compare with the hind ones? See if you can find the hooks which fasten the hind and fore wings together. Compare the wings with those of the beetle, butterfly, and dragon-fly (1) in shape, (2) in size, (3) in structure, (4) in texture. We

call bees membrane-winged insects, just as beetles are shell-winged, and butterflies scale-winged.

Compare also the feet, heads, and shape of the different parts of the body with the same portions of other insects you have examined.

Take a large wasp or bee and examine its mouth carefully. The dried specimens collected last summer may be rather hard to examine, but a little care will show that these insects have a very peculiar mouth fitted both for suction and for chewing. This is different from the butterfly with its long trunk for sucking, and the beetle with his powerful jaws. Examine the sting in the end of the body, and if you have a microscope pull out the sting and examine carefully. The feet will also be found to differ greatly from those of the beetle, dragon-fly, and butterfly. Count the rings in the body.

Tell all you know about bees; their food, homes, and manner of living. Find out more by inquiring and reading. The wonderful government of the hive, the acts of the drones, the workers, and queens, will inspire interest for many days.

Wasps.

Nests of mud-wasps are very common. The large ovoid homes of the paper-wasp are not uncommon in brush and open places. Samples of these as well as of the honeycomb kind can be obtained to exhibit before the class. Tell them how the wasp bites off wood, gnaws it, so to speak, chews it up, and mixes it with saliva to form paper. It is from the wasp that mankind learned how to make paper. Cut open the wasp nest and show the beautiful inside arrangement. Talk about hornets, yellow-jackets, and other insects of this family. It is the most useful to man of all the insect tribes.

Talk about honey as a food; how it is made, its great importance in the ancient world, when it took the place of sugar. Tell how the wax is an excretion from the sides of

the bee; that it occurs in the form of scales, which the bee picks off to use in laying up the walls of the cells.

Ants.

Remark how much they resemble wasps. Ordinarily they have no wings. But some kinds have wings. Ask the class how ants live. Do they make a comb, as the bees do? Do they build homes of mud or paper, as the wasps do? Describe ant-hills. How large is the largest ant-hill you ever saw? Are all ants black? Can they sting? Do ants ever get into houses? What food do they like best?

Bring out the extraordinary strength of ants; how they can carry many times their own weight. How they seem to talk with one another by touching their antennæ together.

Tell the children that there is an acid (formic acid) in ants. The natives of Brazil make ants into salad. They esteem the sour taste of ants as a great delicacy.

Note to the Teacher.—There is no better chance to teach lessons on morals, neatness, industry, thrift, management, economy, etc. than is afforded by using the bee family as a model. Man owes more to bees than to any other insect, if we except the silkworm.

Mention may be made of the "ant-lion," an insect which constructs a den into which the ants sometimes go and are caught. Allusion may also be made to "ants' cows," i.e., plant-lice which yield a drop of sweet fluid when ants touch them.

The famous ant-eater may also be described.

Review lessons to test the memory and to give language and number drills may follow these lessons on bees, wasps, and ants.

NOTE TO TEACHERS.—With each new insect it is always advisable to introduce comparisons between the insect on hand and those previously studied. In this way the memory of past lessons is refreshed, and essential likenesses and differences are more strongly emphasized.

Talk about the Dragon-fly.

Children, the beetle with its hard shell-like wings, and the butterfly, whose wings are covered with beautiful scales, has been in our class-room. Now I am going to show you an insect which is a great friend to boys and girls, but some boys and girls are afraid of it. Can any of you tell me what it is? "A bee, because it gives honey and stings." No, not this time. This is an insect which goes about always doing good, killing the insects which harm us, but we often say very bad things about him. Here it is. What is it? "A darning-needle."

FIG. 17.—DRAGON-FLY.

"A snake-feeder." "A dragon-fly." Yes, it is a dragon-fly. Did you ever hear what mean things people tell of him? "They say that dragon-flies will sew up your ears." Yes, that is what they say, but it is not true. I want you to know and love this beautiful insect, for he does us much good, as you shall see.

Only see what a large head he has, and what a small neck. Look at his great eyes. Each eye is as large as all the rest of his head. If you look closely, you can see that his eyes

are like those of the butterfly; those were made, you will remember, of a great many little eyes.

Into how many parts is this insect divided? How does the abdomen compare with the abdomen of the butterfly? The beetle? How many rings in the abdomen? Where is the end of the abdomen? What is the shape of the abdomen? How does it compare in length with the chest (thorax)? How do the wings differ from those of the butterfly? The beetle? The wings are like lace or netting. How long is the fore wing? Hind wing? How wide is the fore wing? Hind wing? Draw the insect back view, front view, side view. Draw a fore wing exactly. Notice the beautiful veining of the wings. Examine the legs carefully. Notice the little feet. Did you ever see dragon-flies different from this one? Yes, some have shorter bodies with brown bands across the wings, and some are much smaller and deep bright blue in color.

Notice the colors of the wings when held sidewise in the sunlight. This is somewhat like the colors of a soap-bubble.

Natural History.—The eggs are laid in the water, where they hatch out into a large larva. The larvæ feed on wigglers (mosquitoes), and when ready to come out of the water they split open and escape pretty much as the mosquito and the cicada do. Then they fly away in search of more mosquitoes. It is claimed that during their entire life the dragon-flies live on mosquitoes. That is why they are such friends to man, and that is why they like to fly around the water where mosquitoes are to be found.

Did you ever watch a dragon-fly as he flew along? How he darts forward and then pauses in mid-air, seeming to be at rest while his gauze wings beat the air at a truly wonderful rate.

Language Lessons.—I saw a big dragon-fly. A boy said he would sew up my ears. The dragon-fly has four wings. The beetle has four wings. The dragon-fly cannot dig in the dirt like a beetle. If he dug, he would tear his wings. The butterfly cannot dig. The dirt would scrape the dust-

scales from her wings. The beetle can dig in the dirt. The dragon-fly is five inches long. The wings are long and thin. The eyes are big. His neck is like a little string. I should think his head would come off. There are two green stripes on his chest. His legs are bent. He has three tails. He has nine rings to his abdomen. His abdomen is long like a needle.

Number Lessons.—1. A dragon-fly ate 6 mosquitoes for breakfast, 5 more for dinner, and 4 more for supper; how many did he eat that day?

2. There are 9 rings in the abdomen of a dragon-fly; how many rings in 5 dragon-flies?

3. A dragon-fly's body was 2 inches longer than its fore wing, and its fore wing was $2\frac{1}{2}$ inches long; how long was the fly?

4. A dragon-fly flew 6 rods in 2 seconds; how far did he go in 1 minute?

5. How far would he go in 5 minutes.

6. One eye has 12,500 parts; how many in both eyes?

7. How many more antennæ (feelers) has a beetle than a dragon-fly?

8. A butterfly lent one of her feelers to a dragon-fly; how many feelers had she left?

QUESTIONS ON THE DRAGON-FLY (A NET-WINGED INSECT).

Teacher (showing the insect).—Children, what is the name of this animal?

George.—It is a darning-needle.

Helen.—It is called a snake-feeder.

Willie.—It is a dragon-fly.

Teacher.—Why do they call it a darning-needle?

Mary.—Because it will sew up our ears.

Teacher.—That is a very wrong thing to say about this beautiful insect. It does not do such a thing as that. Some call it a darning-needle because its body is long and slender.

George.—Where I used to live they called them darning-spindles, or snake-spindles.

Teacher.—Where do the dragon flies-live?

Willie.—They fly around where there is water.

Teacher.—That is because they feed on mosquitoes. How do you know that this creature is an insect?

Helen.—It has six legs and there are three parts to the body.

Teacher.—Describe the head, Mary.

Mary.—The head is large. It has two big eyes bigger than the rest of the head.

Teacher.—How is the head fastened to the body?

George.—By a small cord. The head is very loose and will turn about.

Teacher.—Describe the chest or thorax, Charlie.

Charlie.—The chest is twice as large as the head. The six legs are on the lower side. The four wings are on the upper side.

Teacher.—What do the wings look like?

All.—A net.

Teacher.—Has the dragon-fly any balancers like the house-fly? How many joints in the abdomen? Describe the tail. Notice the short hairs on the legs. Have any of you ever seen larger ones? Smaller ones? Let us collect different kinds for our collection.

THE FISH.

I have found it very interesting to take almost any living thing, such as a fish or a canary bird, bring it to the school-room in its globe or cage, and let the children study the living creature. There is vastly more interest awakened in observing anything *alive* than the same thing *dead*. The crickets, bees, and other insects are always better studied under a glass when living than when pinned out stiff in death upon a cork. We must not lose sight of the fact that it is *nature* we are studying rather than *science as such*.

Material.—I. If possible have a *living fish* swimming in a dish. A goldfish is good. Goldfish can be hired in the

city, but if boys can catch a fish in the brook it is much better. My boys caught a pike by breaking the ice and getting him with a small dip-net. This is easily done when the water is frozen over, because the fishes then are more or less torpid.

2. Some *dead fish* : These may be had at the market, and even dried *herring* and salted *mackerel* are useful.

3. An entire skeleton or a portion of a skeleton of some fish. The skeleton of a mackerel is easily obtained by scalding and carefully separating the flesh from the bones.

4. Any other parts of fishes that may be procured easily.

FIG. 18.—GOLDFISH.

Observations.—1. *On the living fish.* 2. *On the dead one.*

Notice the shape of this fish. Draw it. The color. How does he move the mouth? The fins? How many fins? Where are they situated? How does he swim?

(Many will say, "With the fins," but careful observation will soon disclose the fact that the fins serve to balance the fish in the water, while it is the tail fin which propels the fish through the water.)

Bring out the fact that the fish has fins to correspond with fore legs and hind legs.

How is the tail divided? Draw it. Are the parts equal or unequal?

We call the fin on the back the *dorsal* fin, and the one below near the tail the *anal* fin. Point out the *dorsal* fin on the dead fish. Point out the *anal* fin. Notice the parts of the fins. See the fine spines which form their framework. How many spines in the dorsal fin?

We call the tail fin the *caudal* fin. Compare the caudal fins of these fishes. Sketch them.

Measure the fish from the tip of the head to the base of the tail. What part of this length is head?

Open the mouth of the dead fish several times. See how the bones and gill-covers move. Is his mouth large or small when compared with the size of his body? Open the

FIG. 19.—PERCH.

mouth wide and feel the teeth. Are there many or few? How do they point? Where are they placed?

Now see the eyes. Can the fish wink? Has he eyelids? Why not? Can he move the eyes around and look upward, right, left, and downward as we can? Why, then, do fishes swim in a zigzag manner? Try to move the dead fish's eye. Can you push it so as to make it turn as our eyes turn?

Can a big fish catch a smaller one easily when the smaller one goes swimming in this way from side to side?

Lift up the gill-covers. See the dark-red fringes of the gills. Put your pencil into the fish's mouth and out at the gills. That is the way water goes as the fish breathes,

The fish does not swallow the water, but merely allows the water to pass through so as to wash the dark-red fringes of the gills. That keeps fresh water near the gills all the time, and so the impure matters of the blood, escaping into the water from the gills, are quickly washed away. Pure oxygen in the water enters the fish's blood through the gills and purifies it.

If we will leave the fish in this water a long while, he will begin to pant, or move his gills very fast. He will come to the surface and swim about restlessly. That is because the water has lost most of its free oxygen. If we did not change the water, the fish would soon die. Why do not fishes in the brooks and ponds die? The plants growing in the water take up the impure matters and give off oxygen to

Pupil's work.

Drawn by Mattie Alexander
Chatham, N.J.

FIG. 20.

the water, and fishes give to the plants just what they need for their food.

Scrape off a scale from the fish. See the little socket where it grew. See the markings like those on a shell; notice how they lap over each other like the shingles on a roof. See how nicely nature made the fishes to swim in the water. How easily their narrow pointed bodies cleave the water.

Let us now see how a fish is built up. Here is a skeleton. See the parts of the backbone (vertebræ). Count them, and also count the ribs. The fish has a backbone (spine), as we have. Note how it joins the skull. See how carefully nature protects the spinal cord by its position. (It is not

desirable for younger pupils to dissect a fish. The anatomy is too complicated to do that. Older pupils may dissect, but in a large school I would not recommend it.)

I conclude this lesson with a sample of pupils' work on the pike, to which I have alluded.

The fish lived in the school-room, having the water repeatedly changed, but at length it died, owing to some hurt received when captured.

After death we studied it as above outlined, and made it the theme for drill in language, punctuation, capitalization, and paragraphing. The following is one of the pupil's compositions :

The Pike.

(Description by Anna Hess, 8th grade, public school, Chatham, N. J.)

The pike is a long slender fish. This one is about seven inches long. It is shaped somewhat like a cigar. Its color is of a dirty greenish white changing to gray. There are eleven black or dark-brown stripes across the back.

The six fins are very delicate pink in color. They move backward and forward in the water, and so balance the fish not to let him tip over.

The bright eyes are on the sides of the head. They are very large and they project from the sides of the head. The fish has no eyelids. He does not need any. The water washes the eyes, and so saves having tears and lids. A fish has no ears, but there is a round spot back of the eyes. That is the ear-drum. The pike-scales are very small and thin. The fishes do not like water unless it is fresh.

The fish acts nervous when the water gets stale, just as boys do when the air in the school-room is bad.

The Clam-shell (a Special Expedient).

Note to the Teacher.—It is not well to pursue the same plan with every lesson. The manner should be varied as much as the matter. As one way to vary the manner of giving the lesson the following is suggested : Let the thing in question be a shell—say a clam-shell. Let the teacher

SUGGESTIONS TO TEACHER FOR FURTHER LESSONS.

1. Let pupils draw the clam-shell open and closed, exterior and interior.
2. Compare clam-shell with that of a fresh water mussel.
3. Compare clam, mussel, etc., with oyster-shell.
4. Get the living clam when possible and examine him.
5. Let pupils write descriptions with the shell before them.
6. Also write a description from memory.
7. A comparison of the above shells will be a good language lesson.
8. Also the differences neatly stated.
9. Let them write what they find as to the habits of life of each of these animals.
10. Let each child take a good shell and neatly print the name of each part upon it.
11. Let them write the story of a clam ; its autobiography.
12. Encourage the collection of shells for the school museum. The pupils will hunt for land- and water-shells, and solicit contributions from people who have them and care little for them.

TABULAR COMPARISON.

Clam-shell.	Oyster-shell.	Razor-shell.
Round-oval	irregularly oval	linear
Lines parallel	lines not parallel	lines parallel
Hard and white	softer and gray	brittle, white
Naked	naked	covered with horny skin
Both shells alike	shells not alike	both alike
Hinged on side	hinged near end	hinged on side
Two muscular impressions	one impression	two impressions
Muscular impressions white	black	white
Sinus pointed	sinus irregular	sinus square

BONES. I.

Note to Teachers.—Bones will be found, and usually one will find its way to the teacher's desk. Whether it does or not, it is well to supply various kinds of bones. Fresh

Alice.—The outside is round.

Henry.—There is a point (beak) on the outside.

John.—The edge is full of fine notches.

Isabel.—There is a dark purple mark on the inside.

Hattie.—There are two shining spots on the inside near each end.

Alice.—One side is sharp like a knife.

Willie.—There are three little sharp teeth on the inside near the point (beak).

Charlie.—There is a line near the edge running all around the shell.

Harry.—The line has an angle near one end of the shell.

Teacher.—That is what I have in mind. The lines on the outside are called lines of growth, because as the clam grew his shell grew little by little. The point on the outside is called the beak or umbo. It is the beginning or oldest part of the shell. The fine notches around the edge help the clam to hold the shell firmly together when it is shut. Some shells have but little of the purple on them, and some are very beautifully colored. The two shining spots inside are where the strong muscles are attached to help the clam to pull his shells together and hold them shut. The sharp knifelike edge on the back is called the hinge, because it fits into a groove on the other shell (valve). The three teeth are to fit into three little sockets on the other valve so as to hold both shells firmly together. Do you see how safe the clam is when his shell is shut?

The clam cannot leave his shell. He grows to it. He has a loose cloak or *mantle* that covers him and grows to the inside of the shell down to the line that runs all around near the edge. The *mantle* rolls up behind and does not grow so near to the edge, and that makes the notch on the back. We call the part of the cloak that is rolled up the *siphon* and the notch on the shell a *sinus*. The word *sinus* means a *bay*, and this is so called because it looks like a bay on the map. The siphon is important, for it helps the clam to eat and breathe.

examine the shell thoroughly before school. Let her notice something prominent, but not too obvious, about the shell.

I am going to give you some shells to-day. I want you

FIG. 21.—THE CLAM-SHELL. (LIZZIE WRIGHT).
a, Outside; b, inside; c, front view.

to observe them very closely. I see something, and I want you to try to find out what it is that I have in mind.

Mary.—It has fine lines or ridges on the outside.

bones, burnt ones, and some which have been buried—all are of use in teaching this subject.

Preparation.—Procure a chicken leg-bone and three soup-bones ; the best are ordinary marrow-bones. One of the latter should be fresh from the market, with marrow in it, and sawn open by the butcher ; the other may be obtained from the kitchen after soup has been made. Boil this second bone in strong suds to remove fat. Scrape off the specks of muscle, etc., and remove the remains of marrow with a soft cloth on a stick ; then get the butcher to saw this bone also. The third marrow-bone should also be an old one, and should be put in the fire for half an hour to burn out the animal matter. The chicken bone should be

FIG. 22.—SECTION OF BONE.
s, s, s, Articulating surfaces.

immersed in diluted hydrochloric acid, and left overnight to remove mineral matter. When the above articles are ready, they may be placed in a box and taken to school for use.

The Lesson.—I. Pass the raw bone around the class. Point out bone, marrow, smooth covering of bone (periosteum), very smooth moist end of bone (synovial membrane); notice where ligaments and tendons join the bone. Bring out the fact that the marrow is merely fat stored away in the bones for use.

II. Give them the boiled bone to examine. Note its form, size, structure ; that it is larger at ends. Why ? That it is softer at ends. Why ? That it is harder and more

slender at middle. Why? Call attention to the marrow-cavity, the delicate fibres of bone at its ends. Describe the cavity. Is it lined with periosteum? etc., etc. Draw figure of the interior of bone.

III. Exhibit the burnt bone. The animal matter is burnt out; what kind of matter remains? Exhibit the chicken bone. The mineral matter is dissolved out; what kind remains? Bone, then, consists of two kinds of matter, animal and mineral.

The above is sufficient for young children. More extensive lessons may be made by calling attention to the end of a freshly broken piece of burnt bone, where the ends of fine pores (canals) may be seen. The effects of weather and soil on bones may be brought out by samples of bone picked up on the ground. Uses of bones as levers, and as organs for protection of delicate parts. Their use as a fertilizer, and their employment in arts, may also be brought out. The pupils may then write what they can of bones.

BONES. II.

SOME EASY AND USEFUL DEVICES FOR TEACHING THEM.

It is a fully determined principle that the way to teach *things* is to bring the *things themselves* into the class-room. This is opposed to the usual way, which gives the pupil a book to study what some one else has seen.

This principle is well established in the teaching of physics and chemistry. It is no less applicable to physiology and kindred subjects.

