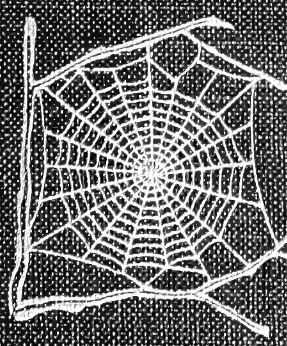
THE NATURAL HISTORY OF THE FARM



THE NATURAL HISTORY OF THE FARM.

The Natural History of the Farm

A Guide to the Practical Study of the Sources of Our Living in Wild Nature.

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CYBELE

Spirit of th' raw and gravid earth
Whenceforth all things have breed and birth,
From palaces and cities great
From pomp and pageantry and state
  Back I come with empty hands
  Back unto your naked lands.

—L. H. BAILEY.

PRESS OF W. F. HUMPHREY, GENEVA, N. Y.

PREFACE.

This is a book on the sources of agriculture. Some there may be who, deeply immersed in the technicalities of modern agricultural theory and practice, have forgotten what the sources are; but they are very plain. Food and shelter and clothing are obtained now, in the main, as in the days of the patriarchs. Few materials of livelihood have been either added or eliminated. The same great groups of animals furnish us flesh and milk and wool; the same plant groups furnish us cereals, fruits and roots, cordage and fibres and staves. The beasts browsed and bred and played, the plants sprang up and flowered and fruited, then as now. We have destroyed many to make room for a chosen few. We have selected the best of these, and by tillage and care of them we have enlarged their product and greatly increased our sustenance, but we have not changed the nature or the sources of it. To see, as well as we may, what these things were like as they came to us from the hand of nature is the chief object of this course.

A series of studies for the entire year is offered in the following pages. Each deals with a different phase of the life of the farm. In order to make each one pedagogically practical, a definite program of work is outlined. In order to insure that the student shall have something to show for his time, a definite form of record is suggested for each practical exercise. In order to encourage spontaneity, a number of individual exercises are included which the student may pursue independently. The studies here offered are those that have proved most useful, or that are most typical, or that best illustrate field-work methods. There may be enough work in some of them for more than a single field trip:

many of them will bear repetition with new materials, or in new situations. Each one includes a brief introductory statement to be read, and an outline of work to be performed. In all of them, it is the doing of the work outlined—not the mere reading of the text—that will yield satisfactory educational results.

The work of this course is not new. Much work of this sort has been done, and well done, as nature-study, in various institutions at home and abroad. But here is an attempt to integrate it all, and to show its relation to the sources of our living. So it is the natural history, not of the whole range of things curious and interesting in the world, but of those things that human kind has elected to deal with as a means of livelihood and of personal satisfaction in all ages.

These are the things we have to live with: they are the things we have to live by. They feed us and shelter us and clothe us and warm us. They equip us with implements for manifold tasks. They endow us with a thousand delicacies and wholesome comforts. They unfold before us the ceaseless drama of the ever-changing seasons—the informing drama of life, of which we are a part. And when, in our rude farming operations, we scar the face of nature to make fields and houses and stock pens, they offer us the means whereby, though changed, to make it green and golden again—a fit environment wherein to dwell at peace.

In the belief that an acquaintance with these things would contribute to greater contentment in and enjoyment of the farm surroundings and to a better rural life, this course was prepared. The original suggestion of it came from Director L. H. Bailey of the New York State College of Agriculture. It was first given in that college by me in coöperation with Mrs. J. H. Comstock. To both these good naturalists, and to all those who have helped me as assistants, I am greatly indebted for valuable suggestions.

JAMES G. NEEDHAM.

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I. MOTHER EARTH

"Brother, listen to what we say. There was a time when our forefathers owned this great land. Their seats extended from the rising to the setting sun. The Great Spirit had made it for the use of the Indians. He had created the buffalo and the deer and other animals for food. He had made the bear and the beaver. Their skins served us for clothing. He had scattered them over the country and had taught us how to take them. He had caused the earth to produce corn for bread. All this he had done for his red children because he loved them."

