

LEAFLET V.

SUGGESTIONS FOR NATURE-STUDY WORK.*

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SUGGESTIONS for nature-study must necessarily be more or less general. Nature-study should be a matter of observation on the part of the pupils. The teacher's part is to indicate points for observation and not to tell what is to be seen.

After the child has observed all that it is possible for him to see, the remainder of the story may be told him or may be read.

The objects of nature-study should be always in the teacher's mind. These are, primarily, to cultivate the child's power of observation and to put him in sympathy with out-of-door life.

Having these objects clearly in mind, the teacher will see that the spending of a certain amount of time each day giving lessons is not the most important part of the work. A great amount of nature-study may be done without spending a moment in a regular lesson. In the case of all the things kept in the school-room—*i. e.*, growing plants, insects in cages and aquaria, tame birds and domestic animals—the children will study the problems for themselves. The privilege of watching these things should be made a reward of merit.

The use of nature-study readers should be restricted. The stories in these should not be read until after the pupils have completed their own observations on the subjects of the stories.

Stories about adventures of animals and adventures with animals may always be read with safety, as these do not, strictly speaking, belong to nature-study. They belong rather to liter-

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ature and may be used most successfully to interest the child in nature.

Blackboard drawings and charts should be used only to illustrate objects too small for the pupil to see with the naked eye. The pupil must also be made to understand that the object drawn on the board is a real enlargement of the object he has studied with his unaided eye.

The use of a simple lens often contributes much interest to the work of observation. The compound microscope may be used to show some exceptionally interesting point, as the compound eyes of insects, the scales on the butterfly's wing, or the viscid thread of the spider. But this is by no means necessary. Nature-study work does not actually require the use of either microscope or lens, although the latter is a desirable adjunct.

The great danger that besets the teacher just beginning nature-study is too much teaching, and too many subjects. In my own work I would rather a child spent one term finding out how one spider builds its orb web than that he should study a dozen different species of spiders.

If the teacher at the end of the year has opened the child's mind and heart in two or three directions nature-ward, she has done enough.

In teaching about animals, teach no more of the anatomy than is obviously connected with the distinctive habits of each one; *i. e.*, the hind legs of a grasshopper are long so that it can jump, and the ears of a rabbit are long so that it can hear the approach of its foes.

While it is desirable for the teacher to know more than she teaches, in nature-study she may well be a learner with her pupils since they are likely any day to read some page of nature's book never before read by human eyes. This attitude of companionship in studying with her pupils will have a great value in enabling her to maintain happy and pleasant relations with them. It has also great disciplinary value.

Reasons for and against graded courses in nature-study.

The question whether there should be a graded course in nature-study is decidedly a query with two answers.

The reasons why there should not be a graded course, are:

1st. The work should be spontaneous and should be suggested each day by the material at hand. Mother Nature follows no

schedule. She refuses to produce a violet one day, an oriole the next, and a blue butterfly on the third.

2d. A graded course means a hard and fast course which each teacher must follow whether or not her tastes and training coincide with it.

3d. There is no natural grading of nature-study work. A subject suited for nature-study may be given just as successfully in the first as in the fifth grade.

There is only one reason why a nature-study course should be graded, and that is so cogent that it outweighs all the reasons on the other side: the training of the grade teacher in nature-study is at present so limited in subject-matter that if the course were ungraded the same work would be given over and over in the successive grades until the pupils became utterly weary of it. To many a pupil in the lower grades to-day, nature-study means the sprouting of beans and peas and nothing more. As a matter of experience, we believe that after a nature-study subject is once studied it should be dropped entirely, the pupil should not again meet it in the schoolroom until he finds it in its respective science in the high school or college. On this account, we have been persuaded that a graded course, or at least a consecutive course, is necessary.

The following suggestions about grading the course are given with a hope of being helpful, and not because we believe that the courses indicated are necessarily the best courses possible. We have graded each subject so that a teacher may follow her own tastes and inclinations, and may not be forced to teach zoology when her interests are entirely with botany, or vice versa.

We have tried to give a distinctive trend to the observations for each year, and have suggested a line along which the work may be done.

As a matter of fact, however, the time to study any living thing is when you chance to find it. If you find an interesting caterpillar or cricket or bird, study it, whatever your grade of work. The probabilities are that it may be long before you chance upon these same species again.

It has been the experience of most teachers that the lower grades are much more interested in nature-study than are the higher. Especially are the seventh and eighth grades difficult to interest. Therefore, we have made this part of the course economic in its bearing, hoping that this may appeal to the grown-up feeling of pupils of these grades.

INSECTS.**FIRST GRADE.**

The first year of work with insects may well be restricted to familiarizing the pupils with the three most striking phases in the life of insects with complete metamorphosis, *i. e.*, the larvæ, the pupæ, and the winged insects. Moths and butterflies are especially adapted for this work with the small children.

Fall work.— In September there are still many caterpillars feeding. Bring them in the schoolroom and feed them in breeding cages. For different forms of cheap breeding cages, see *Insect Life*, pp. 326-330; Cornell Teachers' Leaflet, No. 5 (No. XIX, this volume); *Lessons in Nature-Study*, p. 45.

During October many of the hairy caterpillars will be found hurrying along in quest of suitable winter quarters. These should be brought in and put in box cages having sand or dirt in the bottom. They are seeking secluded corners in which to curl up and hide during the cold weather. Some of them pass the winter in their cocoons, and some do not. *Insect Life*, pp. 239-241; *Manual for Study of Insects*, pp. 317-324; *Moths and Butterflies*, (*b*), pp. 191-198.

Bring in as many cocoons as possible. November or December, after the leaves have fallen from the trees, is the best time in which to hunt for the cocoons of *Cecropia*, *Promethea*, and *Cynthia*. *Insect Life*, pp. 194-196; *Moths and Butterflies*, (*b*), pp. 119-180.

Teach the pupils the difference between the cocoon and the pupa. The pupa is the quiescent form of the insect. The cocoon is the silken bag covering it, and is always made by the caterpillar before it changes to a pupa.