How much clearer is the knowledge possessed by a child of the turbinial bone after he has *seen* one and noted its convolutions. How much clearer is his knowledge of a joint *when he has himself put one together*.

The memorizing of the names of bones, the classifying of various species of joints, is proper when it follows the observation of the things memorized. But when taught, as is usually the case, purely from the text, it results in a most

confusing and evanescent impression on the pupil's mind. As a simple means for bone and joint study, and as a useful bit of apparatus in any school, the following suggestions are offered :

Feet of Fowls.

These are easily obtained from city butcher, or boarding-house cook, or farmer's wife.

I. Give a short lesson on the feet, calling attention to scales, their shape, size, color ; the nails ; the shape and positions of toes. Pull the cords at the upper end, showing that these cords extend to the toes and move them. This will give them an idea of the use of the tendons.

II. Place the feet in a pan, cover with water, and boil for some time. Give each foot thus boiled to a pupil, or let

FIG. 23.—TURKEY'S FOOT.

two pupils work together. If the feet are well cooked, the flesh is easily removed. Let the pupils clean the bones *carefully*, laying each bone by its mate when cleaned. Place the bones on a card or board to dry. When dry, have the pupils arrange them in their order. Bring out the fact that each bone *fits* its neighbor at the joint. *No other bone will fit exactly.* Notice that the bones are grooved at the joints so as to permit motion in *two directions only*. This is therefore called a hinge-joint.

III. Lastly, use glue or strong mucilage and have the

FIG. 24.—QUAIL'S FOOT.

pupils fasten the bones in position. Glue the foot to a card or block ; have it signed by the pupil as a souvenir of the work. Older pupils can bore the bones and wire them.

FIG. 25.—DUCK'S FOOT.

IV. A very practical way of securing the greatest benefit to the greatest number, and having pupils of *one class help another*, is to have the older pupils make awls, bore bones, and have the younger pupils use them for *seat-work*.

1. To make the awls : Select some coarse needles about two inches long. Lay a piece of flat iron or any smooth iron on the lap. Heat the needle-point red-hot in an alcohol lamp or other flame and lay it on the iron and strike it while red-hot with a hammer ; this will flatten the end or point like a chisel. The heating has removed the temper. Reheat to redness and plunge in cold water to retemper. The boys can whittle out handles and set the school-made awls into them.

2. Bore the bones from end to end like beads.

3. For seat-work give a child the bones of a foot which has previously been bored, and give him also needle and thread or piece of fine wire. Ask him to string the bones and make a chicken's foot of them. The feet and also all kinds of wings may be managed in like manner.

BONES. III.

I. *Wings.*

Having eaten the flesh from the wing of chicken at dinner, save the bones and boil them in a little strong soap-suds to remove the grease. These may be glued or wired as in the preceding lesson. If the teacher cannot

find time for such work in school, they may be fixed and mounted on Saturday for use in the school museum, and, being kept, will serve for years in giving instruction on bones and joints.

Nothing affords more interest to the pupil than to procure

FIG. 26.—SHEEP'S FOOT.

and prepare skeletons and parts of skeletons. The feet of sheep, of pigs, and of calves are obtained for the asking of any butcher, and the village and country boys can tell where to find the bodies of horses, goats, and other animals long since deceased. In an experience extending over many

years I have never found lack of *material* or lack of *enthusiasm* in pupils as a reason for neglecting this kind of study. It smacks of adventure. It is conducting them into a field full of new facts and awakens new interest in them.

II. *Sheep's Fore Leg.*

Boil the leg until the flesh is very soft and is easily removed from the bones. If it has been boiled long enough,

FIG. 27.—HORSE'S FOOT.

the bones may be cleaned by wiping off the flesh which adheres. Then add plenty of soap to the water and boil the bones. This will remove the fat and render the bones white. They should be bored and wired.

The teacher who tries this alone, or who requires the pupils to do so, will not regret the time so spent. The

adaptation of bone to bone is as beautiful as the arrangement of the parts of a flower.

BONES. IV.

SUTURES AND BONES OF THE SKULL AND FACE.

Some of the bones of the skull give trouble to students. The *ethmoid* and *turbinal* bones are rarely understood perfectly, and I have found even medical students unable to

FIG. 28.—SKULL AND FOOT OF QUAIL.

point out the first of these two, even from a skull. Few schools possess human skulls, and as a means to make clearer the study of skulls the following is suggested :

Procure any skull, as of a sheep, from the butcher. Have him saw it through the middle from front to back. First give the skull a boiling in hot water with soap or sal-soda ; then rinse it thoroughly and dry.

Point out each bone and call attention to the beautiful sutures that run between the bones. If it is the skull of a

cow, be sure they notice that in lieu of front teeth the cow has a bone (pre-maxillary) not found in man.

Show the interior of the skull. Here the ethmoid and sphenoid bones are exhibited clearly, and the office of each is plainly indicated.

The delicate turbinal bone rolled up in its narrow chamber and the long knifelike vomer are easily found and form most interesting objects. Procure enamel paints and paint each bone a different color, so that the shapes and outlines of the bones and the interlacing of sutures are brought out into sharp contrast. After the paint is dry label each bone and mount the skull on a board.

This will form a useful object for future lessons, a necessary piece of apparatus made by pupils while learning the subject. Of the bones not found in human skulls nothing need be said. The pupils of the Chatham School prepared the skulls of the cow, pig, dog, and sheep one year.

An Incident.—Last fall I learned that a goat had been buried in the vicinity three years before. Knowing that nature had by this time done much toward cleaning the bones, I said to my physiology class that I would be ready to go with the boys any Saturday morning to dig up the goat and prepare his skeleton. On the following Saturday five boys reported at my house, and we set out for the grave of his goatship. We dug "Billy" up, and having placed his bones in a bag, we bore him home in triumph.

After boiling the bones in sal-soda and then soaking overnight in bleaching-powder, we rinsed them in clear water and laid them in the sun to dry. The next day was spent in arranging the bones. One day each week we spent a half hour in boring and fitting, until at last Billy's bones were in position. His skeleton now adorns the school-room. Can any one question the educational value of such work?

(Notice that only those who wanted to go to the digging up went, so that the most objectionable feature was not *forced* upon anybody.)

In arranging the bones one of the boys took a humerus and tried to fit the ball at its upper end into the socket of the hip-bone. He came to me and said, "These bones do not fit." He was *quite sure* that he had a *femur* instead of a *humerus*. On being told to hunt again he went to work, and at length found the shoulder-blade. This taught them that we are not made haphazard. There is method in the way in which bone is joined to bone. The child who catches a glimpse of the plan of the Creator in the structure of animals has caught something worthy to be treasured in his mind and heart.

The accompanying drawings were made by pupils of seventh and eighth grades, from work with bones actually prepared by the children themselves.

BONES. V.

FOR HIGHER GRADES.

In the preceding articles on this theme bones have been studied by putting them *into the hands of the children*, and by requiring a careful study of each bone, its shape, size, structure, and adaptation to the purpose for which it was intended. The lowest pupils strung them like beads, or glued them to cards, putting together the feet and wings of animals. The chicken foot and wing, the simplest structures of this kind, were prepared by lowest primary or second-year pupils. Much composition, language, and number-work was based upon them.

The second step was with the foot of the sheep, and later still the pig's foot. Here again the work was made a basis for language, number, and composition, and the *manufacture of their own drills gave manual training* of a practical character.

The third step, rather more difficult, consisted in more especial work on skulls, noticeably those of larger animals, where the sutures are marked, and it was advised that these bones be painted with enamel paints so as to bring out their

contour the better and emphasize their functions and names upon the pupil.

The last step is the construction of a complete skeleton. For this purpose it is well to select some animal whose bones are large enough to bore and wire easily. I have found that of a dog to be the best. Nearly every child can tell where a dog has been buried. If long dead, the remains can be disinterred without serious offence to eyes or nose. I would advise, however, that the first trial of this kind be made on a fresh specimen.

The boys will readily skin the body and remove the viscera. Then boil the body in water for an hour or two in an old kettle or boiler out in the yard. Having cooked the dog until the flesh is beginning to loosen from the bones, take carefully from the water and remove the legs entire. Give each pupil 1 part to clean, as a leg, a head, the spinal column, or the ribs. This is done without touching the flesh if it is thoroughly cooked. Let each pupil keep his bones separate, and when cleaned have them boiled a few moments in water with soap, sal-soda, or other alkaline substance. This removes the grease and renders the bones white and smooth.

If on drying they still smell of fat, cover with water in which some bleaching-powder is dissolved. This deodorizes and disinfects the bones.

Let each pupil bore and wire his part as he did in the preceding three lessons. When all parts are wired, join them together and mount on a board so cut as to fit the back and mounted on another board for a stand. The accompanying photograph is that of a dog put up and mounted by my physiology class of 1893. The boards were sawed, fitted, etc., the bones bored, wired, etc.—in short, the whole work was done by the boys and girls.

Of course work of this kind is done only by older pupils, but those pupils who have done the earlier work can do this last with ease. It requires little time in school. The boiling and scraping are done out of school hours. The

boring and wiring may be planned to be done in lesson-time twice a week, and so there will be very little interference with regular work.

As to the preparation of skeletons of small animals, like rats, squirrels, frogs, etc., the bones being too small to bore, glue is used, but the specimen is too frail to stand long. Another way is to boil *very little* and remove the flesh, but

FIG. 29.—SKELETON OF A DOG.

keep the bones all united, leaving the cartilage to join the bones. I have done this many times and I have had success in this way.

Another way is to soak the body in strong potash for two days, then rinse and soak again in a weaker solution, repeating until the flesh is dissolved, and the whole skeleton will come out intact. This method is used by naturalists gener-

ally, and Principal Hulsart, of Dover, N. J., has some beautiful specimens of skeletons done in this way. Care must be taken, however, for if the potash is too strong the toes and fingers come off. I should rather advise the use of larger skeletons, as it gives a better exercise where the scholars do the work entirely.

Where a school has a skeleton of a dog, the subject of bones may be taught almost as well as if it were the skeleton of a man instead. I have known pupils to become so enthusiastic in the study of bones that on Saturdays a knot of boys would gather in some grove or meadow to boil a dead animal for next week's study. For many useful hints in regard to work with bones, I am very greatly indebted to Dr. E. W. Claypole of Buchtel College, Akron, O., whose valuable contributions to science are well known.

Chapter XV.

THE SCHOOL MUSEUM.

Every school, no matter what its grade or condition, should have a museum. In Chapter VII the matter of vacation collections will be considered. The present chapter has rather to do with the preparation and arrangement of specimens which may from time to time drift into the school-room and become part of a permanent collection.

1. Classification.—No rigid scientific arrangement is recommended. Many systems are in vogue. The simplest is to conform to the great kingdoms of nature. Thus the separation of all minerals, vegetable forms, animal products, into groups would form the first rude attempt at classification. As the collection grows, it will be found necessary to sub-classify each of the above groups. Thus specimens having an historic value may be separated from others, no matter to what kingdom they belong. Animal collections may be subdivided into insect collections, egg collections, and so forth.

2. Preparation.—Seed collections are best arranged in small phials or pill-boxes. Each phial or box should be labelled, and the entire set of boxes placed in a larger one, so that they may be taken down at a moment's notice. I have found it convenient to place the smallest seeds in homœopathic phials, and arrange these in Clark's O. N. T. thread-boxes, larger seeds in boxes of the same kind, and the thread-boxes placed in a shoe-box just large enough to hold them.

Shells may be arranged in a similar way. Twigs bearing buds are best placed upon large stiff cards. Woods may be cut in uniform length and placed in boxes, or small screw-eyes may be inserted, and they may be suspended from cup-hooks in a lath tacked above the blackboard. Insects should be placed in boxes from which the dust is excluded. Soft animals should be preserved in alcohol and bottled.

In lieu of a cupboard in which to keep these collections a very good one may be devised by employing wooden boxes $3 \times 2 \times 1$ foot in dimensions, such as are used for shipping soap. Two of these boxes placed one above the other form a substantial frame into which shelves may be fitted. A curtain may be hung in front, and the outside may receive a coat of paint or stain, which will convert the boxes into a very respectable cabinet.

3. The Curator.—Nothing is more unpleasant than to see a collection of any kind of curios covered with dust. To keep a museum in good order requires the expenditure of no little time and attention. To this end it is well to have from the outset a curator. Pupils should be made to feel that this office is one of honor. This will make them willing to hold the office. Its duties should be (*a*) to label all new specimens and place them with their kind ; (*b*) to keep specimens clean from dust and be responsible for them while in office. The curator should take care that specimens do not become disarranged, and in schools when a case with lock is provided he should have the key.

4. Exhibits.—I have found a very fertile source of specimens to be the homes of pupils.

In many a house may be found unique and often very valuable curios, which are not cared for by the owners.

Rare minerals, beautiful corals, shells from distant seas are often found relegated to the garret, whence they may be brought to become a perpetual source of instruction in the school-room.

A good way to obtain such treasures for the museum is

to hold *exhibits*—i.e., let each pupil bring in something to tell about. A half hour may be given on some Friday afternoon ; once a month, perhaps. Each pupil is requested to bring some curio to school. When the time comes for the exercise, each one rises and exhibits what he has brought. He tells something about it, and then passes it around for inspection.

These things need not be *given* to the museum. They may be *loaned for the occasion* and taken home again immediately, or they may be *loaned for the term*. But a large number will come to be a part of the permanent collection.

Do not compel pupils to bring things to the exhibit. A few will do so at first, and others will desire to do so later.

An example of such an exhibit is added. During the first three weeks of the month the teacher had said that on the last Friday of the month they would hold an exhibit. She explained what it would be, and requested all pupils to bring in something, at least for exhibition.

On Friday afternoon, one half hour before closing-time, all work was laid aside, except the curios, which were all concealed in pockets or desks. The teacher began by asking how many had brought things to the exhibit.

Many hands went up. Some, of course, had nothing.

John had a piece of iron ore. He rose and said : " This is a piece of iron ore from the mines in northern Michigan." He was asked to show upon the map where these mines are located.

Mary said : " I have a piece of coral. It came from the Pacific Ocean. My uncle brought it home with him."

Stella had a piece of velvet made in Lyons. Martha had found a flint arrowhead. Ivan had a picture of London Bridge, and Henry showed a canteen taken on the battle-field of Gettysburg.

Other facts were brought out on each of these articles, and the lesson was over.

The teacher had taken note of errors in language. These would be taken up in their next language lesson. Some

pupils who had been unprepared went home to search for things for next exhibit.

5. General Exhibits.—In connection with the students' other work it is well once a year to lay out the school museum for public inspection. Many people will be interested, and much valuable material will find its way into your hands.

6. In General.—All specimens should be labelled with name (if known) and the name of the donor or loaner.

Labels may be made after the following plan :

Number Name Locality Donated by
--

Thus :

Number , 25. Name , <i>White Marble</i> . Locality , <i>Rutland, Vt.</i> Donated by <i>Mrs. E. T. Bowser</i> .

7. Uses.—The museum is one of the teacher's most efficient means in imparting instruction. Our museum is used constantly for reference. The specimens are used as objects for drawing, language lessons, etc. On rainy days it is often most useful. Every class in geography finds material for his lesson.

I once overheard one boy say to the curator : " Say, Jim, have you anything on South Africa ? " " Jim " thought a minute. " Yes," said he, " we've got some ivory, a piece of gold quartz, and an ostrich feather. " " Gim-me-um," said the other.

As a device for rainy days it is sometimes well to allow each pupil to select a specimen from the museum, and describe it orally or in writing. I have seen excellent descriptions of starfishes, birds' eggs, and other interesting things taken haphazard from the museum.

Chapter V.

RAINY-DAY LESSONS.

LESSONS ON WATER.

I. *Forms of Water.*

Select a lump of ice, and bring it into the school-room. What is this? Describe it. Clear, cold, brittle. Give each child a piece. What does it do when brought into the house? Why does it melt in the hand? Let us hold the thermometer-bulb on the ice. What does the quicksilver do in the thermometer? How far does it go down? We will melt this piece of ice. What does the heat change it into? Is ice lighter or heavier than water? Will it float on water? Why does the ice stay on the top of the pond instead of sinking?

II.

Now let us put the water on the stove. What does it do? What comes off from this boiling water? Let us put the thermometer in this boiling water. What does the quicksilver do now? How high does it rise? What does cold do to the quicksilver? Heat? Let us put just a little water in this baking-powder box, and set it on the stove. We will put the cover on tightly, and make a small hole in the cover with an awl. When the water boils, what happens? Hold a cold piece of glass in the steam a moment. What is on the glass? Breathe on the glass. What is there on the glass now? We call water when cold and *solid* ice; when *liquid*, as we usually see it, water; when hot, coming from boiling water, steam, *vapor*. In what form is water

that comes from our breath? What form is in the well? Tell me some other forms of water. Fog, snow, cloud, hail, rain.

III.

Catch snowflakes on a piece of black cloth, and examine with a glass. Draw all the different forms you can find. Darken the room and put a thin piece of ice over a hole in the shutter, so that the sunlight can pass through. Now look with the glass. What do you see? Are these crystals like snow crystals? How do they differ? Get a sheet of ice from some little brook or puddle where the water has gone down after the ice was frozen. Examine the beautiful crystals on the under side. Examine crystals forming on a cold window. Examine the steam as it issues from a teakettle. Is it white just where it leaves the spout? Why not?

IV. *Properties of Water.*

1. Take a spoonful of sugar and place it in a cup of cold water. Stir it a second and pour off the water. Is all the sugar there? Where has the rest of it gone? Taste it. Do you taste the sugar? What has the water done to the sugar? Take a spoonful of sugar and put it in a cup of hot water. Stir it also one second, and pour off as before. Where is the sugar now? Does hot water dissolve sugar more or less rapidly than cold water? Water dissolves substances put into it.

2. Place thermometer in freezing water. At what temperature does it freeze?

3. Place thermometer in boiling water. At what temperature does it boil?

4. Place a small dish of water out of doors on a cold night; next day get it and see what has occurred. Why did the dish break? Why did the ice bulge? What does water do, then, in freezing? It expands.

5. Hold up a glass of water. Look through it. Describe it.

V.

Question the class about the uses of water, ice, and snow. Have some of the various poems on snow, winter, etc., read in school. (Lowell's description of winter in the *Vision of Sir Launfall* is among the finest in literature.) Drawing snow crystals is interesting and instructive work. Frost on windows is also very beautiful. An experiment may be made by placing a tumblerful of cracked ice in a warm room. There will soon form on the outside of the glass beautiful frost crystals. This proves the presence of water vapor in the atmosphere.

LESSONS ON TEETH.

Among the most interesting things which will be brought in by children will be teeth of animals. Little children sometimes bring their first teeth, and recount the trials they endured in having them extracted. In the country it is easy to obtain teeth from defunct animals, and in the city any dentist will give you a handful if you ask him.

I. *Human Teeth* (Fig. 30, 1).

Supply each child with as many as possible. Get pupils to describe a tooth as regards its parts, body, roots, and crown. The enamel and the dentine, with the small masses of cement adhering to the ends of the root, are all easily seen and described. If you find among the teeth one which has been decayed, you can show to the pupils the pulp-cavity inside. Differences between single and double teeth should be brought out.