—From the great oration of "Red Jacket," the Seneca Indian, on *The Religion of the White Man and the Red.*

If you ever read the letters of the pioneers who first settled in your locality when it was all a wilderness (and how recent was the time!), you will find them filled with discussion of the possibilities of getting a living and establishing a home there. Were there springs of good water there? Was there native pasturage for the animals? Was there fruit? Was there fish? Was there game? Was there timber of good quality for building? Was the soil fertile? Was the climate healthful? Was the outlook good? Has it ever occurred to you how, in absence of real-estate and immigration agencies, they found out about all these things?

They sought this information at its source. They followed up the streams. They foraged: they fished: they hunted. They measured the boles of the trees with eyes experienced in woodcraft. They judged of what nature would do with their sowings by what they saw her doing with her own native crops. And having found a sheltered place with a pleasant outlook and with springs and grass and forage near at hand, they built a dwelling and planted a garden. Thus, a new era of agriculture was ushered in.

Your ancestors were white men who came from another continent and brought with them tools and products and traditions of another civilization. Their tools, though simple, were efficient. Their axes and spades and needles and shears were of steel. Their chief dependence for food was placed in cereals and vegetables whose seeds they brought with them from across the seas. Their social habits were those of a people that had long known the arts of tillage and husbandry: their civilization was based on settled homes. But they brought with them into the wilderness only a few weapons, a few tools, a few seeds and a few animals, and for the balance and continuance of their living they relied upon the bounty of the woods, the waters and the soil.

A little earlier there lived in your locality a race of red men whose cruder tools and weapons were made of flint, of bone and of copper; who planted native seeds (among them the maize, the squash, and the potato), and whose traditions were mainly of war and of the chase. These were indeed children of nature, dependent upon their own hands for obtaining from mother earth all their sustenance. There was little division of labor among them. Each must know (at least, each family must know) how to gather and how to prepare as well as how to use.

Today you live largely on the products of the labors of others. You get your food, not with sickle and flail and spear, but with a can-opener, and you eat it without even an inkling of where it grew. So many hands have intervened between the getting and the using of all things needful, that some factory is thought of as the source of them instead of mother earth. Suppose that in order to realize how you have lost connection, you step out into the wildwood empty-handed, and look about you. Choose and say what you will have of all you see before you for your next meal? Where will you find your next suit of clothes and what will it be like? Ah, could you even improvise a wrapping, and a string with which to tie it, from what wild nature offers you?

These are degenerate days. One had to know things in order to live in the days of the pioneer and the Indian. But now one may live without knowing anything useful, if he only possess a few coins of the realm and have access to a department store.

"Back to nature" has therefore become the popular cry, and vacations are devoted to camping out, and to "foraging off to the country" as a means of restoration. But fortunately it is not necessary to go to the mountains or to the frontier in order to get back to nature; for nature is ever with us at home. She raises our crops with her sunshine and soil and air and rain, and turns not aside the while from raising her own. While we are engrossed with "developing" our clearings and are planting farms and cities and shops, she goes on serenely raising her ancient products in the bits of land left over: in swamp and bog, in gulch and dune, on the rocky hillside, by the stream and in the fence row. There she plants and tends her cereals and fruits and roots, and there she feeds her flocks. Wherever we leave her an opening, she slips in a few seeds of her own choosing, and when we abandon a field, she quickly populates it again with wild things. They begin again the same old lusty struggle for place and food, and of our feeble and transient interference, soon there is hardly a sign.

As for the wild things, therefore,—the things that so largely made up the environment of the pioneer and the red man—we need but step out to the borders of our clearing to find most of them. If any one would share in the experience of primeval times, he must work at these things with his own hands. To gain an acquaintance he must apply first his senses and then his wits. He must test them to find out what they are good for, and try them to find out what they are like: he must sense the qualities that have made them factors in the struggle for a place in the world of life. Thus, one may get back to nature. Thus, one may re-acquire some of that ancient fund of real knowledge that was once necessary to our race, and that is still fundamental to a good education, and that contributes largely to one's enjoyment of his own environment.

The best place to begin is near home. Any large farm will furnish opportunities. It is the object of the lessons that follow to help you find the wild things of the farm that are most nearly related to your permanent interests, and to get on speaking terms with them. You will be helped by these studies in proportion as your own eyes see and your own hands handle these wild things. The records you make will be of value to you only as you write into them your own experience: write nothing else.