If possible bring in some butterfly larvæ. In September many may be found. The cabbage butterfly especially is always with us. *Insect Life*, p. 245. Also the larvæ of the black swallow-tail may be easily found. *Insect Life*, p. 243; *Everyday Butterflies*, p. 130; *Moths and Butterflies*, (*b*), p. 39.

Show the children (do not tell them) that the butterfly caterpillars do not make cocoons, but that the naked pupa is suspended by a silk button, and in some cases also by a silk thread.

Many teachers complain that but few of the moths are able to get out of the cocoons. The usual reason for this is that in the heated atmosphere of the schoolroom the cocoons become too dry.

To obviate this, the cocoons should be dipped in water every week or two.

Spring work.—During the spring term use the apple-tree tent-caterpillars. Cornell Teachers' Leaflet, No. 5 (No. XIX, this volume); Moths and Butterflies, (*b*), p. 201. Show the four stages of the insect: egg, caterpillar, pupa, and moth. Pay especial attention to the way in which the caterpillars grow.

Summary of methods.—This whole year's work may be done with no regular "lessons," and all the time required will be the care of the breeding cages and the time given to hunting for the caterpillars and cocoons. The child's reading may be selected from the many stories of the caterpillars, moths and butterflies. Yet be very careful to make each child understand that he himself is studying out the especial story of each caterpillar and cocoon in the schoolroom.

SECOND GRADE.

The plan for the second year is to continue the study of the life-histories of insects. The pupil, having learned the different stages of the moths and butterflies, should learn that all insects do not experience such marvelous changes of form.

Fall work.—Arrange a breeding cage like figs. 288, 289, Insect Life, p. 329, placing fresh sod in the flower pot and covering the lamp chimney with a square of wire netting. Push the glass chimney down into the earth so as to allow no crevices through which the insects may escape. In such a cage, place grasshoppers and crickets of all sizes, and study their growth. Insect Life, pp. 33-37.

Show the pupils that the young grasshopper looks like the old one except that the wings are shorter; the same is true of crickets. Keep the sod damp so the grass will not become dry; and when it gets too old replace it with other sod. A good way to keep these insects alive and to keep the children interested in them is to plant wheat and grass seed in several flower pots, and then to move the glass chimney from pot to pot, giving the insects fresh pasturage when needed.

As early as possible start some aquaria. Cornell Teachers' Leaflet, No. 11 (No. XII, this volume); Insect Life, pp. 330-332.

The mosquito is one of the most available insects for study in the aquarium. Insect Life, pp. 131-136; Lessons in Nature-Study, p. 12.

The nymphs of dragon flies and damsel flies and many others may be studied during the entire winter. *Insect Life*, pp. 140-142; *Cornell Teachers' Leaflet*, No. 11 (No. XII, this volume); *Outdoor Studies*, p. 54. Those that have cannibalistic habits should be kept apart, each one in a separate jar. They may be fed by dropping into the jar a bit of raw beefsteak tied to the end of a string. The purpose of the string is that the uneaten meat may be withdrawn before it decays. It should not be left in the water more than twenty-four hours. The insects do not need feeding more than twice a week.

Spring work.—In the spring get new material for the aquaria. In pools where there are many dead leaves look for the caddice worms that build the log cabin cases, for these may be kept in aquaria that have no running water. *Insect Life*, p. 149.

While we advise the introduction of the aquaria during the second year, their use should be continued during the following four grades; there are always new things to study in ponds and streams, and nothing so fascinates a child as watching the movements of these little denizens of the water.

Summary of methods.—There need be no set lessons in the work of the second year, unless the teacher in a few words, now and then, chooses to call attention to certain things as the occasion seems to demand. The object of the year's work is to teach the pupil the life histories of insects which have no quiescent or pupa stage, and this should be accomplished by simple observation of specimens bred in the schoolroom.

THIRD GRADE.

The general subject of this year's work may well be the Homes of Insects. This is a most interesting topic, and if well taught will inspire the pupils to much individual observation and collecting.

The questions to be asked concerning insect homes are:

Of what material are they made? How are they made? What is the purpose of the home? Is it made by the insect for itself to live in, or is it made by the mother for the protection of her young? Is it made as a protection for the insects while they are eating, or do they go out to feed and come back only to rest and spend the night or day?

Fall work.—Leaf rollers: *Insect Life*, p. 206; *Ways of the Six-Footed*, p. 119.

Leaf miners: *Insect Life*, p. 208; *Ways of the Six-Footed*, p. 29.

- Galls : Insect Life, p. 210 ; Outdoor Studies, pp. 18, 38-39.
 Fall web worm : Insect Life, p. 200.
 Scallop shell moth : Insect Life, p. 201.
 Nests of silver spotted skipper : Insect Life, p. 203 ; Everyday Butterflies, p. 190.
 Bag worms : Insect Life, p. 204. Ant lions : Outdoor Studies, p. 81.
 Carpenter bees : Ways of the Six-Footed, p. 108.
 Tiger beetle larvæ : Insect Life, pp. 270-272.
 All kinds of cocoons are found by the children. Ask concerning the cocoons : Where did you find them ? Were they in protected places ? Why ?

Of these nests there are many more than those mentioned above. In fact, to one who sees what he looks at, every plant, every tree, every fence corner and every foot along the country path contains many most interesting homes. The leaf rollers and leaf miners are the most common and most easily found of all.

Spring work.—The spring work in this subject may be to study the way in which caddice worms make their houses ; take a caddice worm out of its house and watch it build another. This is a new phase of the study of caddice worms. Ways of the Six-Footed, p. 133.

Study the homes of beetles under sticks and stones, and find the homes of the engraver beetles under bark. Insect Life, p. 216. This work must necessarily be done by the pupils out of school hours, and their discoveries and specimens of homes should be made topics for lessons for the whole school.