Tell the children to feel their teeth, and see where single and double are. Tell them to count their teeth. If any one brings in a "milk-tooth," show it to the children, and let them see that it has no root, etc.

I have found it very interesting "seat-work" to pass around a large handful of human teeth, and get the chil-

dren to arrange them as they should be, placing them in a semicircle, thus :

FIG. 30.—TEETH.

Such busy-work as this helps to fix knowledge of teeth, their names position, etc., on the child's mind: A sample set may be glued to the inside of a box and be kept for future lessons.

II. *Carnivorous Teeth* (Fig. 30, 2).

Carnivorous teeth are best obtained by securing the head of a cat, dog, or some other flesh-eating animal. When you cannot get such a skull, the best thing to do is to lay a living dog or cat under contribution. Call attention to the greater number of incisors, the long sharp cuspids, the narrow edges of the back teeth. It is easy to discover the vast difference between teeth of this kind and those of a boy or girl. Bring out the adaptation displayed in giving us grinding teeth, and giving to the cat family teeth for tearing and cutting. Make comparisons to show that both have enamel, both have roots, both have cement and dentine.

III. *Herbivorous Teeth* (Fig. 30, 3).

From the butcher you can get cow teeth, and from the veterinary surgeon horse teeth, and the farmer or butcher will supply you with sheep teeth and swine teeth and tusks.

IV. *Fish's Teeth* (Fig. 30, 4).

Procure a fish head. Open the mouth. Pass it around, so that all may see. The teeth are not alone in the jaw. They are all over the sides of the mouth and the roof of it. They are upon the tongue, and away down the throat. Run your finger down the throat and feel them. Note their shape, their lack of root, and their exceeding smallness. If you can show some shark teeth, you will add to the interest.

V. *Omnivorous Teeth* (Fig. 30, 5).

To this class belong the teeth of hogs and bears. Men's teeth are really of this kind. Institute comparisons as before, being sure to bring out the fact that these teeth are like those of the flesh-eaters in some respects, but that they are like those of the herb-eaters in other respects. In other words, nature wisely adapted the teeth of animals to eat different kinds of food. This adaptation of teeth to

food is shown still better in the teeth of the next class of animals.

VI. *Gnawing Teeth* (Fig. 30, 6).

The skulls of rabbits, squirrels, muskrats, rats, and mice are easily obtained and are very interesting to study: the long front teeth, two in each jaw, the *enamel only on the outside in front*, the tops bevelled so as to be like a chisel. These are fitted for gnawing through any hard body. The side teeth are like those of herb-eaters. The front teeth are exceedingly long. Their roots are far back in the jaws. They wear off very fast at the ends and grow out as fast as they wear away, another instance of nature's care and foresight.

TALK UPON TEETH.

See how peculiar these teeth are. Are they the teeth of a flesh-eater? Why not? Are they human teeth? Why not? Compare them as regards size, shape, etc., with the teeth of cats and men. See how flat they are on the top. They are grooved. Why is this so? Break one open to show how it looks within. It seems as if it had been soft once on a time and was then rolled up. Find the eye-teeth. How do they compare with those of men and dogs?

THE EXPLORATION OF A ROSE.

One of the most entertaining lessons I have ever enjoyed giving was an exploration of a rose. Any double rose will do for the purpose, but a cultivated tea-rose, such as is grown by florists, is best.

Each child should be supplied with a rose, a pencil pad, pencil, and, where possible, a simple magnifying glass. The glass is not absolutely necessary, but it aids greatly in showing the curious forms inside the rose. Tell the children that the rose contains some very curious things. Teach them which are sepals and which petals, and then require them to pick their roses to pieces just as you do.

1. Remove the outer circle of petals. Are these alike in shape? Draw one petal.

2. Remove the second circle of petals. Are these like the petals of the first circle? How do they differ? Draw a petal of the second circle if these petals show a tendency to become narrower.

3. Thus, slowly remove one circle at a time, comparing the petals with those of the rows already removed. It is not necessary to draw every one, but only the petals of

FIG. 302.—EVOLUTION OF THE GARDEN ROSE.

those circles which show a difference. The interest will at once be aroused, because, as they approach the centre of the flower, the petals take on various curious and often fantastic forms, until they partake of the nature of both petals and stamens. At last the petal-forms disappear and normal stamens are found. The drawings will show every stage of development from stamen to petal, and each child

will have discovered for himself a strange and interesting fact in nature.

Written and oral descriptions should also be given.

Other double flowers show still more wonderful transformations. Thus the flowering almond has had all its stamens changed to petals and the pistil often to a leaf. The pupils, having had their attention turned to this line of inquiry, will often bring in results of independent observations in the same direction. The water-lily shows every stage of petal development from the stamen.

Having had the foregoing lesson in spring before wild roses are in bloom, direct pupils to examine the single roses for beginnings of this development. They will often find stamens which are beginning to show a change in form; hence the lesson that all our cultivated roses are produced from single wild parents. Similar facts may be introduced to illustrate the working of this law of evolution in other things.

The following are suggested: Apples produced from the wild crab-apple, peaches and almonds from the same wild parents, fantail doves, and indeed all ornamental doves, from the wild pigeon.

The fact that all cultivated things will degenerate into the primitive form unless cultivated will furnish material for lessons in morals.

A STUDY OF CELERY.

Directions.—The teacher should bring in celery, or have the children do so. If possible, plants should be had which have roots attached. It is not necessary that each child have a whole plant. One leaf with its long petiole is sufficient for each.

The lesson on the gentian introduced the pupils to plant-life as a unit. They have seen the roots, stems, leaves, flowers, etc. The object of this lesson on celery is to show the children how some plants are built up.

FIG. 31.—ENTIRE CELERY PLANT,

I am aware that there are people who will shake their heads and declare that to give such work as "structural botany" in a primary room is the acme of folly. In reply I have but to say that the "structural botany" in this outline is nothing more than what may be seen with the naked eye.

I introduce Fig. 32 merely to furnish the teacher with something to put on the board in case she wants to show

FIG. 32.—CROSS-SECTION OF CELERY, SHOWING STRUCTURE.

the children how a thin slice of celery looks under the microscope, for I judge that few schools are supplied with that very useful instrument.

The lesson may be given without any glass whatever, and I am sure that the child will be led to discover something of the way nature builds up her organisms. The gentian is too small a plant to dissect in this way, but celery is

large, coarse, and tender. It is easily cut, and it shows its structure very readily to the naked eye.

The Lesson.—Talk about the plant, its name, taste, smell ; its uses, i.e., as a food, medicine, etc.; its history, i.e., how it was formerly called “smellage,” and how people used to carry bunches of it to church to smell of during three-hour sermons.

Find out how it is planted, what soil it affects, how it is cultivated, how it is cooked or prepared for the table, etc. Note the fibrous roots, the short, hard, woody stem, and the ridges upon the leaf-stems. Bring out the number and arrangement of leaflets (ternately pinnate). Tell pupils that the whole mass of leaflets makes up one leaf. Then such questions as the following may be put :

1. Each leaf has how many parts ?
2. Each part has how many parts ?
3. Each of these last parts is how divided ?
4. Are the divisions all alike ?
5. Are the branches of the foot-stalk all equal in length ?
6. How long are the side branches ?
7. How long is the middle part ?
8. How far do the ridges run up the stem ?
9. Are the ridges alike all the way ?
10. Do the ridges ever run together ?
11. How does the inner side of the celery-stem differ from the outer side ?
12. What color is this celery ?
13. Is it alike throughout ?
14. Why does it vary in color ?
15. Why is it more brittle near the base ?
16. How does the farmer make it so ?
17. What do they call this ?
18. Yes ; they call it bleaching the celery.
19. Why does covering the stalks make them so white and tender ?
20. What makes the tops turn green ?
21. Do plants kept in the dark turn white ?

22. Did you ever see potatoes, onions, and turnips which have sprouted in dark cellars in the winter?
23. How did they look?
24. Taste of the white end and of the green leaf and stem. How do they differ in taste? How in texture (toughness)?
25. The sunlight has done what to the tops of the celery?
26. Break the stem. Is it brittle?
27. Does it break with a clean or a ragged break?
28. What do you see at the end where it broke?
29. How many threads do you see?
30. How long are they?
31. Pull out a fibre and see if it breaks easily. It is tenacious.
32. Look where the three branches of the stem begin (Fig. 31, 15).
33. Break the stem at this joint. Are there as many threads (fibres) here as there are below?
34. Cut the stem at different places and see how many threads are there.
35. Make many slices, beginning just below the joint and going on until you find all three branches.
36. Note how the threads mix, cross, and intercross as they go upward toward the leaves (Fig. 31, 1-12).
37. Notice that these threads are in two rows—one on the outside, one near the surface.
38. Make these sections and draw each one.
39. Describe the threads (tough, elastic, etc.).
40. Notice that the body of the stem is white and full of holes (spongy).
41. See the open place inside the middle stem far up toward the leaf.
42. Press a leaflet and draw it.
43. Are leaflets alike on both sides?
44. Is the stem as thick on one edge as on the other?
45. Why? Because the thinner edge is in between the neighboring leaves, while the thicker one is out by itself.

46. Wash a root. Does a root taste like the stalk?

47. Taste a bit of the woody part of the stem at the base of the leaves. Does it taste like the other parts?

48. Find the small leaf at the centre of the bunch. How does it compare with the others in size, color, taste, smell?

49. How are the little leaves in the centre folded? Plicate.

50. Yes ; they are folded almost like a little fan. See how nicely they are packed away. The old mother celery-plant has no room to spare, so she packs the little leaves tightly in the middle.

51. Some day we will play the game of celery. We will let Harry keep store and sell it to us. Nelly will buy three bunches, and we will have some celery soup, some salad, etc.

In Fig. 32 the thin slice of stem is magnified about 20 diameters. The central cavity and threads (vascular bundles) are also seen. The skin of the stem is seen to be built up of cells close together, while the cells inside are larger and irregularly hexagonal in shape. If this figure be given at all, it should be only briefly treated. There is plenty which the children can see with the unaided eye without giving them the minute structure of any organism.

It is suggested that the teacher go over the foregoing lesson alone before presenting it to the class. Bring out why the long strings run up through the leaves. It makes the stems more elastic. It gives them a sort of internal skeleton.

Other vegetable forms which may be presented in this way are asparagus, rhubarb, lettuce, and the common succulent weeds, i.e., plantain, burdock, and yellow dock, and water-lily stem, Jack-in-the-pulpit, skunk-cabbage (?), etc.

One of the beauties of a lesson on celery is the fact that after the lesson is over the children may be allowed to eat up the remains.

I have seen children do work like this in second primary classes.

A SERIES OF FOUR LESSONS

PROGRESSIVELY ARRANGED TO ILLUSTRATE FERMENTATION,
DISTILLATION, ETC.

I. APPLES.

Here are some apples that you have brought me. What a fine red coat this one has! See how shining this one is.

FIG. 33.—AN APPLE. DISTILLATION.

Tell me what kind of an apple is this. Bring out the various kinds of apples (*pippin, russet, etc.*).

What apples keep all winter? What kinds ripen early? Name some sour apples.

Notice the stem-end, the blow-end, *B*; cut open and show the layers, *L, L*, of the fruit (Fig. 33). Call attention to the little cells, *c*, in which the seeds are. Is this apple ripe? How can you tell?

What will happen if I lay this half apple away for a while? Yes, the cut side turns brown. Why? "Because the air is beginning to rot it." Will apples rot if no air can reach them? "No." When sealed up in cans, they will keep a long time from spoiling.

Now we will put the apple in this glass bottle and crush it with this stick. Charlie may crush it to pulp. We will place it here on the window-sill until to-morrow.

FIG. 33a.

II. FERMENTATION.

Children, come up close and see what has happened to the apples we crushed and put in this bottle. "It has turned brown." "It is rotting." "It smells sour." "There are bubbles on it." "There are bubbles all through it."

Are these air-bubbles? "No, it smells very sour." "It smells like cider."

What is the apple-pulp doing? "It is rotting." "It is working."

It is working or *fermenting*. I will write this new word on the board. Does fruit always ferment? "When the air gets into a can of fruit, it always ferments." Some day we shall learn why fruit ferments.

Did you ever see mamma bring up a can of fruit from the cellar when it was working? "My mamma scalds hers when she finds it working."

Now we will catch some of this gas coming from the fermenting fruit and see what we can do with it. We will first bend a glass tube, and then bore a hole through this cork with a small file and fit the tube in. We will put the cork in tight so that the gas will come out through the tube, *T*. Let us take this glass of limewater, *W*, and let the glass tube dip into it. Watch it carefully. "I see a bubble of gas come from the tube." "When you shake the bottle, more gas comes through the tube and bubbles through the limewater." "The limewater is turning white." "It is looking like milk."

Yes, this proves that the gas is not air, but *carbonic-acid gas*. This gas comes off from all things that are rotting. I will now take the cork from the bottle and you may see what I do. Harry may scratch a match here and dip it into the mouth of the bottle. See what happens. "The match went out." Here are several matches. Each one may scratch one and dip it in this gas. "They go out." "The gas puts them out."

This gas puts out fire and turns limewater milky white. If little boys and girls were to breathe it, it would kill them. Carbonic acid is very poisonous. Now write on your slates what you have learned this morning about carbonic acid. Some other day we will learn more of this dreadful gas.

III. DISTILLATION.

Yesterday we saw how when an apple rots or ferments it gives off what gas? Will this carbonic-acid gas burn? Will a stick burn in it? Could a little boy live in it? What does this gas do when it bubbles through limewater?

Now we will see what is left behind in the apple when the gas is coming away. Let us take this little machine-oil can and strain off some of the apple-juice into it. Then fasten this rubber joint and glass tube on the can. Then put the other end into a small glass bottle. We will put a cold wet cloth on the bottle to keep it very cool.

See me hold the can in the flame of this lamp. Pretty soon we will see something in the bottle. I did not fill the can. I put in only a little cider. "I see some steam on the inside of the bottle." "There is a drop of water on the end of the tube." "The water or cider is boiling in the oil-can."

By filling the can two or three times you can distil several drops of alcohol. Do not let the can boil; keep it hot and with patience you will get the alcohol. Now let us take off this bottle and smell the liquid inside. "It smells strong." "It is not water." "Will water burn?" "No, no." "We put out fire with water."

I will touch a match to this. What does it do? "It burns." "It burns with a pale flame."

This is alcohol. When the cider works, what poisonous gas comes away? "Carbonic acid."

And what substance is left behind? "Alcohol."

Can you tell me anything about alcohol? "It kills folks." "It is in whiskey and beer." "It makes people drunk."

Yes, it is a dreadful poison, and to-morrow we will see how it affects the people who drink it.

IV. ALCOHOL.

Children, here is an egg. Mary, can you tell me how to know a good egg? "Hold it to the eyes and see if it is clear." "Hold it to the lips and see if one end is cold and the other warm."

When I break this egg, how can you tell if it be good? "If the white is clear and the yolk whole."

This (breaking the egg) is a nice fresh egg. The other

day we made some alcohol. To-day we will see what alcohol does to eggs. Here is some alcohol in this bottle. Let us take some of the egg and put it in a dish and pour on a little alcohol. "The white is turning hard and white." "The alcohol is cooking the egg."

We will set the dish on the window-sill and see what it has done by recess. We will also put this piece of fresh meat into some more alcohol and see what happens. I will put this angleworm into some alcohol and see what it does.

(*After recess.*) What did the alcohol do to the egg? "It cooked the egg." "It made it hard like leather." What effect did it have on the meat? "The meat is tough and hard."

And the worm? "It killed the worm."

It is a poison. It kills everything that is put into it. It gets into the blood of people who drink it, and when that blood gets to the brain it makes the brain hard like the egg. That makes the person drunk. He cannot think. He cannot walk straight. He says foolish and wicked things and often kills people. It goes to his heart and gives him heart disease. It goes to his liver and makes him very sick. Wherever it goes it makes that part weak or useless. Is not a man very foolish to put such stuff into his mouth?

This is what the Bible says about drunkards: "A drunkard shall not inherit the kingdom of heaven."

Spelling.

apples	steam	bubbles	bore
shining	distil	cider	cork
russet	leather	machine	file
greening	brown	rubber	tight
Queen Anne	rotten	joint	lime
pippin	rotting	drop	water
crab, etc.	sealed	poison	carbonic
ripen	spoilng	fermenting	acid
sour	glass	fruit	gas

sweet	bottle	scalds	alcohol
flame	crush	bend	inside
lamp	pulp	tube	

Some of the above may be too difficult for the youngest children ; the teacher's judgment must determine what to use.

Language.

I. Simple sentences descriptive of what has been done are enough for lowest pupils. Care must always be taken to see that capitalization and punctuation are attended to.

II. Older pupils should describe the experiments more fully, first orally, later in writing, and great care paid to the sentences and paragraphs. It is well to alternate the lessons, having a day or two intervene between two consecutive lessons, and having the language lesson on each follow it. This will be good to strengthen the memory also.

This series is especially adapted to graded schools, but can be used with advantage in ungraded ones.

Number.

1. One apple contains 6 seeds ; how many seeds in 4 apples ? in 9 apples ? in 12 apples ? etc.

2. If there were 7 seeds in an apple, how many apples would it take to give me 14 seeds ? 28 seeds ? 84 seeds ? etc.

3. If we get 3 bubbles of gas in 1 minute, in how many minutes will we get 20 bubbles ?

4. How many bubbles will we get in 20 minutes ?

5. From 1 apple we obtained 3 drops of alcohol ; how many apples would it take to give 100 drops ?

6. Other and simpler problems as well as more difficult ones will readily suggest themselves to any teacher.

These lessons furnish, 1st, valuable observations in nature ; 2d a basis of lessons in spelling, language, and number ; 3d a good opportunity to teach temperance from both its scientific and its moral side.

TEN LESSONS ON COMMON OBJECTS.

SUBSTANCES.

I. *Charcoal.*

Each pupil is supplied with a small piece. By questions obtain the descriptive terms *black, light, porous, woody structure, soft* (it rubs off on the hands), *tasteless, odorless*, etc.

Questions to find out how it is made. Propose to the pupils to make some by ordinary charring in the stove at home. Try different kinds of wood—pine, poplar, oak, hemlock, walnut, etc.—to see which kinds make the hardest, and which the softest.

This will disclose the fact that some wood makes excellent charcoal (as willow), while another makes a poor quality (as pine).

With older pupils observation may go farther, and show that such woods as pine, hemlock, etc., which contain much resin, do not make good charcoal, while oak, willow, etc., having less resin, make far better charcoal.

Ask for the uses of charcoal, i.e., fires, filters, medicines, artists' work, etc.

Explain (unless the work is carried on in the vicinity) how charcoal is made for the market; how charcoal-burning is a great industry in some parts of the world where timber is abundant. With young children ignore the chemical properties.

II. *Sulphur.*

Pieces of ordinary brimstone are best for the opening lesson. What is its color? Its taste and smell? Will it scratch iron? Glass? Wood? (to test hardness) Will it melt? Burn? Dissolve in water? Show the class some flowers of sulphur. Melt some in an old spoon. Let it take fire. How does it smell? Why do matches smell so?