Suggestions to students: The regular field work contemplated in this course makes certain demands with which indoor laboratory students may be unfamiliar. A few suggestions may therefore be helpful:

1. **As to weather:** All weather is good weather to a naturalist. It is all on nature's program. Each kind has its use in her eternal processes, and each kind brings its own peculiar opportunities for learning her ways. Nothing is more futile than complaint of the weather, for it is ever with us. It were far better, therefore, to enter into the spirit of it, to make the most of it and to enjoy it.

2. **As to clothes:** Wear such as are strong, plain and comfortable. There are thorns in nature's garden that will tear thin stuffs and reach out after anything detachable; and there are burs, that will cling persistently to loose-woven fabrics. Kid gloves in cold weather and high heels at all

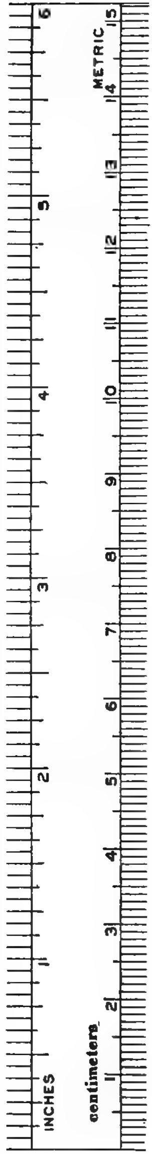

FIG. 1. Metric and English linear measure.

times are an utter abomination. Clothing suited to the weather will have very much to do with your enjoyment of it and with the efficiency of your work.

3. **As to tools:** A pocket lens and a pocket knife you should own, and have always with you. A rule for linear measurements is printed herewith (fig. 1). Farm tools, furnished for common use, will supply all other needs.

4. **As to the use of the blanks provided:** Blanks, such as appear in the studies outlined on subsequent pages, are provided for use in this course. Take rough copies of them with you for use in the field, where writing and sketching in a notebook held in one's hand is difficult; then make permanent copies at home. When out in the rain, write with soft pencil and not with ink.

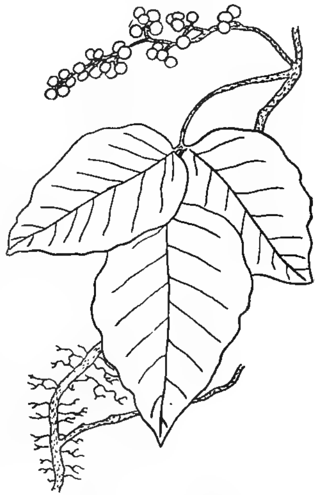

Fig. 2. Poison Ivy.

5. **As to poison ivy** (fig. 2): Unless you are immune, look out for it: a vine climbing by aerial roots on trees and fences, or creeping over the ground. Its compound leaves resemble those of the woodbine, but there are five leaflets in the woodbine, and but three in poison ivy. Lead acetate (sugar of lead) is a specific antidote for the poison; a saturated solution in 50% alcohol should be kept available in the laboratory. It is rubbed on the affected parts—not taken internally, for it also is a poison. If used as soon as infection is discoverable, little injury results to the skin of even those most sensitive to ivy poison. After lesions of the skin have occurred, through neglect to use it promptly, it is an unsafe and ineffective remedy; a physician should then be consulted.

6. **As to pockets:** Some people don't have any. But containers of some sort for the lesser things, such as twigs and

seeds, studied in the field, will be very desirable. You will want to take another look at them after you get back; so prepare to take them home, where you can sit at a table and work with them. A bag or a basket will hold, besides tools, a lot of stout envelopes, for keeping things apart, with labels and necessary data written on the outside.

7. **As to reference books:** "Study nature, not books", said the great naturalist and teacher, Louis Agassiz. By all means, get the answers to the questions involved in your records of these studies direct from nature and not from books. But while you are in the field, you will meet with many things about which you will wish to know. Ask your instructors freely. Get acquainted, also, with some of the standard reference books, which will help you when instructors fail. Only a few of the more generally useful can be mentioned here.