During this term begin a butterfly calendar, made on the same plan as the bird calendar. A collection of butterflies might be started for the schoolroom in connection with the calendar. Study the specimens caught and determine whether they hibernated as adults or chrysalids. If their wings are battered and torn, they spent the winter as adults. If they are bright in colors and their wings perfect, they spent the winter in the chrysalis state.

Hints for collecting insects : Cornell Teachers' Leaflet, No. 7 (No. XVIII, this volume) ; Insect Life, pp. 283-314 and pp. 48-49. How to Know the Butterflies.

Summary of methods.—The work in the third grade, as outlined, requires a lesson period now and then when single specimens are brought in by individual pupils. Each pupil should examine the specimen, and after that the lesson may be given.

FOURTH GRADE.

After having studied Insect Homes, the pupils will be ready to take up the broader subject, How Insects Live. The work of this year may be given on this subject.

In order to study the life-histories of insects, the pupils should know some things about insect anatomy. If the work as indicated in the previous grades has been followed, the pupils know the number of legs, wings, and compound eyes most insects have, without ever having killed a specimen or having received a special lesson in insect anatomy. Now teach the children how insects breathe and how they eat. Show the spiracles on the body of any caterpillar which is not hairy; they may be seen on the abdomen of a grasshopper or of a butterfly that has not too many large scales to cover them.

After they have seen these spiracles or breathing pores, give a lesson, illustrated by chart or blackboard, showing that these holes lead to the breathing tubes of the body. Manual for the Study of Insects, pp. 73-75.

To show how insects eat, allow the pupils to watch the following insects in the breeding cages while feeding: a grasshopper; a leaf beetle (potato beetle is a good example); any caterpillar; an ant; and a wasp. Show that all these have mouth parts made for biting. Let the pupils see an aphid sucking the juice of a plant; this may be done by bringing in a twig infested by aphids. Let the pupils see the water bugs in the aquarium eat. Insect Life, pp. 123-131, and pp. 137-140. Let them watch a fly, a honey bee, and, if possible, a butterfly or moth, eat. All these have mouth parts made for sucking. All this work should be original investigation on the part of the pupils.

After the pupils find out how insects breathe and eat, let them see how each insect lives a life adapted to its own peculiar needs. Try to feed some cabbage worms on clover or grass. Then try turnip or mustard leaves, and watch the result. Change the potato beetle larvæ to some other plant, and watch the result.

Let the pupils first find out how the insects breathe in the water. Each insect in the aquarium tells a different story as to its way of getting air. The teacher will find all these stories indicated in the chapters in Insect Life devoted to pond and brook insects.

Call especial attention to protective coloring of insects. Show that when an insect resembles its surroundings in color it is

thereby enabled to escape its enemies ; or, if need be, is enabled to creep upon its prey unobserved.

Note the color of the grasshopper in the road ; color of meadow grasshopper ; color of the caterpillars of the cabbage butterfly (green and hard to find). Notice the shape and color of walking sticks ; color of the katydids. Note the bright color of the larvæ of potato beetle. Why ? (They are distasteful to birds, and their colors advertise the fact.) Study the Monarch butterfly and the Viceroy. *Everyday Butterflies*, p. 95 and p. 297 ; *Ways of the Six-Footed*, p. 39. Bring out strongly in all this work that the insect in order to live must have its special food plant and must escape notice of its enemies. This is the proper place to begin the study of the valuable work done by birds in destroying insects.

In addition to this general work, study especially the wasps.

Solitary Wasps : Mud daubers. Bring in their nests and examine them. *Ways of the Six-Footed*, p. 96. How are the nests provisioned, and for what purpose were they made ? Find, if possible, nests of other solitary wasps. *Insect Life*, p. 218, p. 262, p. 264.

Social Wasps : Bring in a deserted nest of yellow-jackets. Of what is it made ? How ? What for ? Do the wasps store honey ? Do they live as a colony during the winter ? All these questions may be answered by a pupil who knows of a yellow-jackets' nest in the fall and watches it during the winter. For the teacher there are discussions of these insects in *Manual for Study of Insects*, pp. 660-664. Wasps and their Ways.

Continue the butterfly collection and the butterfly calendar.

Spring work.—In the spring, begin a collection of moths for the schoolroom. *Insect Life*, p. 50. Caterpillars and Moths.

In the spring, notice when the first house-flies appear. What happens to the house-fly in winter ? (Send for Circular No. 35, second series, Div. of Entomology of Department of Agriculture, Washington, D. C., for the life-history of the house-fly.) Explain that one female destroyed early in the season means thousands fewer late in the season.

Encourage the children to bring to the schoolroom all sorts of flies and compare them with the house-fly. The object of this is to teach something of the wonderful variety of forms among small and inconspicuous insects. Make a collection of flies for the schoolroom. For description of flies, see *Insect Life*, pp. 83-84.

A good plan for the spring work is to keep the pupils interested

in the first appearance, after the vicissitudes of winter, of each insect which it is possible for them to find. Note that insects do not appear before their food plants appear.

Summary of objects and methods.—The questions to be answered during the whole year's work are: How do the Insects live,—on what do they feed? How do they escape their enemies? What happens to them in winter? How are the new broods started in the spring? The work is chiefly observation, but occasional lessons may be given and stories may be told to keep the interest in the work from flagging.

FIFTH GRADE.

Fall work.—Study the Bees and Ants.

Fit up ants' nests. *Insect Life*, p. 278.

Teach the whole life-history by allowing the pupils to colonize the nests. *Manual for Study of Insects*, pp. 633–639; *Insect Life*, p. 271. Make observations upon the *eggs, pupæ, workers, males, females*. What are the winged forms that appear in swarms in June and July.

Let the pupils observe the relation of ants to aphids. This may be done on almost any shrub or roadside plant. *Home Nature-Study Lesson 1904*, No. 8.

The teacher should read Sir John Lubbock's "Ants, Bees and Wasps."