Dissolve a little sulphur-flowers in a few drops of carbon bisulphide; let it evaporate slowly, and beautiful crystals of sulphur will form. These look like sets taken from

jewelry (octahedra). Show them to the children. They are very beautiful.

Melt some sulphur. Let it begin to cool around the edge, then quickly invert so as to pour out the melted part in the middle. You will now see another kind of crystals all around the place where the melted sulphur was poured out.

Take a small keg. Hang some wet rags of various colors inside. Then take a shovel of coals, sprinkle sulphur on them, and quickly put it under the keg inverted. After a time the colored rags will be found to have been bleached. Tell the children that straw goods are bleached in this way.

Many other suggestive experiments may be made. It is not wise to give many chemical experiments like the foregoing, and it is not advisable to attempt an explanation to small children.

Where is sulphur found? This will open up the ever interesting topic of volcanoes.

Put some sulphur on a silver dollar; it turns black. Have you observed a silver spoon to turn black in your experience (in stirring eggs)?

Why do silver knives and forks blacken when used to eat cabbage? Such questions set the child to thinking, and disclose the presence of sulphur in many common articles of food; hence its presence in our flesh.

III. *Iron.*

Give each child a nail. A new one is best.

Question so as to obtain *color, weight, hardness and coldness*, and manner of breaking.

Hold one end in the hand and heat the other end in a lamp flame. What happens? Conduction of heat.

Heat a nail red-hot in a stove. Remove with a pair of tongs. See the bluish-black scales that form upon it as it cools. Call these scales "black rust" (black oxide). Put another nail in water and leave it for a day or two. What happens? Red rust.

Heat two nails red-hot. Plunge one into cold water. When

both are cool again, rub one upon the other to see which is hardest. It will be found that the one cooled quickly is harder. Why? Why does the blacksmith plunge his hot iron into cold water? Ask him.

What will it do to a needle to heat it red-hot? Why will it soften the needle? Because heating destroys the temper. This answer is not scientific, but it is sufficient for children. We must ignore those things which the child is too young to understand.

IV. *Iodine.*

Procure one or two scales of iodine ; one cent's worth is plenty. Place them upon a card and pass them around among the pupils. Tell them not to touch it. After all have seen it place it in a test-tube or a large piece of glass tubing having one end closed. Heat gently in the flame. See the beautiful purple (violet) vapor. Cool the tube and see the fine frostlike crystals all over the inside of the tube where the violet vapor has changed back to the solid form. Now add a drop or two of alcohol or ether. See the brown tincture of iodine formed. This experiment alone is enough for one lesson.

Second Lesson on Iodine.

Take a potato, carrot, parsnip, beet, radish, turnip, apple, and any other fruit or root in market. Cut them in thin slices. The best results are obtained if they are cooked. Give small pieces of these vegetables to each child. Take a broom-splint and wet the end in the iodine tincture and touch the slice of potato, carrot, etc. Some will turn blue. Even an apple when unripe will show blue spots scattered through it. Ripe apples will not. What makes these things turn blue? We will find out.

Take a number of small bottles ; into the first put sugar and water, into the second salt and water, into the third a little starch which has been cooked. Add a drop of iodine tincture to the first, second, and finally to the third bottle. What happens? When anything contains *starch* iodine

will turn it blue. Ask children to bring things and test them for starch. Is there starch in bread, cake, flour, corn meal, oatmeal, powdered sugar, etc.

A small drop may be placed on each child's hand, to show that iodine stains the skin, etc.

I have always found iodine a very interesting substance with children.

V. *Lime.*

Bring in a piece of the size of a hen's egg. (It is not well to let the children handle this, as it cauterizes the skin.) Place it in a chalk-box and dash a little water upon it. See it swell and crack open. See the steam rise from it. After a little pour on some more water cautiously, and do not permit the children to stand too near, as it sometimes flies and might burn. See it crumble. The lime is very thirsty. We give it water to slake its thirst. We say we "slake the lime." When it stops hissing, it will be "slaked lime."

Now we will put the slaked lime into a pail of water and stir it. What have we now? Whitewash (milk of lime). We will let it settle. See how clear the water on top is now. This will furnish a supply of limewater of use when carbonic acid in the breath is studied. Thus we make the work of one class help in the preparation of work for another.

VI. *Glass.*

A supply of all kinds of glass should be provided; at least the following should be at hand: window-glass, American plate, French plate, green bottle-glass, yellow bottle-glass, glass marbles, stained glass, and fragments of colored glass. Broken bottles, glassware, sets of cheap jewelry, broken lamp-shades, etc., etc., all furnish the very material needed. When possible, a fragment from some glass-works and pieces of slag from iron-works are useful. The teacher should also have a piece of soft glass tubing at least three inches long.

Take first a piece of clear glass and get the pupils to describe it. Bring out its *transparency*, *weight*, *hardness*, *brittleness*, and other obvious properties. Have a piece broken and examine the fracture carefully. It breaks not in smooth surfaces (planes of cleavage), but rather in irregular lines. These fresh edges will also show what appear to be shell-like markings (conchoidal fractures). I have sometimes had pupils bring me stones where this peculiar breaking looked so like a shell that they were taken for fossils. Drop a glass marble upon a flat stone. It bounds back. It is *elastic*. Place a long strip of glass so that its ends are supported, but the middle is not. Now lay a heavy stone on the middle, and if not too heavy the strip of glass will be seen to sag. Remove the weight. It springs back. It is indeed elastic.

Scratch various things with a piece of glass. It is hard. Can you file glass? Try and see. Rub it on emery-paper. What happens?

Heat the piece of tubing in an alcohol flame. When red-hot, pull gently on the ends. It is ductile. Tell the children about glass-blowing. Tell them about Venetian glassware. Get them to learn what they can about the manufacture and uses of glass. Distribute your specimens and tell them how the colors are produced. Cobalt makes blue, gold red, arsenic white, iron bottle-green, etc. Give as topics for research cut-glass, glass-blowing, etc.

Place fragments of glass in a stove and see them fuse and run down like wax. Cut glass with hot iron, also with a wheel or ordinary glass-cutter.

VII. Soap.

A small quantity of sweet-oil, a very little baking-soda or potash, and a bar of soap are needed. Let the pupils see the oil and the soda. Then place the oil in a baking-powder box cover and add a strong solution of soda drop by drop. Heat over a lamp or upon the stove. The oil will curdle and form a soap. When cold, it may be examined by the

children. Smell, taste, and cleansing power all prove it to be a soap. Compare it with the piece of soap. Ask questions about soap-making. Try to make soap, using lard instead of the oil.

VIII. *Sugar.*

Sugar should be passed around the class. Different kinds of sugar should be compared. Rock candy is pure transparent crystals. Powdered sugar is white. Why? Sugar on the skins of figs is not sweet. Sugar crystallized from molasses is brown. Describe the way maple sugar is made, beet sugar, sorghum. Dissolve white sugar in water. Let it stand to get the crystals. Describe them. Heat dry sugar. It changes to caromel.

IX. *Rubber.*

To make a lesson on rubber interesting, the teacher should have samples of this substance in all stages of manufacture. The gum, sheet rubber, dental rubber, vulcanized rubber in all its forms, should be on hand. Many lessons may be given on it because of its diversified forms and manifold uses.

(a) *Soft Rubber.*

Feel it, smell it, ascertain all its physical properties. Heat a small piece. Burn it. Smell it when burning. Dental rubber may be had from any dentist. It is very thin and soft, and it is wonderfully elastic. Some kinds of chewing-gum are almost pure rubber.

(b) *Hard Rubber.*

Combs, pen-holders, etc., are common. From these the various properties of hard rubber may be ascertained. The way in which hard rubber is made from soft rubber is a secret, but much may be learned about it in cyclopædias.

A FEW SUGGESTIVE LESSONS ON THE HUMAN BODY.

The much to be dreaded languor which so frequently creeps over a school on rainy days, may often be checked by laying aside books and by turning the minds of pupils into different channels of thought for a time. Thus it will often be found that a lesson on some part of the body so planned as to produce motion of that part, will rest the child, and, thus refreshed, he will go back to work on his regular lessons with keener appetite, and the general order of the school will be at the same time improved.

Exercises in stretching, kicking, kneeling, and light calisthenics are good, but any exercise which gets the pupil from his seat and gives his members a chance to change their cramped position will perform that office quite as well.

The following lessons are offered as combining drill on the human body with motion of the body :

I. Parts of the Body.

Place hands upon the head, body, arms, legs. How many parts have you touched? Place hand on neck. Where is the neck? Describe it. It is round, etc., and joins the head to the body. What do we call the upper part of the body? The lower part? To which part are the legs attached? The arms? What is the line of meeting between chest and abdomen called? Place hands at the waist, at the hips, at the sides of neck and head, upon the chest.

How are the lower limbs divided? Thigh, leg, and foot. What are the parts of the foot? Heel, instep, ball, toes. What part of the upper limbs is like the thigh? Upper arm. What part corresponds to the leg? Forearm? Bend knees, ankles, etc.

Compare the fingers with the toes as regards number, size, and usefulness. Name all the divisions of the body which you have learned. Make a table of them, thus :

Note to Teacher.—It is not necessary that this classification be pushed so far as this, and yet some may find it interesting to go farther with it. That will depend largely upon the age and intelligence of the pupil and the time and inclination of the teacher. Thus the names of the fingers and toes might be added to the above classification.

It is well also to require the formation of simple sentences about all the parts of the body mentioned. This will furnish good drill in sentence-building, and it will help to fix these things upon the mind.

It is important that every child know all the principal parts of his body. Some of these names are used very loosely by people at large, including many teachers. Thus the word *limb* is often made to answer for *leg*, when it applies equally to upper and lower extremities, and the word *leg* is made to do duty for the *entire lower limb*, when it is in reality that portion of the lower limb between the *knee and ankle*.

It is often amusing to see where elocutionists, ministers, and other public speakers often locate their hearts in gesture. A little judicious drill with the young will do much to eradicate these errors so common with older

people. In such a lesson each part must be touched in order to give the exercise needed.

II. *Joints.*

Having introduced the children to the various parts of the outside of the body, the next step may be to observe how these parts are united. Thus it is excellent exercise to take some joint, as the elbow. Give its name. In how many directions can you bend it? Try to bend the forearm in other ways, holding the upper arm firmly while you do it. Develop the likeness to the opening of a door, trunk, blind, etc. These things open on *hinges*. Give me a good name for the elbow-joint. A hinge-joint. Find other joints of this kind. In like manner the various other kinds of joints can be developed. How many hinge-joints have you in each hand? Fourteen. In each foot? What part of the hinge-joints in your body are found in the hands? Why are there no hinge-joints in your neck? What kind of a joint has the lower jaw where it is attached to the skull? Why is this hinge-joint loose? So as to admit of a side motion as well? In order to chew the food.

III. *The Flesh and Blood.*

Lay your left hand upon the right upper arm and raise the right forearm. What do you feel with your left hand? Why does it become larger and harder where you lift the arm? Feel of the "calf" of the leg. How does the flesh there compare with that about the face and neck? Why?

Bring in a piece of lean beef and give each child a small portion. What is its color, smell, texture? Can you not see the soft *fibres* in it? This is flesh or *muscle*. Your flesh is like this in color and texture.

With a fine needle prick your hand so that a drop of blood comes out. Describe the blood. If you have a microscope, examine some to see the little circular corpuscles it contains. This is blood. It flows all through the muscles in very fine tubes called capillaries.

Take your piece of beef and wash it very carefully and thoroughly. The blood will all be washed out and the muscle will become almost white. What, then, is the real color of muscle? To what does it owe its red color? Why are some people pale? Why are our lips red? Why do our hands show red color when held up to the sunlight?

In like manner the different organs of the body may be taken up, always introducing facts in the *child's own experience* when possible, and always bringing into school the *thing* to be studied itself when such part can be had. Thus exercises in breathing, feeling the pulse, "feeling the muscle," allusions to having swallowed the "wrong way," the mouth watering, etc., may be very useful means to introduce subjects of physiology which are really so near to us, and yet seem often to be so far away. A heart, lungs, and liver may be easily obtained from the butcher. Every child should know the heart, lungs, larynx, etc., not merely from having read of them, but from having *seen* and *handled* them, and in this way having formed an actual acquaintance with them.

Chapter VII.

LESSONS IN THE SCHOOL-YARD.

LESSONS ON A RAINY DAY.

A rainy day is always more or less difficult to get through with. This difficulty is equally hard upon the teacher and the pupil. There is something in the atmosphere that renders all such days oppressive. The opening exercises drag ; the first class fails ; the teacher scolds ; the other classes go badly ; they are kept in at recess ; and so on, until the close of school. Then the pupils go home, thinking how hateful a place school is, and what an "ugly old bear" the teacher is; and the teacher goes home with a heavy heart, thinking that her lot was not cast in pleasant places, and wishing that she were a clerk, stenographer, or nurse-maid.

But why adhere so rigidly to the programme on such a day ? Why not turn this very kind of a day to account, and make it a theme for instruction to the pupils and relaxation to yourself ?

There is much in an ordinary shower to furnish themes for instruction in all manner of lines of thought.

If the weather threatens rain, bring out the fact in some way. The following is suggested :

Before the Rain.

What makes it so dark in the school-room ? Why have clouds come between us and the sun ? What kind of clouds are they ? Rain-clouds. Do we always have clouds before a rain ? Let us go out and look at the clouds. What color are they ? Why do they move about so fast ? Why does the air feel so damp ? In what direction is the wind

blowing? What do we call such a wind? A north wind comes from the north. Winds are named from the place whence they come.

During the Rain.

Children, see how the rain is falling. Why are people holding their umbrellas in that slanting way? Why does the rain come in such a slanting direction? How does the water get up so high in the air? In what form is it before it falls? Vapor, like steam from the kettle. Did you ever see a cloud in the house (steam)? How did it look? When did you see it? Why does the water change into steam in the kettle? Why does water change to vapor outdoors? Do I have to heat water to make it change to steam? Let us put some water here in this dish and leave it until to-morrow. What is the rain doing to the ground? Where does the water go after it falls on the ground? What becomes of that which soaks into the earth? Will we ever see it again? When? What becomes of the water that runs off on the ground? Why does it run toward the gutter, Mary? Dwell upon slopes. When it gets to the gutter, why does it not stop running, Charlie? Where, then, does it go, Emma? Why does it flow that way? Push these questions until no one knows where the water goes, and then appoint some pupil to find out. Thus, for example, you may find that the water runs in little rills to the gutter because the land slopes that way; thence to another ditch, thence to a river or pond. Do not trace it more than a mile, and with little children a half mile is enough. Lead them to see that it goes on and on. Teach them that there is something beyond; so will their minds, beginning with the little rills, open out toward the rivers and sea. The gentle slopes (plains) and steep slopes (hills) are easily taught in this manner.

After the Shower.

Now, children, we will try to see what the rain did to the ground. See where the little drops fell here under the

eaves of the house. What do you see here? Why do these hollows come here? What has it left behind? Let us find where the water ran away from the house. Who can find the place? What makes you think this is the place where the water ran? Yes, it has left a little channel in the ground. The little stream that ran away from the side of the house did some work, didn't it? Every little stream has its work to do.

FIG. 34.—DRAINAGE OF SCHOOL-YARD.

Let us follow this little channel and see where it goes. What made it bend here, Freddie? Why did it go so straight here, Fannie? Why did it get larger here, Josie? Now we will follow it. Here it is quite large. Why is the coarse sand left here and the fine sand carried farther down? Georgie, take this stick and see where this little pond is deepest. Why is the fine sand piled over there? Where is the coarse sand? Here is a weed dug out by the little stream. Let us see if we can draw on our slates the

shape of this little pond, and show where the sand is piled, and where the little stream runs into it and out of it.

The above lesson gives opportunities to bring out higher lessons with higher classes. The rainfall as the origin of streams and the laws of streams apply to the diminutive rill whose source is the eaves of the house and whose mouth is the little temporary pond in the lowest part of the school-yard. Whole rivers and systems of rivers may be traced and mapped, and the laws of their growth, flow, deposits, and erosion studied from so humble an object, the watershed in this case being the roof of the building itself, and for that reason all the more conspicuous.

The formation of a mud-bank, *S*, and the delta, *D*, are well worth study. This shows how streams are the enemies of lakes. The inlets are constantly trying to fill up the lakes with mud, while the outlets are trying to cut open a wider and deeper channel to let out the water stored up.

Our pupils found a rill flowing down the hillside, which emptied into a small puddle of quiet water. At the mouth of this rill a delta had formed with thirteen separate streams. The sediment had been sorted in a truly wonderful manner. Practical and systematic observations upon temperature by the aid of the thermometer are valuable as lessons. They are best given in the school-yard. I have found them very helpful to geography work later on.

TEMPERATURE.

I wonder how warm it is this morning. Frank, you may take the thermometer out and find how hot it is. Frank returns, having found the thermometer to register 72° . Where did you take the temperature? Go out and see if it is just the same on the north side of the building, Mary. Mary finds it only 70° . Floyd is now sent out into the road to find the temperature there. He returns and finds the temperature about 71° . Try to find the reason for such difference of temperature. Is it warmer on the north or

south side of the building? Why? Where is it warmer—near the house or out in the field? Why?

Such facts as these will help us in all our work: Why is Mr. Clark's cow-shed open on the south side and shut on the north? Why are Mr. Ryan's rose-houses fixed with their roofs sloping toward the south? Why has Mr. Moore put his garden on the south slope of the hill? Why does snow remain longer where I live than where Sanford lives? Why do the cows always get on the south side of the fences in cold weather? When the sun shines on the ground, it warms the air, and if we can have a fence, or shed, or wall to keep the wind from blowing this warm air away, it will be warmer for our plants and animals.

When I came to school this morning, I saw that Elsie had all the geraniums and heliotropes covered with papers. Why did she do that, Irving? "To keep the cold out." "To keep them from freezing." Why does such treatment prevent plants from freezing, Mattie? "Because the papers keep the air under them very quiet, and the wind cannot blow the warm air away." The earth is being warmed every day, all day long. When the sun goes down, this heat escapes from the ground. It warms the air next to the ground. Now if we can cover the plants, this warm air will be kept in, and so the plants will be saved. From what does all this heat come? Yes, it comes from the sun. The sun is the source of heat. Do you think we could live without the sun's heat? No, every living thing would perish. The sun gives us heat, and so it is the source of life, too. How can we help warm plants and animals so that they will thrive and increase for us? Yes, by sheds, walls, and protections against winds and cold. I saw radishes in market last March. The frost was in the ground. It was very cold, and the wind was blowing as it always does in March. "They grew in a cold-frame or a hotbed." "Perhaps they were raised in a greenhouse." That is right. Let us see what you can tell me about these things. These are the principal ways that we have of

catching the sun's heat and holding it so as to make our plants grow before the weather outside will permit.

Henry may find out what a cold-frame is and how to make one, and tell us to-morrow. James may tell us about hotbeds. This art of raising early vegetables is called "forwarding." This is an important business near large cities. Carrie may look up this word and tell us about it to-morrow.

THE LEAF-BUD.