There are three classical manuals for use in the eastern United States and Canada, that have helped the naturalists of several generations. These are Gray's Manual of Botany, Jordan's Manual of the Vertebrates and Comstock's Manual for the Study of Insects. There are two great cyclopedias, both edited by Professor L. H. Bailey—The American Cyclopedias of Horticulture and of Agriculture. There are many books of nature-study, but most useful of them all is Mrs. Comstock's Handbook of Nature-Study. The best single bird book is Chapman's Handbook of North American Birds. A new book that will help toward acquaintance with aquatic plants and animals is Needham and Lloyd's Life of Inland Waters. All these should be accessible on reference shelves.

Note—At Cornell University the field tool that is furnished to classes for individual use is a sharp brick-layer's hammer weighing about a pound. It is not heavy enough to be burdensome, and it is adaptable to a great variety of uses, such as digging roots, cracking nuts, stripping bark, splitting and splintering kindling, planting seedlings, etc. A light hatchet will serve many, but not all of these uses.

Study 1. A General Survey of the Farm

The program of this study should consist of a trip over the farm with a good map in hand, showing the streams, the roads, the buildings and the outlines of all the fields and woods.

The record. The student should record directly on this map, the sort and condition of crops found in all the fields and the character of all the larger areas not used as fields. He should put down the names of all prominent topographic features, hills, streams, glens, etc., that bear names. The amount of additional data to be required—dwellings and their inhabitants, barns and their uses, etc.—will be determined by the area to be covered and the time available. If crops are few, colors may be used to make their distribution more graphic. If inhabitants are to be recorded, the dwellings may be numbered upon the map and the names of their occupants written down in a correspondingly numbered list. The object is a preliminary survey of the whole area that is to be subsequently examined in detail.

II. THE WILD FRUITS OF THE FARM

"The mandrakes give a smell, and at our gates are all manner of pleasant fruits, new and old, which I have laid up for thee, O my beloved."

—The Song of Solomon, 7:13.

The bounty of nature is never more fully appreciated than when we see a tree bearing a load of luscious fruit. A tree that has been green, like its fellows, suddenly bursts into a glow of color, and begins to exhale a new and pleasant fragrance as its product ripens. The bending boughs disclose the richness and abundance of its gift to us.

Among nature's delicacies there are none so generally agreeable and refreshing as her fruits. They possess an infinite variety of flavors. Before the days of sugar-making, they were the chief store of sweets. They everywhere fulfill an important dietary function, both for man and for many of his animal associates.

All fruits were once wild fruits. Most of them exist today quite as they came to us from the hand of nature. A few have been considerably improved by selection and care. But none of them has been altered in its habits. They grow and bloom and bear and die as they did in the wildwood.

They have their seasons, the same seasons that the market observes. First come the strawberries, breaking the fast of winter's long barrenness. What wonder that our Iroquois Indians celebrated the ripening of the fragrant wild strawberries by a great annual festival! Then come the currants and the raspberries and the cherries and the buffalo-berries and the mulberries and the plums and many others in a long succession, the season ending with the grapes, the apples, the cranberries and the persimmons.

The wild fruits have their requirements also as to climate, soil, moisture, etc., and these we must observe if we cultivate them. Cranberries and some blueberries demand bog conditions which strawberries and apples will not endure.

The wild fruits in a state of nature, have their enemies also, which are ever with them when cultivated. The fruit-fly of the cherry, the codling moth of the apple, the plum-curculio and all the other insect pests of the fruit garden, have merely moved into the garden from the wildwood. And they flourish equally in the wildwood still. When, for example, an orchardist has rid his trees of codling moths, a fresh stock soon arrives from the unnoticed wild apples of the adjacent woods, and infests his trees again.

So, we must go back to nature to find the sources of our benefits and of their attendant ills.

The wild fruits of the farm all grow in out-of-the way places that escape the plow. They grow in the fence-row, by the brookside, on the stony slope. If in the forest, they grow only in the openings or in the edges; for fruit trees do not grow so tall as the trees of the forest cover, and cannot endure much shading. The bush fruits especially are wont to spring up in the fence-row, where birds have perched and have dropped seeds from ripe fruit they have eaten. They are a lusty lot of berry-bearing shrubs and vines that tend to form thickets, and when cut down by the tidy farmer, they spring up again with cheerful promptness from uninjured roots. In a few years they are in bearing again. The neglected fence-row is, therefore, one of the best places to search for the lesser wild fruits.