Many stories on these subjects may be told and read, especially those concerning the habits of exotic ants and ant wars which the children are not likely to see; also of the slave-making ants. These slave-making ants are quite common in New York State; their nests may be found under stones. They resemble the brown mound-builder ant; the slaves are black.

Spring work.—In the spring work in this grade, study the habits of the honey bee. An observation hive is desirable but not necessary. Bring in the honeycomb filled with honey. If there are apiarists in your neighborhood, they will gladly give you specimens of brood in the comb. Read *The Bee People* and the *Manual for Study of Insects*, p. 673.

Develop all the facts of the wonderful life in the hive by letting the pupils observe them as far as possible. Then give them the many interesting stories:

Story of the Workers.

Story of the Queen.

Story of the Drone.

Story of the Bee Larva.

Story of Honey Making.

Story of Wax and Comb Making.

Story of the Swarm.

In connection with the study of the honey bee, study the bumble bee. Manual for Study of Insects, pp. 672-673; Insect Life, p. 256. Begin with the study of the big queen that appears in May or June. Show that she is of great benefit to us and must not be harmed or frightened. Let the bumble bee's nest be a problem for summer observation, and finish the study in the next grade in the fall.

Summary of objects and methods.—The work of this year should have for its objects the harmonious life of social insects; their unselfish work for each other; their devotion to their respective colonies; their ways of building and of defending their habitations.

The work should be based upon observations made by the pupils in and out of the schoolroom. Many lessons should be given, mostly in the form of stories. Ways of the Six-Footed, pp. 55-94.

SIXTH GRADE.

Fall work.—Study the spiders. Lessons in Nature-Study, p. 103; Insect Life, pp. 223-232. Cornell Teachers' Quarterly, final number (No. XV, this volume).

In order to study spiders, they need not be handled with bare hands. While all spiders are venomous to the same extent, perhaps, that a mosquito or a bee is venomous, there is only one species in the eastern United States (and that is very rare) the bite of which need be feared by human beings.

The use of spiders in nature-study does not have to do with handling living specimens, but rather with the habits of the different species and the building of the webs. In catching spiders to bring into the schoolroom, use the method indicated by Professor Kellogg in Nature-Study Lessons. Capture the specimen by the use of a pill box: take the box in one hand and the cover in the other, and catch the spider by suddenly closing the box over it.

The pupils should be made to observe the chief differences between spiders and insects; *i. e.*, spiders have two regions of the body instead of three as in insects; eight legs instead of six,

simple eyes instead of compound. Compare spiders with daddy-long-legs.

If the teacher chooses to kill a specimen and show the arrangement of the eyes and the spinnerets under the microscope, she may do so. This is not necessary, although I have seen it done successfully in the sixth grade. Diagrams and blackboard drawings may be used instead of the microscope.

Let the pupils observe the uses of silk by the spider :

1. Snare for prey.
2. To enwrap prey when first entangled.
3. Nests for eggs.
4. Lining for habitations.
5. Means of locomotion.

Introduce the grass spider into the schoolroom in glass jars containing grass sod, and let the pupils observe it at work.

Encourage a study of cobwebs. Capture the owner of an orb web, and bring it in a glass jar to the schoolroom. Try to give it its natural environment ; *i. e.*, some sort of frame or branch of tree on which it may fasten its web.

The orb web : 1. How is it made? 2. Of how many kinds of silk? 3. The way the spiral thread is arranged as shown by drawings. 4. The position of the spider on the web. 5. The way the spider passes from one side of the web to the other. 6. The way it treats its prey when the victim is once entangled.

The engineering ability shown in making this web is one of the most marvelous things in all the realm of animal life. These observations may well cover two months of this term.

Study the ballooning spiders, the jumping spiders, the running spiders, and the crab spiders. Study as many egg-sacs of spiders as possible.

Another topic for study during the fall term is the Songs of Insects. *Insect Life*, p. 235. Bring in the katydids, crickets, and meadow grasshoppers, place them in cages containing green sod, and observe them while they are singing. Note that only the males sing. Show the ears of the crickets, katydids, and meadow grasshoppers in the elbows of their front legs. The ear of the grasshopper is on the side of the segment of the abdomen next to the thorax. *Ways of the Six-Footed*, pp. 3-27.

Study snowy tree cricket. *Manual for Study of Insects*, p. 118.

If possible, get a cicada as these insects continue to sing through the warm days of September. Show the cover to the drums on the lower side of the common cicada. *Cornell Nature-Study Bulletin*, No. 1, p. 24 (No. VI, this volume). This can be made a most

interesting subject, and pupils should be encouraged to do observation work outside of school.

Begin a general collection for schoolroom.

Spring work.—Continue making a general collection for the schoolroom, and specialize in this direction. When an insect is brought in and added to the collection, if the teacher knows the insect, a lesson should be given on its life and habits. This connecting of the life and habits of the insects with the collection of dead specimens is of greater value from a nature-study point of view than the collection itself.

Summary of methods.—While this year's work must be based on the observations of the pupils in the schoolroom and out-of-doors, yet many interesting lessons may be given by the teacher.

SEVENTH GRADE.

The study of this entire year may be the relation of insects to flowers. Most of the references are given in the Plant-life work for this grade.

The insect work may be limited to: What insects visit flowers? How do they carry pollen? How does each kind of insect reach the nectar? Which insects are robbers, and which are true pollen carriers? The use of pollen by insects. Outdoor Studies, pp. 7-12.

Take up the study of golden rod and its insect visitors, *i. e.*, let the pupils watch a bunch of golden rod and note all the insect visitors. For directions concerning this work see Outdoor Studies, pp. 29-46.

In the same way take up the study of asters and the late flowers, and their insect visitors. Describe the visitor; what it does; what part of the plant it visits.

Summary of objects and methods.—The object of this whole year's work is to show the beautiful inter-relation between insects and flowers. The studies must necessarily be made in the field. But many delightful lessons may be given on the structure of flowers, that make of greatest use to the flowers the work of insect visitors.

EIGHTH GRADE.