Much time and attention have been given of late to primary lessons on plant-forms and plant-life. The seed, its coats, its cotyledons and germ have been taken and studied, and their development has been watched and each stage drawn.

Comparatively little, however, has been done with leaf-buds. Now these are nearly as interesting objects of study as are the seeds. They have the added advantage of being larger, and are thus much easier for pupils of primary grade to study.

Children, there are interesting things in the yard. Let us see if we can find them. How brightly the sun shines! Pretty soon the trees will spread their leaves and we shall have shade here. Who has a sharp knife? Henry, you may get me some twigs from this tree. James, you may get some from that tree. Mary may get some from the bush over yonder. Let each get enough for the class. Now we will go in and study them.

We will put the twigs in water and keep them fresh. Here are some twigs from a hickory-tree. See what large buds it has. What is the shape of this bud? Where is the bud (end or side)? How many outer scales are there? What color are they? Are they hard or soft? Smooth or rough? Thick or thin? How do they differ from the inner scales? How do the insides of scales differ from the outsides? What do you find on the edges of these inner bud-scales? Why is the fine down put on these scales? See how beautifully these scales lap over each other.

Carefully remove the scales, one scale at a time ; have the children notice the beautiful lustrous down covering the scales until the little tuft of leaves is reached. What do you find in the centre of this bud ? Leaves. How are these leaves folded in the bud ? How many leaves do you find in your bud, Harry ? Pick these off and tell me what you

FIG. 35.—BUDS.
a, Ailanthus ; b, beech ; c, sycamore ; d, sumach.

find now, Lucy. Yes, there is a smaller bunch of leaves inside this larger one. Are these leaves all in one cluster, or are there several clusters ? Are the outer ones tough or tender, Jennie ? Why are these bud-scales put so thickly around this little branch of tender leaves ? To protect them. From what do the scales protect the tender young branches ?

Heat, cold, moisture. Is not nature kind to wrap up this little baby branch so warmly, just as mamma wraps up her little baby, to keep it warm in the cold and wet weather?

Now you may take your slates and write all you can tell about this pretty hickory-bud.

TWIGS AND BUDS.

Name.	Scar.	Position.	Shape.	Scales.		Vernation.
				Outer.	Inner.	
Beech	small, narrow	alternate	slender, long, pointed	brown, dry, acute	brown, smooth, acute	folded
Whitewood	V-shaped	alternate	oblong	two large, oval	none	folded from apex to base
Horse- chestnut	large, triangular, dotted, gray	opposite	pointed, egg-shape, large	dark brown, blunt, sticky	brown, pointed, sticky	folded like a fan

The above is offered as a suggestive schedule for recording observations on buds. Let each pupil secure a good twig having one or more buds upon it. Let these twigs be cut of uniform length and mounted neatly on a card, with the name of each bud under it. Pupils of older grade may draw these also and thus get added stores of knowledge.

If the teacher supply herself with plenty of twigs, she can use them with advantage in *number-work* and *busy-work*, thus :

Distribute twigs of different sorts to the pupils and give them such directions as the following on the board :

1. Place your beech twigs on the right side of your desk.
2. Put the horse-chestnut twigs in the middle.
3. Put the hickory twigs on the left side.
4. If you have a twig with 5 buds upon it and pick off 2, how many have you left? If 1 twig has 3 buds and another has 5 buds, how many buds have both? etc., etc.

The teacher can vary such work indefinitely, and the pupil will become more and more expert in noticing buds,

and his observing powers being cultivated in this direction, he will come to see other things with greater ease.

A very attractive way to mount twigs is to select a circular piece of heavy cardboard as large as a barrel-head. Place a cross-section of a branch from some tree in the centre by means of glue and then arrange the twigs along the radii of the circle. A permanent arrangement may be made by fastening the buds to a square board with small staples or double-pointed tacks ; then give the whole a coat of varnish or hard-oil dressing.

TREE-BUDS.

Preparations for Winter.

Here are some twigs which I cut off this morning on the way to school. The red autumn leaves have scarcely gone, but see what I find here on the branches. Yes, they are buds. How do they differ from the tender leaf-buds which have been growing and expanding all summer ? Yes, they are shut up very tight. Do you see any other difference ? Why, yes, to be sure, there are scales all over them. Did you ever see buds like these before ? So they do look like the buds we studied last spring. Does the tree put on its winter buds in September ? Why is this ? Old Mother Nature is very kind to the little buds. She is now putting on their nice warm coats, for she knows that winter will soon be here. Pretty soon we shall put on our winter flannels, and bring out our thick, warm overcoats, too.

Can you tell me anything else that is beginning to prepare for the cold weather ? The horses' coats are getting thicker ; kitty's hair is not coming out now ; the hens are not shedding so many feathers as they did in July. The little seeds have fallen upon the ground and are fast asleep. Do you think that the little buds know that winter will soon be here ? Does the old tree say to the little buds, " Keep still, little children ; I am going to put out some nice warm bud-

scales all around you to keep you warm, for it will soon be very cold ”?

No, the tree is dumb. She does not know that winter is near, but the Creator takes care of the little buds and covers them with scales to protect them from frost and snow. He has given us kind fathers and mothers to wrap us up when winter comes to chill us. Ought we not to be very thankful that these little buds, too, are so kindly cared for? If it were not for these bud-scales coming out early enough to protect the tender buds, they would freeze, and the tree could not grow. What other signs do you see that winter is coming? The leaves have fallen. The weather-pole is casting longer shadows. The thermometer shows that it is getting cooler. I saw a flock of birds flying southward this morning. All the crops are ripe and gathered in. There was a frost last night. The days are getting short. Yes, all these things teach us that winter will soon be here. Tomorrow you may bring to the language class a fable about a bud becoming clothed to protect it during winter.

WHAT CAN BE FOUND UNDER A FLAT STONE.

Children, let us all go out at recess, and see what new thing we can find. Here is a nice shady place. We shall find something here. There is a large stone. I wonder if I have a boy who is strong enough to turn it over. You may try, Charlie. Now, children, get in a ring around this stone, and when Charlie turns it over we must use our eyes and try to see everything that is under it. Now, ready—over it goes! (Pointing) What is that little black insect with hard shiny wings? (A bug.) Yes, that is called a bug. Who can tell me another name for it? (A beetle.) Yes, this is a beetle. We will put it in this box and examine it some other day. What is that black insect with big claws and short black wings? (A cricket.) Yes, that is a cricket. Let us catch him also and keep him until another day. What is this curious little creature which has so many legs? Do not touch him. A hundred-legged worm. Yes,

it is a hundred-legged worm. Now most of these things have crawled away, but I want to see who can remember some other things we saw there which got away before we had time to catch them or talk about them.

"I saw an angleworm." "I saw a great many ants." "I saw a snail," etc., etc. That is right. Now let us go in and write on our slates all the things we saw. I will let the one who gets the best list write it on the board, and then you may copy it for future use.

Note to the Teacher.—Never put any of your own observations on the board. It will cause the children to depend on you rather than upon themselves. The beetle and cricket may be killed after the children are away with a drop of benzine or gasoline, and thus they will not see you take a life, and the ethical value of the lesson will not be impaired.

Ask the children why do the insects all run away when the stone is turned. Why is the grass under it white? Here is a list made by a child of seven years :

WHAT I SAW UNDER THE ROCK.

I saw a beetle, five crickets, some fishworms, a thousand-legged worm, a grub, some ants, a slug, five sow-bugs, and some ants' eggs.

On another day a board may be turned over ; let them write on What may be found under an old board.

On another day turn the bark of a decayed tree ; let them write What can be found under the bark of a rotten tree, etc., etc.

Ask the boys if the same things are found under stones in the brook. If not, what is found under such stones ? Gather some of the insects and other living creatures in water, and watch their ways of life.

I have often found material for as many as twenty lessons on living things under a stone or board in a moist shady place.

Making the foregoing lesson a general introduction, follow it up with a number of special lessons on the creatures found

under it. These creatures are of so many types of animal life that the child who has studied what was found there has acquired a knowledge of much of the underlying facts of biology and zoology at the same time that his senses have received valuable training, and his love of nature has been increased.

When possible, have some sort of aquarium,—any large vessel will do,—and people it with the living things from ponds and brooks. The child always prefers a living subject to a dead one. Fishes, crayfish, and water-snails are at least abundant enough to begin with.

THE EARTHWORM.

An observation lesson for lowest primary pupils. Place, the school-yard. Time, the recess.

FIG. 36.—*a*, EARTHWORM; *b*, HEAD MAGNIFIED.

Now, children, let us go out in the yard and see what we can find during recess.

They go out into the yard. They go to some portion of the school-grounds where the earth has not been trampled down hard, and where the ground is moist. One of the boys may bring a spade to dig with, or perhaps a large flat stone, as in the preceding lessons, may be overturned. If the former, they dig for bait and give each child an earthworm. All the boys will take them in hand eagerly. It savors of going a-fishing. Some of the girls will handle

them also; others will shudder and turn away. Do not compel such a child to take one. Such aversions will soon pass away, and even the most timid will come to handle these and other harmless creatures without any feelings of dislike.

When all are supplied, direct them in an examination of this little creature. *Tell them nothing.* Ask questions like the following :

Who can tell me the name of this little animal? What color is it? What shape has it? How does its head differ from the tail in shape? Where are its eyes? Has it any feelers? Of what is its body made? How many rings do you find, Charlie? How many rings has your worm, Nellie? Is its body smooth or rough? Which way is it rough—from head to tail or tail to head? Look closely and see if you can tell why it is so rough. Can you find its little mouth? Look just below the pointed head and see if you can find the mouth. Its mouth is very small, and it has no teeth. How does the earthworm move? Watch it crawl. What part does it push forward? How long can your worm stretch, Mary? When it pushes its head forward, what does it do with the back part of the body? What keeps its tail from sliding backward while it moves its head forward? What does the angleworm eat? I will tell you: it swallows soil, from which it obtains food, and then voids it upon the ground in the form of small roundish masses called worm-casts. These you may see on the ground in any garden where angleworms abound.

How do you think that this little worm, with such a soft body, can bore holes through the ground? I will tell you: the pointed end pushes forward, and the minute hooks on the rings that make them feel so rough hold the body from sliding back. Do you see the sticky wet fluid that comes out on the surface of the worm? That helps to keep his body moist, and so he can breathe. Did you ever see one of these worms on the ground? When do they come out of the ground? Why do they come out at night

and after showers? Why do they dig down deeper when we have dry weather and cold winter weather?

These poor little blind creatures have a great many enemies. If they come out on the ground, the robins and chickens, toads and other animals, eat them up. Did you ever see a robin have one in her mouth? Did the old hen ever watch you when you were digging bait, and pick up the worms when they came out of the ground? But they have enemies underground also. The moles often follow them and eat them. Boys dig them and use them for fishing. These worms do much good for us. By digging in the ground they help to loosen it up, and they make it rich by the worm-casts that they leave on the surface.

If I cut it, the earthworm does not feel it so badly as other animals. We will take a box of this nice moist earth and sift it, so that there will be no worms in it. Then we will cut this big worm in two, and put both pieces in the box—so. I will put on the cover so that this worm cannot get away, and we will watch to see what will occur.

When earthworms are cut in pieces, the parts will develop a new head and tail respectively, and form two individuals. This usually requires some time. The earth must be kept moist. The dirt in the box should be sifted again in a month, and the worms carefully examined for proofs of the statement. The writer, when a boy, had an aquarium in an old tub. On the bottom was a layer of earth free from earthworms. He fed his fish with angle-worms chopped fine. Some pieces fell to the bottom, and when the tub was cleaned after three months the earth was filled with small worms. But whether the worms came from the pieces fed to the fishes, or whether the new worms were hatched from eggs already in the mud, he is not now prepared to state.

Earthworms eat many things besides dirt. Leaf-mould and particles of food found on the surface of the ground form part of their diet. Darwin found that they will eat sugar, starch, meat, crumbs of bread, etc.

When they crawl out at night, they pull small things down into their holes. The worms are wise little fellows, for they always pull *the small end* into the hole first. We should love worms, for they are our friends. There are many millions of them in the ground. By boring the ground they keep it loose. It is a sort of ploughing that they give the ground. But when they pull leaves into their holes, they help to enrich the ground. So you see that they are the friends of man.

Suppose you try to write a story, *What a Worm Said*.

FIG. 37.—GARDEN-SLUGS.
a, Stalked eyes ; b, feelers.

THE GARDEN-SLUG.

We went out the other day, and down in the back yard we turned over a large flat stone. How many of you can remember what we found under it? Jessie, you may tell what we saw under the stone. "I saw big black crickets." That is right, but did you not see anything else? "I saw ants."

Note to Teacher.—Accustom the children to remember all they saw there. Such a list will doubtless include angle-worms, ants' eggs, sow-bugs, slugs, snails, thousand-legged and hundred-legged "worms," crickets, spiders, and many other things.

What did these creatures do when we turned over the stone? Why did they avoid the light? Why did they run and crawl away? How did the grass that had been covered by the stone look? Why? What makes the uncovered grass green, then? Why? Is that grass green now? What has changed it from white to green? Light of the sun.

James, you may go out and turn over the stone now and bring in a slug. Now let us look at him. What color is he? What shape? How does he move? We will let him be quiet here and see how he moves. Watch him carefully. What does he do first? What then? See how he moves along. See the little waves that move along on his under side. This little creature has no bones. His little body is soft. We will put this small tomato here where he can crawl upon it. Pretty soon we shall see him eat. Look at his horns closely. Take this glass and look at them. Look at the ends of them. What do you see there? Eyes. Yes, his eyes are on the tops of these stalks. Why are his eyes put where he can lift them up so far? So as to see on all sides. Yes, he has to watch on all sides to look out for his enemies. Who can name some of this poor slug's enemies? Robins, chickens, all other birds, toads, and moles. The poor slug has no shell to protect him, as the snail has. But his color hides him, because it is gray or brown, like the ground. Some day we will get some snails and see how much they are like the slug.

Now I will tell you something about the slug. His tongue is like a file, and his 18,800 teeth are on his tongue. He runs out his tongue and files off the soft plant-leaves and fruit, and so gets his dinner. See where this slug has crept. What has he left behind him? A shining track. Yes, he has left a shining mark behind him. His body is soft and it gives off this sticky substance, so as to let him go over the ground faster. He oils the ground just as mamma oils her sewing-machine to make it go easier.

Let us put a little salt on this slug—so. See what he does. Do you think he likes salt?

Now, Mary, tell us what you know about the slug. What do slugs eat? Who ever found one eating a strawberry, a tomato, a grape?

For to-morrow's language lesson I want you to make up a story about a slug. Put into your story some things you have learned about slugs. Be careful about your capitals, periods, and commas. You must write it very neatly and well.

THE SNAIL.

Teacher.—Henry has found some snails. What animal do they look like? Like slugs. Yes, they are like a slug, but they have a shell, and the slug has none. Is the shell a part of the snail, or is it the house of the snail?

1st Pupil.—It is a part of the snail, because he cannot get out of the shell.

Teacher.—What does he do with his shell when he goes from place to place?

2d Pupil.—He carries his shell on his back.

Teacher.—We will put some snails on this piece of glass and watch them.

1st Pupil.—He is beginning to stretch out.

2d Pupil.—He is putting out a pair of feelers.

3d Pupil.—He has two pairs of feelers like the garden-slug.

Teacher.—Can the snail feel?

1st Pupil.—I touched his body and he drew in his feelers and rolled up his body into the shell.

2d Pupil.—When I touched his feelers, he pulled them in and did not put them out for a long time.

Teacher.—Can you find the snail's mouth?

3d Pupil.—This snail is eating the lettuce-leaf, and his mouth seems to be just below his feelers.

Teacher.—Yes, the snail is like the slug. His mouth is just below in front. He has a tongue like a file, and so gets his food to eat. Are there rings to his body? Is the snail warm or cold? Does he leave slimy marks behind him?

Note to Teacher.—The snails may be placed in a box of moist earth, rotten wood, and dead leaves, and supplied with a fresh head of lettuce or a leaf of cabbage. The pupils can then observe their ways of life.

The soft jellylike eggs will soon be seen, and the young snails will appear with their minute shells having $1\frac{1}{2}$ whorls.

The pupils may draw the shell and write the results of their observations illustrated with the drawings.

Water-snails may also be studied in a jar of water. Their habits will furnish an endless supply of material for observations.

It is a good plan to make a collection of land and fresh-water shells, placing each kind by itself in a small box. If you do not know the name, label each box with the location where it was collected.

Slugs and snails belong to a very large family of animals. We call this family the mollusks. All mollusks have soft bodies, and most of them have shells into which they can crawl.

THE MILLIPEDE AND CENTIPEDE.

Here are two curious creatures found under a stone. Let us examine them. We will not touch them, for they are poisonous. Let us see wherein they are alike.

Both are long and slim. Both have jointed bodies. Both live under stones and in damp places. Both have many legs, and long feelers on their heads. We call them thousand-legged worms. Do you suppose that they have so many legs as that? No, indeed. Which kind has the most legs? How do they differ in color? We call the one with the greatest number of legs a *millipede*, and the other a *centipede*. The centipede is flat, but the millipede has a round body. The hind legs of the centipede are bent back like two tails. How does the millipede act when I touch him with this pencil? He rolls up into a ball. Which has longest feelers? The centipede. Are these feelers composed of one piece, or are they jointed? Which one is most active?

The centipede grows to be almost a foot long where it is warm all the year. It is very poisonous in such countries. The millipede sometimes becomes as large around as a pencil. The centipede is so flat that he can get under stones and into very narrow places; he eats insects; his horns or feelers are longer than those of the millipede. A baby centipede is just like a big one only he has fewer joints in his body. Millipedes often live in damp moss and under rotten wood and leaves. Once in a while these curious little creatures shed their skins and get more joints to their bodies. Look at them carefully with this glass. Do you

FIG. 38.—*a*, CENTIPEDE; *b*, MILLIPEDE.

see any difference in the way the legs are attached to the bodies? Yes, in the centipede each joint has one pair of legs, but in the millipede each joint has two pairs of legs.

Would you call these curious creatures insects? Why not? Because in insects the body has three distinct parts and always six legs. Most insects have wings also. Do you think that these creatures are friendly to the crickets, ants, and beetles which we saw under the stone? No, they are the enemies of insects, and often eat them.

Some people call them “earwigs,” but they are not true “earwigs.”

Chapter VII.

WALKS WITH THE CHILDREN.

Many books on nature study urge upon the teacher the duty and necessity of walks with the children, and the using of such occasions as opportunities for instruction. Now it is very beautiful to see a teacher surrounded by a party of eager children, inhaling the "odors of the forest," and walking along a country road overhung by trees and bordered with spring flowers. The picture is beautiful ; but *is it practicable ?*

How many teachers can do this in school-hours without bringing down upon them the accusation of "not 'tending to business" ?