Of nature's fruits there is endless variety. They grow on tree, shrub, herb and vine. They are large and small, sweet and sour, pleasant and bitter, wholesome and poisonous. They mellow in the sun like apples, or sweeten with the frosts like persimmons. They hang exposed like plums, or are hidden in husks like ground-cherries. The edible ones that remain growing wild in the autumn are a rather poor lot of small and seedy kinds, that have been hardy enough to hold their own, in spite of mowing and grazing and clearing. They compare poorly with the selected and cultivated products of the fruit farm. Yet many of them once served our ancestors for food. Collectively they were the sole fruit supply of the aboriginal inhabitants of our country. The Indians ate them raw, stewed them, made jam, and even jellies. They dried the wild strawberries, blueberries, raspberries and blackberries, and kept them for winter use. They expressed the juice of the elderberry for a beverage: indeed, the black-berried elder they used in many ways; it was one of their favorite fruits. And even as the crows eat sumach berries in the winter when better fruits are scarce, so the Indians boiled them to make a winter beverage.

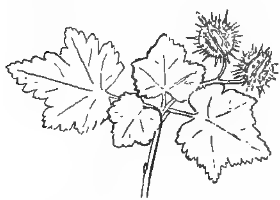

FIG. 3. The Wild Gooseberry.

The cultivated fruits are but a few of those that nature has offered us. We have chosen these few on account of their size, their quality, and their productiveness. We demand them in quantity, hence they must either be large or else be easily gathered. Some, like the Juneberry, are sweet and palatable, but too small and scattered and hard to pick. The wild gooseberry is a rich and luscious fruit, but needs shearing before it can be handled. The quantitative demands of our appetite, the qualitative demands of our palate and the mechanical limitations of our fingers have restricted us to a few, and having learned how to successfully manage these few, we have neglected all the others for them.

Our management has consisted, in the main, of propagating from the best varieties that nature offered, and giving culture. Any of the wild fruits would probably yield improved varieties under like treatment. All the wild fruits show natural varieties, the best of which offer proper materials for selection.

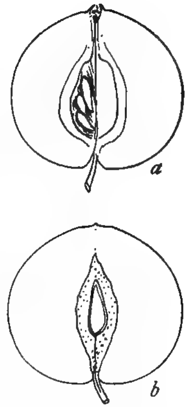

FIG. 4. Diagrams of pome fruit, (a), and stone fruit, (b).

Wild fruits, like the cultivated, fall chiefly in three categories: core fruits (pomes), stone fruits (drupes), and berries. The structural differences between pome and drupe are indicated in the accompanying diagram. The apple is the typical core fruit (*pomus*=apple; whence, pomology). The seeds are contained in five hardened capsules (ripened carpels), together forming the core, surrounded by the pulp or flesh of the apple, which is mostly developed from the base of the calyx. The calyx lobes persist at the apex of the apple, closed together above the withered stamens and style tips. The plum is a typical stone fruit: the single seed is enclosed in a stony covering that occupies the center of the fruit and is surrounded by the pulp. The term berry is used to cover a number of structural types which agree in little else than that they are small fruits with a number of scattered seeds embedded in the pulp.

If, with the coming of improved varieties of cultivated fruits, the wild ones have ceased to be of much importance in our diet, they still are of importance to us as food for our servants, the birds. The birds like them. Nothing will do more to attract and retain a good population of useful birds, than a plentiful supply of wild fruits through the summer season. Who that has seen orioles pecking wild strawberries or robins gormandizing on buffalo-berries or waxwings stripping a mountain ash, can

FIG. 5. Wild chokecherry (*Prunus sp?*) and nannyberry (*Viburnum lentago*).

EDIBLE WILD FRUITS

NAME	Kind of Plant[1]	Type of Fruit[2]	No. Seeds	Cluster of Fruit[3]	Size[4]
1. Crab Apple					
2. Hawthorn					
3. Mountain Ash					
4. Wild Cherry					
5. Chokecherry					
6. Nannyberry					
7. Spicebush					
8. Hackberry					
9. Wild Grape					
10. Elderberry					
11. Barberry					
12. Yewberry					
13.					
14.					