The object of this year's work is the economic side of insect-study. Many pupils do not continue these studies to high school or college. Yet if they have homes with gardens or trees in city or country, they must learn to cope with the many insect enemies

that feed upon cultivated plants. They should also learn to discriminate between insect friends and foes. They should learn the best methods of combating the foes and preserving the friends.

Explain first that in fighting an insect enemy we must know how it eats. If it inserts its beak in the stem of the plant there is no use trying to kill it by putting poison on the leaves.

COMMON INSECT FOES.

To be studied in the schoolroom :

Fall work.—Codlin-moth. *Insect Life*, p. 180. Show work on an apple, and give methods of destroying it.

Plum curculio. *Insect Life*, p. 182.

The pomace flies. *Insect Life*, p. 184.

Scale insects. *Manual for Study of Insects*, pp. 165-174.

Potato beetle. *Manual for Study of Insects*, p. 176.

Spring work.—Tussock moths and canker worms. Circular No. 9, 2d Series, Dept. Agr., Div. of Ent., Washington, D. C.; Cornell Teachers' Circular, No. 1.

Cabbage worms. *How to Know the Butterflies*.

Currant worms. *Manual for Study of Insects*, pp. 613-614.

Plant lice or aphids. *Insect Life*, pp. 177-178.

Carpet beetle. Circular No. 5, 2d Series, Dept. Agr., Washington, D. C.; *Manual for Study of Insects*, p. 539.

Clothes moth. *Manual for Study of Insects*, pp. 257-258; Circular No. 36, 2d Series, Dept. Agr., Washington, D. C.

Tent caterpillar. Cornell Teachers' Leaflet, No. 5 (No. XIX, this volume).

A study of spraying should be made. *Insects and Insecticides*, pp. 39-56. Spray Calendar, distributed free by the Cornell Agricultural Experiment Station.

Important Insecticides. Farmers' Bulletin No. 127, Dept. Agr., Washington, D. C.

INSECT FRIENDS.

Fall work.—Lady bugs. *Insect Life*, p. 179.

Aphis lions. *Insect Life*, p. 178; *Ways of the Six-Footed*, p. 125.

Red clover and the bumble bee.

Parasitic insects. *Manual for Study of Insects*, pp. 621-630.

Spring work.—Bees and orchard in blossom.

Summary of methods.—The observations may be made in the schoolroom or out-of-doors. There should be observations of

experiments in spraying. This may be accomplished in most localities by encouraging the pupils to visit orchards undergoing the operation of spraying. However, by means of syringe or watering pot, the infested plants brought into the schoolroom may be sprayed and the results noted. Lessons should be given on the importance of preserving insect friends while we are destroying insect enemies.

OTHER ANIMALS ADAPTED FOR NATURE-STUDY.

The Toad and Frog. The study of either of these two species is delightful spring work for any grade. Cornell Teachers' Leaflet, No. 9 (No. XVI, this volume); Wilderness Ways, p. 25.

Salamanders or Efts. Familiar Life of the Roadside.

Fishes. Observations upon goldfish or minnows kept in an aquarium should be made the basis of lessons upon the life of fishes. Study: (1) The shape of the body; see how it is especially adapted to rapid movement through the water. (2) The shape and arrangement of the fins, and their uses. (3) How the fish propels itself through the water. (4) How the fish breathes. (5) The shape of the fish's mouth, and how and what it eats. (6) Experiment to ascertain the ability of the fish to see and hear. Cornell Teachers' Leaflet, No. 21 (Nos. XIII and XXXVI, this volume).

Encourage observations of habits of different species of fish common in our ponds and streams. Study their eggs and the places where they are found. Teach the children the reason for the game laws, and impress upon them a true respect for those laws. Food and Game Fishes.

Mice. Some house mice in an improvised cage may be placed in the schoolroom, and the habits of the little creatures observed. Give them paper to see how they make their nests. Note how and what they eat, and how they clean themselves. Note shape of teeth and their use. If possible, study the wild mice. Squirrels and Other Fur Bearers, p. 111; Wild Life, p. 171.

Squirrels and Chipmunks. The work on these animals must be based on out-of-door observations. Try to get the pupils to discover for themselves answers to the following questions: How and where do they travel? What do they eat? Where and how do they carry their food? Do they store it for winter? If so, where? What do they do in winter? Squirrels and Other Fur Bearers, p. 15, p. 134; Wild Neighbors, p. 1.

Rabbits.—A domesticated rabbit should, if possible, be kept in the schoolyard so that the pupils may make their own observations upon its habits. Let them study: How and what it eats. The shape of its teeth. The form and use of the ears. How does it travel? What sort of tracks does it make, and why? From these observations lead the pupils to think of the life of the wild rabbit, how it is adapted to escape from its enemies and to get its food. *Ways of Wood Folk*, p. 41; *Story of Raggylug*.

Guinea pigs.—These little animals are easily kept in the schoolroom, and, though not particularly interesting in their habits, they prove attractive to the smaller children and may be studied in the same way as the other animals.

Domestic animals.—These need not be studied in the schoolroom, as the pupils, if they have opportunity, can make the observations at home. Studies of the horse, cow, pig, sheep, and goat, and also the cat and dog may be made most interesting. Such questions as these may be asked concerning each: What is the characteristic form of the animal? What is its clothing? What does it eat? How are its teeth adapted to its food? What is its chief use to man? How does it travel, slow or fast? How are its feet adapted to its way of running or walking? Has it a language? How many emotions can it express by sound? How many can it express by action? How does it fight, and what are its weapons? What sort of life did its wild ancestors live? How did they get their food, and how did they escape from their enemies?

Summary of methods of nature-study of animals.—Study only so much anatomy as is clearly adapted to the animal's ways of living. Observations made by the pupils should be arranged into lessons by either pupil or teacher. Such lessons make excellent English themes, and they may be adapted to any grade.

BIRDS.