However desirable this mode of teaching may be to satisfy the patrons, the majority of teachers must find time for it after school-hours or on Saturdays. In my own school, excursions have been made to neighboring towns to observe various modes of manufacturing, and three or four times a year journeys have been made by single classes in search of minerals, insects, or plants. In all such cases the length of the journey should be proportioned to the age and learning of the children ; and be it always remembered that one need never go far to find an abundant supply of material for study. The effect of excursions is so very excellent that they should be undertaken when allowable ; and it is urged upon every teacher who may read this book to try the effect of an occasional walk with his pupils. It is believed that one walk, under intelligent guidance, affords

a better understanding of geography than many lessons from the best existing text-book.

A WALK IN EARLY SPRING.

At close of school—earlier if possible—plan to go out with the little ones. Do not take a long walk.

If we are very good to-day and can get our work done, we will take a walk. Let us see what we can find. The grass has not yet begun to grow, but perhaps we can find some little wild flowers even now peeping up beside the road. I saw a snowdrop this morning, and Lottie says that her crocuses are almost open.

Now let us all have our eyes open for signs of spring.

What bird is that yonder? How do you know it is a robin? Hark! perhaps we can hear him sing. How do robins go on the ground? Name some other bird that hops. Where do the robins live? How do they build their nests? What kind of eggs do they lay? Did you ever see a young robin? What does the old robin feed her little babies with?

Here is a pine-tree. Let us get some of the bark and leaves. Get some of those cones, too.

Here is a small, clear, glassy stone, and there a milky one. These are quartz. See if you can find one that is pink in color.

Anna.—Here is some snow by the side of this rock.

Teacher.—On which side is it?

Jane.—On the north side.

Teacher.—Why does the snow stay so much longer on the north side?

Charlie.—Because the sun does not touch it.

Teacher.—Do you remember the snowflakes which we saw last winter, and how they looked?

Frank.—They were like stars.

May.—They had six parts to them.

Teacher.—Does this snow have such beautiful forms?

All.—No, ma'am.

Teacher.—That is because the snow has been here so long. It has melted and frozen many times, and the pretty stars are gone.

Charlie.—Here is a fern coming up by this stump.

Teacher.—See how the fern-leaf is rolled up, and how much soft wool is around the young bud to keep it warm.

Frank.—I have found some gray moss.

Teacher.—That is reindeer moss. The reindeers eat it away in Lapland, where it is very cold.

May.—I see some pussy-willows, but the pussies are very little.

Teacher.—We will not pick them now, for they are too small. Some other day we will get them, when they are larger. Hark, do you hear those birds cawing? What are they?

Jane.—They are crows. They say "Caw, caw."

May.—See how fast they fly.

Anna.—They are going to find their supper.

Teacher.—What will these crows have for supper?

Frank.—They will pick up things on the ground. When they can, they eat corn in the field.

Charlie.—My papa has a scarecrow in the field every year.

Teacher.—The crows build their nests in March and April. They take bark to build their nests. They line them with sticks and dry grass.

Anna.—I saw a crow's egg. It was green, with brown marks on it.

Jane.—A crow's egg is over an inch long.

Teacher.—Crows try to hide their nests, and when we go near them they fly away to deceive us. When they have eggs, they are very brave. They eat snakes, mice, and insects in the spring, and berries and grain in the fall. But we must now go home. Let us come again soon and see how things have grown. We have collected things for some interesting lessons.

OUTLINES OF LESSONS ON THE THINGS COLLECTED DURING THE FIRST WALK IN SPRING.

I. *Quartz.*

Yesterday we found some very pretty pebbles and stones when we were walking. Here is a stone that Jessie found. It is clear, like glass. Charlie may take it out and break it. Will it scratch glass? Wood? Iron? Zinc? Tin? Find out by having them try it on the window, the floor, the stove, the zinc under the stove, and their dinner-pails. It is quartz. Sometimes we find quartz in very beautiful forms, like Fig. 39. These pebbles were once so formed, but they have been worn round. Here is a milky one. Did any of you find a pink one? We call that rose quartz. And here is one with a pale purple hue. It is *amethystine* quartz; but that is too big a word for you. We will call it purple quartz. Now write on your slates what you can of quartz.

FIG. 39.—QUARTZ CRYSTALS.

II. *Bark.*

Look at this piece of bark. Who can tell me what it is? What is its color? Does it cut easily with a knife? Is it tough or tender, rough or smooth, thick or thin? Can you peel off layers of it? Can you strip it up in fine pieces (threads, fibres)? Does it smell? Compare the bark in question with birch, oak, pine, grape, cork, etc., etc. The teacher should collect many varieties of bark, to facilitate comparison.

III. *Pine-needles.*

Here are some of the pine-needles that we found the other day. Are the needles put on singly or in bunches? How many needles are there in a bunch? See if all bunches contain the same number of needles. How long

are the needles? How wide? • What color are they? Were there any needles on the ground under the tree? What color were they? When does the pine-tree shed its needles?

IV. *Pine-cones.*

This is the fruit of the pine-tree. What do we call such a fruit? See if you can find a thin scale inside your cone. These are the seeds of the pine. Do you find a clear sticky substance on your cone? This is what? Resin. Did you ever see a baby cone? In a few days we will take another walk and try to find some. Now let us dip our cones in this water and leave them there until recess, and we shall see what happens to them.

(*Later.*) What has happened to the cones? Yes, they have shut up very tight. What made them do this? Do cones close when it rains? Why do they do this? By closing the little seeds are often loosened, and so scattered on the ground. Can you find a seed in your cone? What does it look like? Yes, it looks somewhat like a maple-key or elm-seed. Why did nature give the pine-seed a wing? Let us throw it up and see if it will fly for us. Name some plants which have seeds with wings. What would happen if the pine had no wings to its seeds?

SECOND WALK IN EARLY SPRING.

Take a little wider range in this walk, but do not go too far. Remember that there is such an abundance of material near by that it is not wise to go far. Let each child carry a small box in which to put his collections. A baking-powder box is excellent for this purpose. The teacher should have a pocket microscope also.

Call attention to the different kinds of clouds—woolly (cumulus), feathery (cirrus), etc.; point out how the woolly ones are lower, how they are drifting. Tell them the tale of Apollo's sheep. Get them to note the various birds seen in passing. Point out the different trees along the way. Col-

lect the long-pointed buds of the beech, the blunt ones of the elm, the sticky ones of the horse-chestnut, the beautiful downy buds of the hickory, etc., etc.

See the young maple-keys sprouting. Note how the beechnut has opened its seed-leaves. Find some acorns with their sprouts starting, etc., etc.

Now sit down and give them ten minutes to collect objects. Divide the party into three or four sets, send them in different ways, and tell them that they must come back when you call them.

Back they come at your call, spring's earliest trophies in their hands.

Harry has a crayfish from the brook. Anna and her party bring back lichens, bark, willow catkins in every stage of development. May has found a box-turtle tightly shut in its mottled shell. Others bring arbutuses, cinquefoils, anemones, cowslips, and buttercups. Frank has a bunch of spring-beauties, and you tell them that this delicate flower has a little sort of potato at its root, and ask them to find one. Away they go, digging in the rich dank mould. See how the eyes sparkle and the cheeks glow as the fortunate ones come back with the desired object. Charlie comes last with a snake he has killed and some frogs' eggs in a bottle of water.

Having enough for many days, we will place our collections in our boxes and go back to school. The frog's eggs will be put in a jar of water and we shall see what comes of them.

Note to Teacher.—When shall we take longer walks? I have often brought it about in this way: Promise the children that if order is good all day you will dismiss ten minutes earlier and take a walk. It is often better to say, "We will go on a hunt." There is something about the word "hunt" which inspires an interest among the boys. Force no one to go, but make it so interesting to those who do go that next time there will be others who will desire to accompany the "hunting party." Never prolong such a trip

until any one is tired. It is often very handy to have one of the boys take a hammer for breaking stones.

Do not forget that the *mere collection of materials* is *not* the end and aim of the trip. It is to bring pupils in contact with nature, and so cultivate the heart. This is one great end of nature study. When the materials collected on this walk have been used, there is an excuse to warrant another "hunt."

OF THE SECOND WALK IN SPRING.

Lessons on Materials Found.

I. *Young Maple.*

Here are some maple-keys that we found sprouting yesterday. How many leaves has it? Are they like common maple-leaves?

Hattie.—They are long and slim.

Josie.—They are bent and twisted.

Teacher.—Yes, these leaves were rolled up and folded in the seed. Now they are straightened out. Has any one a little maple with more than the first two leaves?

Anna.—My maple has four leaves. The second leaves are wider.

Willie.—The second leaves are more like real maple-leaves.

Teacher.—Yes, the second leaves are wide, and the third pair are like large leaves. Are the leaves opposite or alternate?

Hattie.—They are opposite.

In like manner study all the young seedlings collected. The first and second beech-leaves are opposite, later ones alternate. The young pine-leaves are in a whorl. The young oak-leaves alternate from the first. Parts of the seed come up in some plants (beech, bean, maple, etc.). In other plants the seed remains on the earth (pea, acorn, horse-chestnut).

II. *The Crayfish.*

Its color, size, shape. Two sets of legs, five pairs of large true legs, and five pairs of false ones. Two pairs of horns (antennæ). How does the first pair differ from the others? How do the first three pairs differ from the others? What shape is the tail? Fan. Describe the eyes. How does the crayfish move?

After studying the crayfish alive add a little salt or vinegar to the water to kill it. When killed, remove from the water and spread it out on a piece of wood and dry it. It may be glued to a block and varnished, and become an interesting specimen in the museum.

If near the seaside, lobsters, crabs, and shrimps may also be collected and studied in the same way, but these larger ones should be cured with glycerine, alcohol, or corrosive sublimate to keep them.

Tell the children how these strange creatures may lose a leg, or any single part, and another will grow in its place. Examine the eyes with a microscope and show them the many parts each possesses.

III. *Frog's Eggs.*

Study their form, size, and color. Get the children to discover that the eggs are laid in chains or strings of white, having the yolks scattered along at regular distances.

Put the eggs in a glass vessel and have pupils record observations from time to time. Interest will reach the pitch of enthusiasm when the tadpoles begin to hatch.

As the weeks roll along the date of each stage of development should be noted and recorded, so that when the perfect frog is developed the time since the eggs were found should be known.

This is real scientific work, and these observations are of incalculable value to the child and to the teacher.

Procure a large number of bottles, with wide mouths, getting as clear glass as possible. Place some of the eggs in one, add alcohol or dilute glycerine and label it No. 1.

In No. 2 put the smallest polliwogs.

“ “ 3 “ “ larger ones.

“ “ 4 “ “ first signs of legs.

“ “ 5 “ “ later leg development.

“ “ 6 “ “ diminishing tail.

“ “ 7 “ “ perfect frog.

This collection shows every stage in the development of the frog, and is always on hand for reference.

Similar collections to illustrate the metamorphosis of insects are always of use in nature study.

THIRD WALK.

TREES. I.

Take your pupils out for a walk. Make it a short walk, proportioned to the age of the pupils. The lowest grades should never go far beyond the school-grounds. There is abundance of material there. A higher grade may go short distances. The pupils of still higher classes may venture a half mile or farther.

Make the walk *interesting*. Let nothing escape the attention.

See how the tree yonder has a trunk that runs upward through the branches to the very top. Yonder is a tree whose trunk is all broken up into branches. Note how some branches ascend, others are horizontal, others arch, and others droop.

Call attention to the various hues of green in foliage—the whitish green of some willows, the dense green of oaks, the tender green of maples. Teach them to observe the *gray* bark of the beech, *white* birch, *rough* black oak, and *smooth* *ruddy* cherry.

After walking some distance ask all to be seated. Let us sit under this fine old tree. See how the roots spread out over the ground. Do you think its roots are as large as its branches? Why do its roots spread out so? To gather food and moisture, and to hold the tree firmly in

the ground. What kind of a tree is it? How do you know that this is a beech? Its bark is gray and smooth. Its leaves? Saw-edged, smooth, pointed. Now each of you take as much ground as you can cover with your handkerchief. Each one take out his handkerchief and spread it smoothly on the ground. Now when I say "Ready" you may take them up. When you take them up, see how many things you can find on the ground under the handkerchiefs. "Ready."

Etta.—There is nothing under my handkerchief.

Teacher.—Oh, yes, there is. Here is something. What is it?

Etta.—An old beechnut.

Teacher.—What are these brown scales?

Etta.—They are from the buds last spring.

Teacher.—What have you got, Harry?

Harry.—I have found some beechnuts, some pods that used to have nuts in them, some bud-scales, and a dried beech-leaf.

Martha.—I have found a young beech-tree only six inches tall.

Teacher.—Scrape up some soil and tell me what you find in it.

Jane.—This dirt is full of pieces of leaves.

Martha.—There are pieces of leaves and shucks of nuts in it.

Ida.—The soft parts of the leaves are all rotted away, but the stems and veins are left.

Etta.—The soil is made up of rotten leaves and bark. There is fine sand in it.

Teacher.—Save these things and examine them carefully. This is soil.

Harry.—Here is a maple-key, too.

Teacher.—How did a maple-key come under a beech-tree?

Martha.—The wind blew it here.

Teacher.—Do you see the wing on the maple-key?

When it fell from the mother tree, its wing made it turn swiftly round and round, so that it could not get to the ground at once. Then the wind blew hard, and the maple-key was blown away and away far from the mother tree until it fell down here.

Ida.—Oh, here is such a funny flower. It has no leaves, and it is white all over.

Teacher.—Yes, that is called *beechnuts*. It grows on beech-roots. It is a plant that grows on other plants. Let us dig away the soil and find the root.

Jane.—Oh, it is scaly at the base. It grows to the root of the beech-tree. I cannot pull it off.

Teacher.—When one plant or animal lives on another, we call it a *parasite*. We will look on roots of other trees and find other kinds of parasites. See the leaves of this beech-tree. Let us gather some to take home with us. See the edges of these leaves. How are they placed on the stem? Are the first leaves of your young beech-sprout opposite, Martha?

Martha.—Oh, yes, they are opposite. But the leaves on the tree are not opposite; they are alternate.

Teacher.—After the first pair of true leaves, which are always opposite, the beech puts forth alternate leaves. Do you know what beech wood looks like, Jane?

Jane.—No, ma'am. May I break off a branch to see?

Teacher.—Yes, and we will have the boys cut off a larger branch to take home. Then we can saw it, and see what kind of wood it has. Harry, you may measure the tree around, three feet from the ground.

In like manner bring out the facts:

- 1, That the beechnut is three-sided and has three sharp edges;
- 2, that the pod which encloses the beechnut has small prickles on the outside and is smooth within;
- 3, that the bud-scales are thin, dry, brown, and glossy;
- 4, that soil is largely made rich by decomposing vegetable matter;
- 5, that the young beech-tree has for its first leaves the halves of the nut; that these are pale green above and white

beneath; that the second pair of leaves is opposite and the succeeding leaves alternate, etc., etc.

The lesson may be varied by taking some other tree, and special forms of trunk—*excurrent* (unbroken), *deliquescent*

FIG. 40.—WHITE OAK. DRAWN BY JENNIE MILLER.

(much broken)—may be brought out. Pines, spruces, hickory, are types of the first class. Elm, maple, oak, represent the second class.

II.

The best time for studying trees to get their form and

mode of branching is after the leaves fall. This forms good material for work in winter, when other natural objects are hard to get.

It is well not to go too far, but to map out a certain definite extent of territory and study the trees in it first. To one whose observation has not been directed to it, it will be amazing what a wide range of trees is to be found within very narrow limits of almost any school-house. This does not, of course, apply to crowded city schools.

I will here give the plan followed in the Chatham school. We took a radius of about forty rods, and observed the trees within those limits. We began with a white oak. It was first drawn as seen from the school-room windows. At recess the pupils went over to measure it three feet from the ground, and to bring back bark, twigs, acorns, dead leaves, and anything else from the tree. The best drawing was reproduced on the blackboard, and from this diagram the general form and manner of branching were brought out. Its sturdy, rugged, storm-defying attitude was noted. One bright imaginative pupil remarked that the oak seemed to be ready to shake his fist at the winds. The leaf was drawn and its outline carefully noted. Its tough texture and the texture of the branches also came in for a share of the study. The topics *White Oak*, (1) *Its Uses*, and (2) *Its Geographical Range*, were given to classes, the former to younger and the latter to older pupils. The "Charter Oak" was talked about.

III.

A fine symmetrical pin-oak grows just back from the school in the centre of a wide pasture. It has never been cramped by other trees, and so it has been free to expand on all sides. The pin-oak follows the white oak for two reasons : 1, because both were oaks ; 2, because both were handy to the school. The straight central shaft, the finer and more graceful branches, the smoother bark and every way more elegant appearance, furnished topics for much conversation.

Samples of wood, bark, and leaves were also obtained and studied. The leaves are noticeably different. The white oak with its broad rounded lobes and sharp narrow sinuses is the very opposite of the pin-oak, whose lobes

FIG. 41.—PIN-OAK. (DRAWN BY HOMER WAGNER.)

are sharp and whose sinuses are broad and rounded. The fact that both these oaks keep their leaves late into the winter was not unnoticed.

IV.

The elm-tree was one of the earliest trees observed. Its trunk is so different from that of the pin-oak in branching

FIG. 42.—ELM. (DRAWN BY B. KIRKPATRICK.)

(deliquescent), and so unlike the white oak in outline, that it forms a pleasing contrast. Its branches, flung here and there, always tipped with slender sprays, make it a favorite

wherever shade and graceful beauty are desired. The lichen-covered bark is also deserving mention. The leaves are hard to get perfect, owing to the myriads of beetles

FIG. 43.—GREEN ASH. (DRAWN BY MARGARET LYNCH.)

which feed upon them. Parasites seem to love the elm more than any other tree.

Reference was made to the famous Washington Elm.

The veining of the leaf is also peculiar, and the doubly

serrated margin presents a marked contrast to the oaks of the preceding lessons.

V.

The next tree observed was a large green ash, growing not far away. In addition to the preceding line of study on trees more attention was given to the wood. Some very pretty specimens of ash were obtained, and together with cross-sections, radial sections, and tangential sections of the stem were mounted upon a large card. Later leaves, flowers, and fruit were also mounted here, so that the ash-tree told its own story by means of samples of all its parts. Here again we found novelty in the compound leaves with their cuspidate apexes and serrate margins.

The uses of ash brought out much material for composition-work.

VI.

The poplar was next studied. This particular tree was selected to show how early trimming of branches often entirely changes the form of the tree. Why did men cut off its top before planting? Why did all these branches start? Because of dormant buds which started only because the main branches were cut off. The leaf also is of a different type from those studied. The difference between trees pruned and those allowed to grow in their own way shows in this instance the wisdom of pruning for shade.

VII.

The above was the last lesson given on special trees in school. Each pupil was then required to draw and write a description of two trees not previously studied, growing somewhere between home and school. This resulted in drawings and descriptions of the following trees :

The sycamore with its wide irregular mode of branching, its brown-gray bark peeling off in large patches exposing the

light bark underneath, the broad-toothed leaves with their peculiar caplike petioles for fitting over the young buds of

FIG. 44.—POPLAR. (DRAWN BY MATTIE ALEXANDER.)

next year, and its interesting balls of fruit, furnished a report from one member of the class.

VIII.