Begin the study of birds by the careful study of some domesticated species that may be observed closely and for a long period. The hen is perhaps the best for this purpose. Study carefully all of the adaptations of her anatomy to her life necessities. Study shape of her body; the feathers; the bill; her food; how she eats; drinks; the shape of her feet; their covering; how she sees; hears; smells; sleeps; study the life of a chick; study the language of chick, hen and cock; embryology of a chick. Study a robin or some bird that builds near houses. Note all its habits from the time it appears in spring until autumn.

Bird houses and bird protection. Usefulness of birds. Our Native Birds, Lange. Publications of U. S. Dept. Agr.

Summary of methods.—It is much more important that the pupil know the habits of one species than that he should know by name many species. Therefore encourage patient watching and careful observation concerning the things which birds do. Such observations may be made into lessons by pupil or by teacher for the benefit of all the pupils. First Book of Birds, and Second Book of Birds; Bird Lore; The Story of the Birds; Bird Neighbors.

PLANTS.

FIRST GRADE.

Fall term.—Let the children study the different forms and the colors of leaves. By no means teach the botanical terms for all the shapes of leaves; simply let the children gather and bring in all the different kinds of leaves they can find. Let them draw the different forms in their blank books. Press leaves and mount them.

The object of this work is to give the child an idea of the great number of leaf forms and colors, and to get him interested in observing them. References: Botany, Bailey, pp. 90-100; Lessons with Plants, pp. 79-90; Gray's How Plants Grow, chapter on Leaves and Forms of Leaves; Elements of Botany, pp. 89-93.

Winter and spring terms.—Let the children study vegetables. The following questions should be answered concerning a vegetable. What part of the plant is it? Does it grow below or above ground? What sort of leaf has it? What sort of flower? What sort of fruit or seed? Lessons with Plants, pp. 353, 356, 364; First Studies, pp. 50, 51, 174; Botany, Bailey, pp. 31-37; Cornell Teachers' Quarterly, No. 7 (No. XXXIX, this volume).

SECOND GRADE.

Teach the use of the flower. Do this by bringing in all flowers possible, and show that as the flower fades the fruit becomes evident. Let the pupils observe for themselves the fact that the flower exists for the sake of the fruit. Interest the pupils in all kinds of fruits and seeds. This is not the place to teach seed dispersion, but simply the forms and colors of fruits and seeds. Let the pupils also observe that insects carry pollen from flower to flower. Do not give the explanation of this to children of this age, but let them see the bees at work.

For this work see *Plant World*, by Mrs. Bergen, pp. 80-107.

Let the pupils observe the following things in plant physiology :

Flowers sleep : Botany, Bailey, p. 50 ; Lessons with Plants, p. 402 ; Plants, Coulter, pp. 9, 10, 48 ; Elements of Botany, p. 98.

Plants turn toward the light : Elements of Botany, p. 100 ; Botany, Bailey, p. 50 ; First Studies, p. 136.

Effect of frost on flowers and leaves.

Winter and spring work.—Seed germination : First Studies, pp. 1-24 ; Lessons with Plants, pp. 316-331 ; Botany, Bailey, pp. 164-171 ; Cornell Teachers' Leaflet, No. 1 (No. XXVIII, this volume) ; Plants, p. 307 ; Lessons in Nature-Study, p. 22.

Let the pupils observe in the field : Position of leaves when first open. A Reader in Botany, by Newell, Part I, p. 84.

Position of leaves and flowers in the rain. First Studies, p. 135 ; Elements of Botany, pp. 175-176 ; Plants, p. 51.

THIRD GRADE.

Fall work.—The fall work of this grade may be (1) The way flowers make fruit, *i. e.*, the way the fruit is formed from the flower. (2) The dispersion of seeds.

Fruits. First Studies, pp. 168-171 ; Lessons with Plants, pp. 251-310 ; Botany, Bailey, pp. 147-157.

Seed dispersion. First Studies, p. 176 ; *Plant World*, pp. 133-156 ; *Little Wanderers*, by Morley ; *Seed Dispersal*, by Beal ; Cornell Teachers' Quarterly, No. 2 (No. VIII, this volume) ; *Seed Travelers*, by Weed ; Botany, Bailey, p. 158.

Let the pupils observe : "How some plants get up in the world." First Studies, p. 150 ; Lessons with Plants, p. 396 ; Botany, Bailey, p. 108.

Spring work.—Opening of the buds. Lessons with Plants, pp. 48-63 ; First Studies, p. 33.

Arrangement of buds. Lessons with Plants, pp. 63-69.

Expansion of bark. Lessons with Plants, pp. 69-72.

FOURTH GRADE.

The object of this year's work may be the teaching of the value of earth, air, light, and water upon plants.

Fall work.—Experiments to show these to be carried on in schoolroom. Experiments to show value of earth to plants :

(1) Plant seeds in fertile earth ; poor earth ; clean sand or sawdust.

(2) Plant seeds in sawdust and on cotton batting placed on water in a jar.

Experiments to show use of light to plants :

(1) Sow seeds in two boxes of earth prepared just alike. Place one in the window, one in a dark closet, and note results.

(2) Place house plants from greenhouse in a window, and note change of position of leaves.

(3) The story of the sunflower.

Experiments showing use of water to plants :

(1) Place a very much wilted cut plant in water, and note result.

(2) Place seeds in earth which is dry, and in earth which is kept moist.

(3) Plant seeds on batting floating on a tumbler of water, and note results.

These experiments should extend over several weeks.

Winter and spring work.—Begin the study of trees. Choose some tree in the schoolyard, if possible, and make this the basis of the work. The following is an outline for the study of a maple tree: Begin observations in January. Make drawings of the tree, showing the relations of branches to trunk and general outline. Note the following details: The color of trunk and branches in January, and the color in February and March; when the buds begin to swell; the arrangement of buds; watch closely to determine whether a bud develops into a blossom or a leaf; the peculiarities of bark on trunk and branches; do the leaves or the blossoms appear first; the shape and color of the blossoms; draw them and study them thoroughly; the color and position of the leaves when they first appear; draw the different stages of the unfolding of the leaves; keep a calendar of all the year's history of the tree; when in full leaf make another drawing of the whole tree; study the tree from below, and if possible from above, to show arrangement of leaves in reference to light; make drawings of the fruit when it is formed; study how it travels; when the first autumn tints appear; make colored drawings of the tree in its autumn foliage, and note when leaves begin to fall and when the branches are finally bare; note different form of maple in the open and maple in the forest.

In connection with the year's history of the tree, study the tree from an economic point of view. Make a special study of sugar-making in connection with the maple tree. Study maple wood. To do this get a quarter section of a piece of maple log and study

the grain lengthwise and in cross sections. Study all the industries possible in which maple is used. Devote one notebook to all the work on the maple tree, and at the end summarize the observations. For drawing of trees, see Cornell Teachers' Leaflet, No. 12 (Nos. XXIX and XXX, this volume). Home Nature-Study, Vol. V, Nos. 2, 5.

FIFTH GRADE.

The work during this grade may be devoted to plant physiology. For this work use First Studies of Plant Life, Atkinson. The experiments described in this book are simple and excellent; they give the pupil definite knowledge of the life processes of plants, and the use to the plant of roots, stems, leaves, flowers, and fruit.

Continue studies of trees. Select some other species than the one studied during the last grade. Study it in the same way. Note the differences between the two. Two or three contrasting species may thus be studied.

SIXTH GRADE.

Having studied in the previous year the uses of different parts of the plant, the pupil will be fitted now to take up the general subject of weeds.

Take some common forms and let the pupils observe that they grow where other plants do not grow, or that they drive out other plants; then study the special reasons why each kind of weed is able to do these things. Botany, Bailey, pp. 214-222; Elements of Botany, pp. 196-205.

During the autumn another subject for study in this grade is *Mushrooms*. Lead the pupils to see how these flowerless plants produce seed, and let them bring in as many forms as possible. Do not try to teach which mushrooms are poisonous. Lessons with Plants, p. 347; Mushrooms, by Atkinson.

Winter work.—Evergreen trees. Cornell Teachers' Leaflet, No. 13 (No. XXXIII, this volume).

Spring work.—The spring work may well be the making of a calendar for trees and plants. Keep a record each day of the leafage of plants, the appearance of weeds, and the appearance of blossoms of fruit trees and all common flowers. Record which appear first, leaves or blossoms.

This work will be good preparation for the study of the "struggle for existence," which comes in the next grade.

SEVENTH GRADE.

The work for this year, both fall and spring, may be the study of the cross fertilization of flowers. Choose a few of the common flowers, and let the pupils study the means by which pollen is carried from flower to flower.

In studying any flower fertilized by insects always ask : Where is the nectary ? Where in relation to the nectary are the stigma and the anthers ? What path must the insect follow in order to get the nectar ? Do the flowers attract insects by color ? By fragrance ? What insects do you find visiting the flowers studied ? Lessons with Plants, pp. 224-245 ; Plants, Coulter, pp. 109-137 ; Elements of Botany, pp. 182-196 ; Readers in Botany, Newell, Part II, p. 86 ; Plant World, Bergen, pp. 57-127 ; Ten New England Blossoms, Weed.

The cross fertilization of flowers is only one adaptation for succeeding in the struggle for existence.

Study as many other ways of insuring the continuance of a plant as is possible. Botany, Bailey, pp. 197-217 ; Lessons with Plants, pp. 15-20 ; Elements of Botany, pp. 199-212.

Study plant communities. Botany, Bailey, pp. 219-227 ; Plant Relations, pp. 146, 162, 168 ; Plant Structures, p. 313 ; Cornell Teachers' Leaflet, No. 19 (No. XXXV, this volume).

EIGHTH GRADE.

It seems to be the experience of most teachers that pupils of the seventh and eighth grades are with difficulty kept interested in nature-study. This is probably due to the fact that the methods suited to earlier grades are not suited to these. Pupils of this age, now feeling "grown up," are attracted only by more mature work. They may be interested in some of the following subjects :

Horticulture and Gardening.— Cornell Teachers' Leaflets. Garden-Making ; The Pruning-Book ; The Principles of Fruit-Growing ; The Principles of Vegetable-Gardening, all by Bailey. Plant Culture, by Goff.

Forestry.— Relations of forests to preservation of rain-fall and streams. Preservation of Forests. Use of Forests. Reforesting waste lands, etc. A Primer of Forestry by Pinchot, United States Department Agriculture. A First Book of Forestry, Roth.

Ferns.—Study and make collections of all the ferns of the locality. Make drawings of each fern and its fruiting organs, and press and mount the specimens with full accounts of habits and locality of the plant. How to Know the Ferns, Mrs. Parsons; Gray's Botany; Our Ferns, Clute.

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INSECTS.

Every Day Butterflies. S. H. Scudder. Houghton, Mifflin & Co. \$2.00.

Insect Life. J. H. Comstock. D. Appleton & Co. \$1.25.

Lessons in Nature-Study. Jenkins & Kellogg. W. B. Harrison. \$1.00.

Manual for Study of Insects. J. H. Comstock. Comstock Pub. Co. \$3.75.

Moths and Butterflies. (a) Julia P. Ballard. Putnam's Sons. \$1.50.

Moths and Butterflies. (b) Mary C. Dickerson. Ginn & Co. \$2.50.

Stories of Insect Life. Weed & Murtfeldt. Ginn & Co. 35 cents.

Outdoor Studies. James B. Needham. American Book Co. 40 cents.

Bee People. Margaret W. Morley. A. C. McClurg. \$1.25.

The Butterfly Book. W. J. Holland. Doubleday, Page & Co. \$3.00.

Caterpillars and Their Moths. Eliot and Soule. The Century Co. \$2.00.

Wasps and Their Ways. Margaret W. Morley. Dodd, Mead & Co. \$1.50.

The Ways of the Six-Footed. Anna Botsford Comstock. Ginn & Co. 40 cents.