Another student had an account of the tulip-tree near her home. The valuable wood, so extensively used under the

FIG. 45.—SYCAMORE. (DRAWN BY CARRIE WARD.)

name of "white wood" in inside work, was mentioned. Drawings and pressed specimens of the gorgeous tuliplike flowers and the odd-looking cucumberlike fruit were shown.

Some had never seen the leaf, and were much surprised to see the strange cut-off appearance of its apex.

FIG. 46.—TULIP. (DRAWN BY IRVING LUM.)

IX.

One of the most interesting lessons was on the white birch. These trees usually grow in clumps of from three to twelve, appearing to start from one root. This, of course,

renders the separate parts unsymmetrical, but the clump usually forms a well-rounded cluster. The sprays are always

FIG. 47.—WHITE BIRCH. (DRAWN BY WILLIE ELDER.)

fine and feathery, being extremely delicate. These trees are also striking in having such white trunks, while the finer branches are darker, often being dark red brown in color.

Here also we found another kind of bark, namely, one consisting of many thin layers easily splitting off from the tree trunk. The use of birch bark by the American Indians in building canoes and wigwams added no little interest to the study of this tree. Observations on the bark brought

FIG. 48.—PERSIMMON. (DRAWN BY ROBERT LUM.)

out the fact of its toughness, flexibility, smoothness, etc. It required some close observation to discover why the outside is so white while the underlying layers are brown. At length it was decided that the whiteness is due to the bleaching action of sun and rain. Longfellow's lines in *Hiawatha*, beginning, "Give me of your bark, O birch-

tree," were learned. The grammar class was given this stanza for parsing and analysis on the same day. Pupils were asked to be on the lookout for another kind of tree whose bark resembles that of the birch. This was to introduce the wild cherry, with its rich, shining, red bark and valuable wood.

X.

Interest in trees was now becoming so great that several uncommon trees were observed, drawn, and described by various pupils.

The following description and the accompanying drawing were done by a pupil whose interest in trees had become very marked :

The Persimmon-tree.

(Description and drawing by Robert Lum.)

This persimmon-tree grows in Mrs. Day's pasture near Black Brook. It is really two large trees springing from the same root. The trunks are very straight and give off but few branches.

The bark is rough and cracked somewhat like an oak bark. The wood is tough and light-colored. The branches are irregular and some of them are very much bent.

The little branches and twigs are crooked. The leaves are shaped like cherry-leaves, but the veins are not much like the veins of the cherry-tree. The veins are crooked like the branches. They bend around and come back again to the mid-rib. Only a few veins go out to the margin.

I never saw the flowers of this tree, but the fruit is very good after frost comes. Before frost the fruit tastes like alum.

Suggestion to the Teacher.—In concluding this series of lessons on trees I am led to make some general remarks upon the study of woods and barks. In the beginning it is well to have a few kinds of wood to study. Any large boy will procure several varieties, and any carpenter can supply numerous kinds to start with.

Preparation.—Pieces two or three inches in diameter and six to eight inches long may be sawn from branches of trees. These should be thoroughly dried for a long time to prevent checking. When dried, cross-sections should be made one inch thick, and each section should then be cut through the

centre and also near one side. Such a way of cutting gives the wood in three aspects, *i.e.*, *radial*, *tangential*, and cross-grain or *transverse*. When neatly sandpapered, they may be treated with some clear varnish to give them a finish. It is advisable to varnish only *half* of each aspect. This will show how each wood appears plain and dressed.

What to Note.—In giving the lessons the thickness of the bark, its color, texture, smell, etc., the ring and rays in the wood, sap, wood, pith, and bast, coarseness, hardness, etc., should all be noted. The amount of pith should also be noted, as woods differ very greatly in this particular.

Arrangement.—There are many ways of classifying and arranging woods. If the specimens are large, they may be labelled and arranged in rows upon the shelves of a case. Smaller sized specimens may be arranged in boxes. A very convenient way is to collect specimens one inch in diameter and three inches long. These may be glued or wired to a board or stiff card. A good way is to have each piece mounted with a cross-section just above it. Such a collection may be placed upon the walls to ornament the school-room.

It should not be forgotten that the mere act of collecting, however good that may be, is *not the end* in studies of this kind. Pupils should know their specimens well. They should handle them until thoroughly familiar with their minutest details. To this end it is often good to give pupil a mixed assortment of woods to arrange as seat-work. Another stimulating exercise is to play the game of trees. This is to have pupils take turns in describing some particular kind of tree or some individual tree and have the others guess its kind.

FOURTH WALK.

Farming—A Brook.

In this walk the class is not supposed to go more than a half mile.

Here is Mr. Jones' farm. What has he planted in this field? What is growing in that field? How many acres are there in this field? Charlie may find out how many acres and how many bushels of corn, oats, or wheat Mr. Jones expects to get. That would be how many bushels to the acre? What kind of soil is this? Is sandy soil as wet as clayey soil? What crops grow best on loose sandy loam? On heavy clay soil?

Here is a hill or knoll. Let us see if the corn grows better on one side than another. On which side is the best corn? Why? What kind of weather is best for corn?

Obtain direct answers where possible, and require pupils to find out when ready answers are not forthcoming. These questions will arouse Mr. Jones, and he will see that the children are inquiring after practical things.

Here is a haystack. Let us see how large it is. How many tons of hay does it contain? How long will it feed the stock? When was this hay cut? What fodder plants are in it? Timothy, blue-grass, red and white clover, etc.

Let us now go down into the meadow. Why does Mr. Jones not cultivate the meadow? Why does he prefer the meadow for pasture? Yes, it is too wet to cultivate, and there is a brook where the cows can drink.

Where does this brook rise? In what direction does it flow? Into what does it empty? Why does it bend here? What makes it run faster there? Let us make a bridge out of this log. Now suppose we were to play that the other side of the brook went farther and farther away until it got over yonder by the woods, what would we call it? Yes, it would not be a brook then, but a river. How many of you ever saw a river? What river was it?

Sometimes rivers are very wide, so wide that you cannot see across them. Why does this brook flow this way and not that? Why does it not run over its banks? In what season is the brook highest? Why? Lowest? Why?

Let us walk up to the brook. Does it grow larger or smaller? Why?

If the brook be a small one whose source is not far away, as is the case with those which flow out of springs, the walk may be followed to the source, and all changes in the direction, size, and nature may be noted. When the spring is reached, such questions as the following may be asked :

Here is the source of the brook. It comes from the ground. How did the ground get it? Why does it come out here?

Lead them to see that it is merely rain-water that has soaked into the earth until it has found a layer of clay or rock on which to run until here it has reached the surface.

(Many things, such as insects, crayfish, minnows, lizards, frogs, and turtles, can be caught on this expedition, and carried to school for future lessons ; the method of using them has been given previously.)

If not too large, the stream should be mapped. A map of the meadow might at least be made, and a relief-map of Mr. Jones' farm would be of much value to the one who made it. The walk may be followed by a language lesson next day telling the story of the previous day's expedition.

HINTS FOR LANGUAGE-WORK ON THE PRECEDING.

The Farm.

In what direction from the school-house is Mr. Jones' farm? What kind of a house has Mr. Jones? What direction does it face? How many acres has he? Is it all cultivated? How much meadow? How much woodland? How far from the house to the meadow? What crops has Mr. Jones planted? What ones are doing best? Why? What kind of fences has he? Are they in good condition? When will Mr. Jones reap his wheat? What will he do after reaping? Where will he take it? Why? How much will the miller charge to grind it? Tell all you can about making flour,

FIFTH WALK.

A Hill.

Gravity.—How many of you have sleds?

What do you do with them? Draw, ride on, etc.

When do you ride on them?

Did you ever ride on a sled when no one drew it? How could you do it?

How did you get up to the top of the hill? What made your sled come down? What is the highest part called? Top.

What is the lowest part called? Bottom.

What is the part called where you rode? Slope or side.

If the top of the hill were very much higher, so high that it went up to the clouds, what would we call it? Mountain.

If you stood on the top of a hill or a mountain and the mountain should go away and leave you up there, what would you do? Fall.

What would make you fall? There would not be anything to hold me up.

Yes, when there is nothing under us to hold us, we fall to the earth.

The earth pulls us. Why does the sled slide down the slope? Because the earth pulls it down.

Why is it harder to draw a sled uphill than down? The earth pulls it back all the time.

Erosion.—When it rains on a hill-top, where does the water go? Yes, some soaks in and some runs off. When the water soaks in, it makes the soil softer. How does the water look that runs off the sides of the hill? Yes, it is muddy. What is the running water doing to the hill? Yes, wearing it away. What will become of the hill some day? Yes, it will all wear away and become flat.

Weathering.—But there is something else in the hill besides the soil and gravel. Henry, what is under the soil in the hill? How do you know that there is rock under

the soil? When the rain has washed off all the soil, what will be left? Yes, the rock is the skeleton of the hill. A hill has bones like a little boy or girl. What are the bones of a hill? Yes, rocks are the bones of hills. They are the bones of the whole earth, too. Now when the soil is all washed from the rocks, what will happen? Here is a piece of rock with a lichen growing upon it. Charlie may dig off some of the lichen with his knife carefully. What is under the lichen? Yes, there is a little dust under the lichen. How did it come there? I will tell you. Rocks are slowly crumbling in the air. This dust was once a part of the rock. The lichen, growing on the rock, took root in the dust and feeds on the rock.

“The granite rocks disorganize to feed the hungry moss they bear,
And forest trees drink daily life from out the viewless air.”

You know now what the first line of this stanza means. The rest of it we will understand later. Now if a lichen grows in a little crack in a rock, and the rain falls on it, it will soak it up like a sponge. What would happen if a little crack in the rock, all full of wet lichen, were to freeze? Yes, it would become full of ice. And when ice freezes what happens? Oh, yes, the ice bulges. What will that do to the rock? Split it apart. The lichens growing on the rock then help to break it up by changing the rock to dust, and by holding the water so that when it freezes it can split the rocks and so help tear down the hill. Only see what humble things God takes to do his work.

SIXTH WALK.

The Ground.

Did you ever dig angleworms for fish-bait? About how deep do you have to go to find the worms? Yes, you are right. That depends upon how dry the soil is. Did you ever, in digging, come to a different kind of earth below the top-soil? Oh, yes; it was of a lighter color than the top-soil.

We will call it subsoil, or undersoil. What else do we sometimes find in digging? Oh, yes, and stones are hard to dig out when they are large. Are stones living things? Oh, no, there is no life in them. They are pieces of rock broken off and buried in the soil. Can you tell me anything which stones can be used for? Oh, yes, we use them for building foundations of houses. Some kinds of stones are very valuable. We call them precious stones. Do you not know any other valuable things that are taken from the ground? Oh, iron, copper, gold, and silver are dug out of the ground. Stones and other things dug from the ground are called minerals.

Minerals—Metals.

Some minerals, like gold, iron, silver, copper, and zinc, are called metals.

Quarrying.

The getting of stone out of the ground is *quarrying*. Some of you have seen a stone-quarry. Others dig down very deep after the metals. These men are called miners, and what they do is called mining. Let us now look at these pieces of stone; they were dug out of a cistern. Are they not all alike? See how the outside of these stones is softer and lighter than the inside. That is because these stones are becoming softer and wearing away from the outside. The rain and frost help to tear away the little pieces from the outside of the stones. We call it weathering, because the weather makes the stones rot. If you go to a hillside where there has been a deep cut made, you will often see top-soil, then subsoil full of pieces of stone, then the rock underneath. The frost has broken off pieces from the rock, and these pieces are the stones in the subsoil.

Soil and Subsoil.

We will dismiss ten minutes earlier, as I want you to go up on Long Hill to-day, at the close of school, where Mr. Doran is grading down the street.

I want you to look first at the upper surface, where the grass grows. Robert may get us a handful and we will examine it. What do you see in it? Remains of leaves, rotten wood, etc. Examine with this glass. "Oh, I see grains of fine white sand mixed with it."

Yes, we call it loam. This loam is rich with remains of dead vegetation. Now look just below the top-soil. What do we call this? Yes, it is called subsoil, because it is under the soil. How does its color differ from that of the soil? Yes, it is not so dark. Examine the subsoil. It has more sand and clay in it also. How deep is the top-soil? The subsoil? What comes next? Rock. Yes, here is hard rock. Can you not see where the top of the rock is weathering into subsoil? See the cracks running downward through the rock? It is where the frost has split the rocks apart. Willie, please to break open a piece of this rock; we will see how it looks inside.

See how dark the inside is, while the outside is much lighter. Is it harder within or without? Yes, the outside is softer, for it has begun to weather. The subsoil is formed of this rock after it has weathered. Let us take some of this subsoil and some of the top-soil in these paper bags.

When we get back to school, we must plant something in each and see which grows the best. Soils vary greatly in the amount of clay, sand, and vegetable matter they contain. Which would be the principal part of the soil in Great Swamp? Yes, it is nearly pure vegetable matter. Would the top-soil be thicker or thinner down yonder in the meadow than up here on the hilltop? To be good a soil should possess both sand, clay, and vegetable mould. How, then, might you make a sandy farm more fertile? How would you make a swampy place better after having drained it? Why do the people in the cranberry marshes spread sand on the black peaty soil? What would you do if you owned a field having a heavy clay soil? I wonder if we can find what part of soil is made up of each of these

things. We will dig up a few pounds of top-soil and put it on a board. Now let us mix it until it is fine and all alike throughout. Now let us weigh out exactly a pound.

Charlie, can you weigh it? Here is a pound. How many ounces is that? Now we will feel of it. Is it dry? No, it is moist. How can we get the water out of this soil? That is right. We must dry it. We will put it in paper and carry it back to school and put it under the stove or over the heater for several hours. Mary may stir it at recess, and Georgie may stir it at close of school. To-morrow we will weigh it once more to see if it has lost any of the water. When the soil has had time to dry in the air, have it weighed once more. It will be found to have lost some of its weight. This is called "air-drying." Record the loss of weight by drying. Later question as follows: The soil lost some of its weight when we dried it. Did all the water pass away? Is it perfectly dry? Let us see. Here is a tin pan. Let us put the soil in the pan and set it in a hot oven. Perhaps Mrs. Martin, across the way, will let us use her oven. I will ask her myself. We will put it into the oven and leave it there until noon. How long will that be, Charlie? Yes, it will be nearly three hours. This is called "kiln-drying" or "fire-drying."

When dried thoroughly, we will weigh it again. Now how much has it lost? Now if we could get rid of the vegetable matter, we would be able to tell how much mineral matter there is in this pound of soil.

How can we get rid of the vegetable matter? Can we pick it all out? Oh, no; we must burn it out. Let us now put it on this flat fire-shovel and put it into the stove and leave it there. We must stir it once in a while, but be careful not to push any off the shovel. What part burns? Yes, it is the vegetable matter which burns. Will the sand or clay part burn? Oh, no; they cannot burn. How does it burn? It does not burn with a flame. No; it smokes and smoulders away. The vegetable matter is going up the chimney now. Can you see it? It is smoke. When it

stops smoking, we will look at it again. Now we will weigh it again. Has it lost much? How much did it lose by burning?

Now let us see what we have learned from these experiments on the soil. We had 1 lb. or 16 oz. of soil.

16	oz. fresh top-soil.
2½	oz. lost by drying in air
<hr/>	
13½	oz.
3½	oz lost in oven.
<hr/>	
10	
7	oz. lost in fire.
<hr/>	
3	oz. ash remaining.

The above affords a great number of problems for all grades. The percentages lost each time give practical work for higher classes, while all the fundamental rules may be applied to the heart's content. Now ask each pupil to analyze the soil in his own father's farm in this way and bring results to school. Ask the children to find whose farm is richest in vegetable matter. Thus a child's instincts for playing in the dirt can be turned to practical account.

EXCURSIONS.

The taking of older pupils to visit places of interest in one's town or neighborhood can hardly be overestimated in its value to the pupils. Quarries, clay-pits and gravel-pits, mines, factories, and places of historic interest should be visited by students under the direction of their teachers.

The Chatham pupils visited paper-mills, gas-factories, tanneries, electric-light power-houses, waterworks, pumping-stations, and numerous places of interest in and near Chatham. In addition to this excursions were made to New York and Brooklyn, where points of interest from Castle Garden to the Grant Monument were seen and talked about.

Chapter VIII.

COLLECTIONS DURING VACATION.

WHAT TO COLLECT FOR NATURE STUDY AND HOW TO COLLECT IT.

The progressive country teacher who is face to face with nature all the time hardly needs to ask, "What shall I collect during the summer vacation to interest my pupils next year?" She has but to direct the observing powers of her pupils into the ever-widening channels of nature study, and she reaps a harvest of curiosities for her cabinet of which many a museum might be proud.

The city teacher, penned up between brick walls, with a brewery on her right and a livery-stable on her left, high buildings in the rear and a noisy street in front, must make collections in the far-away country, at the seaside, among the mountains, or anywhere out of the hurly-burly of her daily life.

Do I hear some tired teacher exclaim, "Vacation collections. Out upon them! Let us rest!" and the like? True, you are not paid to collect objects in the summer. True, your labors are at an end when your *reports for June are in*. But if you can rest your tired body, if you can gain a fund of fresh zeal and energy, if you can do something that will make your next year's work easier, more interesting, and profitable by collecting materials for nature study, aren't you willing to do it?

Let us, then, suppose that you are going out of town for part of the summer vacation; no matter where. Nature is lavish in her distribution of things for study. No matter

where you go, as Oliver Wendell Holmes has said, nature never loses a place to hide things, even to the joint of a tavern bedstead.

I. *Insects.*

Such varied and beautiful things cannot fail to be most interesting objects of study.

(a) **How to Catch.**—The easiest method of catching is to fix a net out of thin cloth, like tarletan or mosquito-net. Sew in form of a conical bag, and hem. Bend a piece of

FIG. 49.

common stovepipe wire and run into the hem. Fasten the ends of the wire together by twisting, and insert into the end a stick about three feet long. With a little practice one can become very expert in capturing insects on the wing with this simple net (Fig. 49a).

(b) **How to Kill.**—The cruel method of transfixing with a pin cannot be too strongly condemned. There are two ways which are easy and quick, and not in the least cruel. Put a drop of benzine or naphtha on the insect and he is killed instantly. The benzine does not injure the most deli-

cate structure. It speedily evaporates, leaving every portion as perfect as in the living creature. Another method is to kill by means of the fumes of potassium cyanide.

A collecting-bottle will be needed, and, if you do not care to make it yourself, go to a druggist and procure a wide-mouth, large bottle, six or eight inches high, with cork to fit it tightly (a pint glass jar will do). Have him put some small fragments of potassium cyanide in the bottle; then mix a small quantity of plaster of Paris and water. Pour in enough to just cover the piece of potassium cyanide and let it stand a few moments until the plaster of Paris has had time to set. (The plaster being porous, the fumes of the poisonous KCN pass out into the bottle, and the plaster serves to keep the KCN down so that the fragments cannot shake around and mutilate the insects in the bottle.)

To use it, having caught the insect, drop him into the bottle and cork tightly. The fumes will soon kill him. Any teacher can make such a bottle herself at a cost of three cents (Fig. 49*b*).

(*c*) **How to Mount.**—Procure a tight wooden box about $10 \times 12 \times 3$ inches, having a sliding wooden cover. Remove the cover and slide in a piece of glass. If the box is pine, it needs no further fixing, but if of some harder wood it is well to get two or three dozen corks for small vials. Glue these corks at regular intervals to the bottom of the box. It is well in either case to line the box with plain white paper to prevent the entrance of dust, lice, etc., and to give the box a neater appearance. If a little corrosive sublimate or other poison be used in the paste, it greatly aids in keeping out all such intruders. Having lined the box, put the corks in place, and having fitted the sliding glass covers, your cabinet is ready. Take each insect when dead and thrust a sharp pin through the thorax and mount on one of the corks.

After one or two summers of collecting it is well to rearrange your insects, putting them in classes according to

their families, having a separate box for each order of insects, i.e., one for butterflies, one for beetles, one for flies, one for crickets, etc.

(d) **How to Preserve.**—All entomologists complain of the ravages of dust, lice, etc. These pests will get into the tightest cabinet and eat away the most beautiful portions; and then “chankings” may always be seen in the bottom of every box of insects. This can be very largely prevented, at least greatly checked, by wetting the insects once in a while with benzine or gasoline. This may be done without opening the case. Take a large dripping-pan and pour in about one inch deep of gasoline. Set your “bug-box” into it until the insects inside are wet. Each box may be set in, and so all insect pests are killed. Such treatment is not needed oftener than once or twice a year.

II. *Mollusks.*

One need not be a conchologist to enjoy the beauty of shells. Their colors, their exquisite shapes, their infinite variety, all furnish material of keenest interest to teacher and pupil.

If you should spend your summer at the seaside, you will have the best opportunity for such collections; but if among the mountains or in the country near a stream or inland lake, you also have a chance to collect shells. Land-shells are also interesting. Scarcely a moist stone but has its mollusca living in their delicate shells beneath it; hardly a plant in the deep woods but will be found on examination to have them somewhere upon it. *In collecting* the teacher should be supplied with a large number of phials for small shells. Into a phial put all of one kind and cork. Label each phial with the locality where found. If there are living mollusks in the shells, a few drops of alcohol in the phial will preserve. A convenient mode of arrangement is to put small shells in such phials, while larger shells may be kept in small boxes. A friend of mine purchased one of Clark's thread-cases of drawers, made compartments in each drawer,

and placed the different varieties on mats of cotton in each compartment. Some such method is indispensable to one who has a large collection.

III. *Other Animals.*

Summer is the time for creeping things. Alcoholic preparations are easily put up. One who attempts such collections will be able to interest the children where he may be, and thus his collection will immeasurably grow with but the slightest effort on his part. To illustrate: A collection of over 500 insects, 240 skulls, and 17 snakes, worms, etc., was made with scarcely an effort on my part. As soon as the children learned my fondness for such things everything curious drifted toward me. I never feel like encouraging the collection of eggs.

IV. *Minerals.*

Minerals may be gathered if one is among the mountains, but not there alone, for the gravel and bowlders round about any country place are filled with most interesting and beautiful things.

V. *General Collections.*

If the teacher spends her summer in the city, she has many advantages for securing specimens for her classes. Every manufactory should be laid under contribution for samples to illustrate processes. Thus, samples of rubber in all stages of manufacture, leather, cloths, paper, china, glass, gas, and metals in various stages of reduction serve as hints of what may be collected in many cities.

VI. *Historical Collections.*

Things from places made famous in history, may serve a double purpose if they are also of scientific value. Nature may be made the most entertaining feature of school-work, and yet not interfere with the three R's. It may be made a basis on which all the other work of the school rests. It is sometimes more interesting and profitable to the teacher to

collect in some one line each summer. I have sometimes tried this. One summer it was *grasses*; another *sedges*; two years ago it was *manufactures* in various stages; last year *fresh-water shells*. The coming summer it will be *mosses*.

Of course, any and all things accessible should be taken, but it is often well to have some particular hobby to ride each summer.

Under such a course as the above the teacher will find herself broadening; she will see beauties where she never saw them before; her ideas of nature and nature's marvellous plan will be more accurate. And filled with the new impulse that comes of having drawn inspiration from the fountain-head, she will enter upon her fall term full of zeal, and new knowledge and power. Let the champion of the three R's try it and see.

COLLECTIONS TO ILLUSTRATE THE OCCUPATIONS OF MEN EVERYWHERE.

Glass Manufacture.—Varieties of sand and chemicals used. Plate-, crown-, flint-, bottle-, stained, spun-, cathedral glass.

Sugar.—"Nigger-toe," New Orleans, black strap, syrup, white drip. Grades of sugar: coffee A, etc., loaf, cube, granulated, pulverized, rock candy, maple, sugar, glucose.

Lead.—Sheet, foil, pipe, ore, bullets, shot, litharge, minium, sugar of lead, white lead, etc., chrome yellow, orange, etc.

Tanning and Leather.—Upholsterer's sole, kip, calfskin, kid, chamois, morocco, russia, bookbinder's, sheep, vellum, parchment, patent, dongola, alligator, tug, trunk, harness, kangaroo, rawhide, tan-bark before and after use, buckskin.

China Manufacture.

Rubber Manufacture.

Lithographing.

Milling.—Flour, wheat, bolting-silk, etc.

Smelting.—Iron, pig, wrought, steel, etc., slag, etc.

Lumbering.—White oak, red oak, etc.; pine: white, yellow, red, Norway, etc.; maple: curly, white, bird's-eye, etc.; hemlock, spruce; cedar: red, white, etc.; mahogany, ebony, sandal, rosewood, etc., etc., etc., birch, beech, hickory, etc., walnut, cottonwood, whitewood, cypress.

Textiles.—Flax: tow, linen, etc., thread; hemp: rope, cord, canvas; manilla: rope, burlap; cotton: muslin, lawn, gingham, calico, etc., thread, twine, cord, rope; woollen: wool, yarn, crewel, flannel, rep, etc.; silk: cocoon, raw, woven, bengaline, moire, etc.

Paper.—Process, kinds, etc., pasteboard, straw-board, etc.

Seeds arranged in bottles or small boxes.

Nuts.—Walnut, butternut, beech, hickory, pig, chestnut, horse-chestnut, hazel, Brazil, pecan, filbert, almond, English walnut, French chestnut, cocoanut, acorns.

Blacksmithing.—Iron, oxide, coal, etc.

Carbon.—Anthracite, cannel, bituminous, coal tar, pitch, coke, graphite, gas carbon, charcoal, asphalt, lampblack, bone-black, ivory-black, soot, peat, muck, electric light pencils, diamonds.

Metals.—Iron, tin, zinc, copper, silver, etc.

Alloys.—Brass, bronze, type-metal, pewter, etc.

Chapter XX.

DEVICES AND HELPS IN NATURE STUDY. BOOKS OF REFERENCE.

The Weather-chart.

The weather-chart is a very useful device now to be found in many schools. It consists of a large card, in the centre of which is a square divided into 49 smaller squares, 7 on each side, i.e., 7×7 . These smaller squares are two inches each way.

Down the first column of squares the days of the week are written. Then for each day of the month a circle of colored paper is pasted in the square representing that day. In the Chatham school the pupils selected red for clear and warm, blue for clear and cold, light gray for cloudy, and dark gray for stormy.

Observations are made at 12 M., and the direction of the wind each day is indicated by an arrow cut out of white paper and mounted across the colored circle. Thus a blue circle having an arrow pointing upward indicates that at noon of that day the wind was in the south and the day was cold and clear. It is necessary to have 42 squares in which to represent the days of the month, since the month begins on different days of the week. Pupils become at once very much interested in these observations. The record is kept, and at the close of each month the card is put up above the blackboard and a new card is put up for the new month. The names of days and an appropriate heading are printed by some pupil especially skilled in that line of work, while the four colors are placed just below the square to explain their use above.

It is well to give some questions at the end of each month, to be answered from the chart. Comparisons between two consecutive months are helpful, and it often is very interesting to compare a month of one year with the same month of the next.

LESSON ON THE WEATHER-CHART.

The following questions on the chart for December, 1894, were given as a language lesson :

1. On what week-day did December begin ?
2. How many days in the month ?
3. How many days were pleasant and warm (above 32°) ?
4. How many pleasant, but cold (below 32°) ?
5. How many cloudy days ?
6. How many stormy ones ?
7. On the average, was December cold or warm ?
8. Cloudy or clear ?
9. Stormy or not ?
10. How many days had north winds ?
11. South ?
12. East ?
13. West ?
14. Northeast ? etc.
15. What days had no wind ?
16. Judging from the December chart, does there seem to be any truth in the saying that the weather of the first three days forecasts the entire month ?
17. How did the wind blow on the first Sunday ?
18. Were the other Sundays like it as regards weather ?
19. Does there seem to be truth in the statement that all the Sundays of a month are like the first Sunday of that month ?
20. Can you discover any relation between the condition of the weather and the direction of the wind ?
21. In general, a south wind accompanies what kind of weather ?
22. What was the prevailing wind for the month ?
23. On the average, was the month pleasant or unpleasant ?
24. Compare December with November and January.

The "Weather-pole."

Do you know what a "weather-pole" is? No? Well, I think every school ought to have one. No, it is not a flagpole. Can you not guess? Does the name give you no hint? Oh, yes; it is because the pole tells something about the weather. How? We shall see how; but first we must have a vane to put on the pole. Can one of you boys make us a weather-vane? How long is this pole? Yes, about eight feet. At recess we will stand it in the yard. Let us nail it firmly to the south fence. We will go out at noon and see where its shadow will be. Why do we put the weather-vane on the pole? Yes, we put it there so that we may know how the wind is blowing at any time. What is the reason that we must place the pole at some distance from the house? Because when the wind sweeps around the corners of the house its direction is often changed. We want to know what direction the wind blows when not turned out of its course by any building or other object.

Now take a sheet of legal cap and fold it twice so that you will have four leaves. You may use a small memorandum or pad instead. If you use paper, fold several sheets as directed and make them into a book. Rule the pages as I do now.

WEATHER RECORD FOR SEPTEMBER.

Date.	Temp.	Wind.	Amount.	Clouds.	Shadow.

Now we are ready to use our weather-pole. Let us go out at noon and see it. Let us take a thermometer with us and hang it on the shady side of the pole. First let us observe the long shadow which the pole casts on the ground. Henry may drive this stake into the ground just where the

shadow ends. We will leave it there for a long time. It will tell us something after a while. Now let us observe the vane. In what direction is the wind blowing? From what direction is it coming? How do we name winds? Yes, they are named from the direction in which they blow. What shall we name this wind? Yes, it is a northeast wind. Does it blow light or heavy? Notice the clouds, their color and kind. Are there many clouds? Now observe the thermometer. What does it tell us?

We will now fill up a line in our little book, putting the date in column 1, then temperature, etc. Under "Wind" put such words as N., N.E., E., S.E., S., S.W., and W.; under "Amount," light, heavy, moderate, strong, calm, clear, fair, cloudy, very cloudy; and under "Shadow" put its length in feet and inches. Thus the record taken at Chatham public school for the school-days of the month of December, 1894, was:

WEATHER RECORD FOR DECEMBER, 1894.

Date.	Temp.	Wind.	Amount.	Clouds.	Shadow.
3	28+	N.E.	strong	cloudy	4 ft. 7 in.
4	31	E.	"	"	4 7
5	33	S.E.	moderate	"	4 6½
6	29	N.E.	"	clear	4 6
7	21	N.E.	"	"	4 5½
10	12	N.	moderate	clear	4 ft. 5½ in.
11	11+	N.	"	cloudy	4 4½
12	17	N.W.	"	very cloudy	4 4
13	16	N.W.	"	" "	4 3½
14	20	N.W.	"	fair	4 3½
17	21	E.	calm	cloudy	4 ft. 3 in.
18	25	S.E.	moderate	fair	4 3
19	35	S.E.	"	"	4 2½
20	40	S.E.	strong	clear	4 2
21	38	S.E.	"	"	4 2
24	30	S.E.	moderate	cloudy	4 ft. 2 in.
25	18	N.E.	"	"	4 2
26	10	N.	calm	clear	4 3
27	16	N.	"	"	4 3½
28	18	N	moderate	"	4 3½

To the Teacher.—Such observations may be begun in September and continue through the year. I prefer September 20th as the best time for beginning these observations, for it is autumnal equinox and the shadow begins to lengthen then toward winter.

A few hints to the children to watch the shadow and measure it every noon will soon show them that the great change from summer to winter is recording itself on the ground. It is not advisable to measure the shadow every day. Once or twice a week is sufficient, and the lengthening of the shadow will show itself more than if measurements are taken daily.

At the end of the month such questions as these may be asked: What has been the hottest day this month? What was the temperature that day? In what direction have the prevailing winds been blowing? How was the wind blowing the hottest day? The coldest day? How has the shadow changed during the month?

If possible, keep record of temperature with Centigrade thermometer, and compare the readings C. and F. In the above table the temperature is taken in degrees Fahrenheit.

The shadow may also be measured in linear and in metric units so as to give practice in both tables. It is also a good plan to have a large card of Bristol-board ruled and the weather record kept on it and hung up in the school-house for reference.

The following facts will usually be brought out: 1. A fall of temperature accompanies a change of wind toward the north. 2. The thermometer shows less variation of temperature on cloudy calm days than on clear gusty ones, etc.

An additional column may be added headed "Weather," and under this head may be placed such facts as rain, snow, etc.

Definition Cards.

Some years ago the author made a collection of botanical specimens to illustrate every definition in Gray's *Botany*.

Nearly every form of root, stem, leaf, inflorescence, etc., was collected and mounted on cards 14×16 inches and filed away in envelopes for future use.

These "definition-cards" proved so useful in nature lessons that he has never failed to recommend them as a helpful device.

Prof. Davey of East Orange exhibited some "definition-cards" at Dover, N. J., recently. These were made circular in form, and upon one of these circles of Bristol-board were mounted leaf-margins; upon another apexes and bases. The idea of circular cards originated with one of the East Orange teachers. The effect is very artistic and pleasing, and such things may serve somewhat to decorate the often bare walls of a school-room.

Wherever possible, the child should see the *things* themselves. In Morristown, N. J., several school-rooms have large cards covered with mounted vegetable forms. The educational value of this method cannot be denied even in schools of highest grade.

Dr. Rusby, of the New York College of Pharmacy, showed the writer definition-cards which are constantly in use in that great institution.

Dr. Rusby has thousands of specimens illustrating every vegetable form. These are classified in a large room, and a very large part of the work in botany is done upon such specimens as these. If schools of highest rank require such aids as these, how much more are such things needed in schools of the humbler sort.

Moisture of the Air.

A very good device for detecting the relative amount of moisture in the air may be made by selecting a stick of straight grain, about three or four feet long. This stick should be whittled off to a long tapering point at one end somewhat like a blackboard pointer, while the other end should be left large and round. A large newspaper, thoroughly dried, should be opened out flat and then lifted up

by its centre so that the sides and ends hang downward. It may be crumpled into smaller space, but it must be loose, so that the air may reach all parts of it.

The paper should then be suspended by a thread to the pointed end of the stick. Then the device should be carefully balanced. The heavy end of the stick will bring the centre of gravity well toward that end. When the apparatus has been properly balanced, it should be suspended so as to hang in a horizontal position. After hanging a short time the balance will be destroyed. The moisture of the air penetrates the paper, making it heavier. It therefore sinks, and, since the stick is long, the depression is readily seen. Every hydrographic change in the atmosphere may be thus observed and recorded. A very sensitive piece of apparatus can be used to measure the moisture in the air of outdoors as compared with that inside of the house. When taken into the cellar, the paper end will soon be depressed. Near a stove it will again rise. This simple device will often indicate the coming of rain also for the same reason. An ingenious pupil arranged a sort of protractor at the point of suspension so that the number of degrees of depression could be determined. Such a device is a sort of hygrometer. A better one consists of balancing a leaden weight at one end and a large sponge at the other. The sponge should be first wet in strong brine and then dried. The salt within the sponge makes it more sensitive to the presence of atmospheric moisture.

The above device together with the thermometer, weather-vane, and weather-pole are very helpful in making observations on the weather.

The following list of books will be helpful to teachers, but let it not be forgotten that the greatest book on nature study is Nature herself.

A LIST OF BOOKS WHICH HAVE BEEN
HELPFUL IN NATURE STUDY.

Colton's Zoology.
Tenney's Zoology.
Guides to Science Teaching.
Seaside and Wayside.
Morse, First Lessons in Zoology.
Gray's Botanies.
Youman's Botanies.
Apgar's Trees.
Animal Life, Land and Sea.
Orton's Zoology.
Fairy Land of Science.
Fairy Land of Flowers.
Life and her Children.
Birds and Bees.
Thoreau's Walden.
Kingsley's Madam How and Lady Why.
Kingsley's Town Geology.
Jackman's Nature Study.
Packard's Zoology.
Packard's Entomology for Beginners.
Parables from Nature.
Newell's Botany.
The Coming School (E. E. Kenyon).
Adventures of a Young Naturalist.
In Nesting Time.
Abbott's Science for the Young.
Prang's Natural Science Series.
Northrop's Earth, Sea, and Sky.
Meyer's Real Fairy Tales.
Treat's My Garden Pets.
Hooker's Child's Book of Nature.
Wollf's Wild Animals.
Barnard's Talks about Useful Plants.
Barnard's Talks about the Soil.

Barnard's Talks about the Weather.
Mrs. Kelley's Leaves from Nature's Story-book, 4 vols.
Rick's Natural History.
Boys' and Girls' Biology.
Bidgood's Biology.
Paul Bert's First Steps in Scientific Knowledge.
Frye's Brooks and Brook Basins.
Frye's Child and Nature.
How to Know the Wild Flowers.
Newhall's Trees of the Northeastern United States.
J. G. Wood's Half Hours with a Naturalist.
Calkins' Primary Object Lessons.
Calkins' Manual of Object Teaching.
Sarah Arnold's Way-marks for Teachers.
Ginn & Co.'s Nature Readers.
Johonnot's Series of Readers.
Tenants of an Old Farm.
First Steps in Natural Science.

Any of the above and all books on Nature and Nature Study can be obtained of E. L. Kellogg & Co., 61 East 9th St., New York.

The Best Educational Periodicals.

THE SCHOOL JOURNAL

is published weekly at \$2.50 a year and is in its 25th year. It is the oldest, best known and widest circulated educational weekly in the U. S. THE JOURNAL is filled with *ideas* that will surely advance the teachers' conception of education. The best brain work on the work of professional teaching is found in it—not theoretical essays, nor pieces scissored out of other journals. The Monthly School Board issue is a symposium of most interesting material relating to new buildings, heating, and ventilation, school law, etc., etc.

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is published monthly from September to June at \$1.00 a year. It is the ideal paper for primary teachers, being devoted almost exclusively to original primary methods and devices. Several entirely new features this year of great value.

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Autumn Thoughts,
The Return of Thanksgiving,
Thanksgiving Exercise for Little Children,

What the Months Bring,
Thanksgiving in the Past and Present.
The Gifts of the Year,
The Mistletoe Bough (for Reading and Tableau),
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A Visit from Santa Claus, (Tableaux).

SONGS FOR THANKSGIVING.

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