How to Know the Butterflies. J. H. and Anna Botsford Comstock. D. Appleton & Co. \$2.25.

ANIMALS OTHER THAN INSECTS.

Animal Life. Jordan & Kellogg. D. Appleton & Co. \$1.25.

* This list comprises some of the books that have been helpful to me. It is not intended to be complete. Good new books are constantly appearing. The teacher should endeavor to keep up with the new books.

Familiar Fish. Eugene McCarthy. D. Appleton & Co. \$1.50.
 Story of the Fishes. James N. Baskett. D. Appleton & Co.
 65 cents.

Familiar Life of the Roadside. Schuyler Mathews. D. Appleton & Co. \$1.75.

Squirrels and Other Fur Bearers. John Burroughs. Houghton, Mifflin & Co. \$1.00.

Wild Life in Orchard and Field. Harper & Bros. Wild Neighbors. The Macmillan Co. Ernest Ingersoll. \$1.50 each.

Kindred of the Wild. Roberts. L. C. Page. \$2.00.

Wild Life Near Home. Dallas Lore Sharp. The Century Co. \$2.00.

Four Footed Americans. Wright. The Macmillan Co. \$1.50.

American Animals. Stone & Cram. Doubleday, Page & Co. \$4.00.

Food and Game Fishes. Jordan & Evermann. Doubleday, Page & Co. \$4.00.

Various books that deal with animals from the story or narrative point of view will be found to be interesting and helpful. They are often useful in arousing an interest in the subject. There are many good animal books not mentioned in the above list.

BIRDS.

Bird Homes. A. R. Dugmore. Doubleday, Page & Co. \$2.00.

Bird Life (with colored plates). Frank M. Chapman. D. Appleton & Co. \$5.00.

Bird Neighbors. Neltje Blanchan. Doubleday, Page & Co. \$2.00.

Birds of Village and Field. Florence Merriam. Houghton, Mifflin & Co. \$2.00.

First Book of Birds. Olive Thorne Miller. Houghton, Mifflin & Co. \$1.00.

Second Book of Birds. Olive Thorne Miller. Houghton, Mifflin & Co. \$1.00.

Our Native Birds. D. Lange. The Macmillan Co. \$1.00.

Story of the Birds. James N. Baskett. D. Appleton & Co. 65 cents.

How to Attract the Birds. Neltje Blanchan. Doubleday, Page & Co. \$1.35.

The Bird Book. Eckstorm. D. C. Heath & Co. 80 cents.

The Relations of Birds to Man. Weed & Dearborn. Lippincott. \$2.50.

The Woodpeckers. F. H. Eckstorm. Houghton, Mifflin & Co. \$1.00.

Bird Lore. A magazine. The Macmillans. Houghton, Mifflin & Co. \$1.00.

PLANT LIFE.

Botany ; an Elementary Text for Schools. L. H. Bailey. The Macmillan Co. \$1.00.

Corn Plants. F. L. Sargent. Houghton, Mifflin & Co. 60 cents.

Elements of Botany. J. Y. Bergen. Ginn & Co. \$1.10.

Familiar Flowers of Field and Garden. S. Mathews. D. Appleton & Co. \$1.75.

First Studies in Plant Life. George F. Atkinson. Ginn & Co. 70 cents.

Flowers and Their Friends. Margaret W. Morley. Ginn & Co. 60 cents.

Flowers of Field, Hill and Swamp. C. Creevey. Harper & Bros. \$2.50.

Glimpses at the Plant World. Fanny D. Bergen. Ginn & Co. 35 cents.

A Guide to the Wild Flowers. Alice Lounsberry. Frederick A. Stokes Co. \$2.50.

How Plants Grow. Asa Gray. American Book Co. 80 cents.

How to Know the Ferns. Mrs. Frances Theodore Parsons. Chas. Scribner's Sons. \$1.50.

Our Ferns in Their Haunts. Clute. Stokes Co. \$2.00.

How to Know the Wild Flowers. Mrs. Wm. Starr Dana. Chas. Scribner's Sons. \$2.00.

Lessons With Plants. L. H. Bailey. The Macmillan Co. \$1.10.

Little Wanderers. Margaret W. Morley. Ginn & Co. 35 cents.

Mushrooms. George F. Atkinson. Andrus & Church, Ithaca, N. Y. \$3.00.

Plants ; a text-book of botany. J. M. Coulter. D. Appleton & Co. \$2.00.

Plants and Their Children. Mrs. Wm. Starr Dana. American Book Co. 65 cents.

Reader in Botany. J. H. Newell. 2 vols. Ginn & Co. 70 cents.

Seed Dispersal. W. J. Beal. Ginn & Co. 40 cents.

Ten New England Blossoms. Clarence M. Weed. Houghton, Mifflin & Co. \$1.25.

With the Wild Flowers, \$1.00; Field, Forest and Wayside Flowers, \$1.50. Maud Going. Baker, Taylor & Co.

Flowers and Their Insect Visitors. Gibson. Newson & Co. \$1.00.

TREES.

A Guide to the Trees. Alice Lounsberry. Frederick A. Stokes Co. \$2.50.

Familiar Trees and Their Leaves. S. Mathews. D. Appleton & Co. \$1.75.

Our Native Trees. Our Native Shrubs. Harriet Keeler. Chas. Scribner's Sons. \$2.00 each.

A Primer of Forestry. Pinchot. U. S. Dept. Agri.

Getting Acquainted with the Trees. J. H. McFarland. Outlook Co. \$1.75.

The First Book of Forestry. Roth. Ginn & Co. \$1.00.

Among Green Trees. Julia E. Rogers. Mumford. \$3.00.

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Nature Pictures by American Poets. The Macmillan Co. \$1.25.

Arbor Day Manual. Charles Skinner. Bardeen & Co. \$2.50.

Songs of Nature. John Burroughs. McClure, Phillips & Co. \$1.50.

Among Flowers and Trees. Wait & Leonard. Lee & Shepherd. \$2.00.