[1]Tree, shrub, vine, etc. [2]Pome, drupe, berry, etc. [3]Diagram.
[4]Dimensions in millimeters.

Proportion of Pulp	Used for What[5]	Taste	Animals eating it[6]	Remarks
				1
				2
				3
				4
				5
				6
				7
				8
				9
				10
				11
				12
				13
				14

[5]Leave blank unless you have personal knowledge.
[6]Specify whether foraging on it or living within it.

doubt it? Their tastes have a wider range than ours. Waxwings like cedar berries, and crows eat freely the fruit of poison ivy. The close-growing habit of wild bush fruits gives congenial shelter and nesting sites, also, to many of the smaller birds.

From all the foregoing it should appear that a little study of the natural history of the wild fruits in any locality will reveal much concerning the origin and the environing conditions of one of our valuable resources.

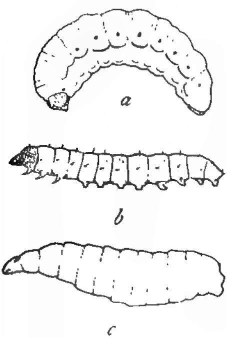

Fig. 6. The larvae of three common fruit insects: (*a*) the plum-curculio; (*b*) the codling moth; (*c*) the cherry fruit-fly.

Study 2. Edible Wild Fruits

Program—The first part of this study is a comparative examination of the wild fruits of the farm. The fruits are to be sought in nature, examined carefully one at a time, and their characters are to be written in the columns of a table prepared with headings as indicated in pp. 20 and 21. The fruits named in the first column are those commonly found about Ithaca, N. Y., in autumn. Earlier in the season, or in another region, the list would be very different.

The second part of this study is a comparison of individuals of one kind of wild fruit, such as hawthorns, wild grape, or any other that is abundant, with a view to discovering natural varieties. Half a dozen or more selected trees, bearing number-labels, 1, 2, 3, etc., should have their fruits carefully compared as to (1) quality of flesh (as tested by palatability at this date); (2) proportion of edible pulp (as compared with seeds, skin and other waste); (3) earliness; (4) size and form; (5) productiveness; (6) immunity from fungus and insects, as evidenced by the cleanness of the fruit inside and outside. (Immunity from birds and mammals is not desired, since these are attracted by the qualities we like). These qualities may be set down as column headings to a table, the first column being reserved for tree numbers, and then it will suffice if the order of excellence be written in each column in numerals. For example, in the column for palatability, if tree No. 3 be the best flavored, write 1 in line 3 in that column; if tree No. 4 be the worst flavored (of 6 trees), write 6 in line 4 of that column. Arrange the others likewise according to your judgment of their flavor.

The record of this study will consist of the two tables completed, so far as data are available.

III. THE NUTS OF THE FARM

"The auld guidwife's weel-hoordet nits
Are round an' round divided."

—Robert Burns (*Hallow-e'en*).

Nature puts up some of her products in neat packages for keeping. Among the choicest of them, preserved in the neatest and most sanitary of containers, are the nuts. Rich in proteins and fats, finely flavored, and with a soft appetizing fragrance, these strongly appeal to the palate of man and many of his animal associates. Squirrels and other rodents and a few birds gather and store them for winter use. In pioneer days hogs were fattened on them. It was a simple process: the hogs roamed the woods and fed on the nuts where they fell. And it is credibly claimed that bacon of surpassing flavor was obtained from nut-fed hogs. In earlier days the Indian, who had no butter, found an excellent substitute for it in the oil of the hickories. He crushed the nuts with a stone and then boiled them in a kettle of water. The shells sank to the bottom; the oil floated, and was skimmed from the surface.

Most nuts mature in autumn. A heavy, early frost, and then a high wind, and then—it is time to go nutting; for so choice a stock of food, clattering down out of the tree-tops onto the lap of earth, will not lie long unclaimed. It is real trees that most nuts grow on—not underlings, like fruit trees, but the great trees of the forest cover; trees that are of value, also, for the fine quality of their woods. They are long-lived and slow-maturing. So, in our farming, we have neglected them for quicker-growing crops.

Practically all the nuts found growing about us are wild nuts, that persist in spite of us rather than with our care. Here and there a valued chestnut or walnut tree is allowed to

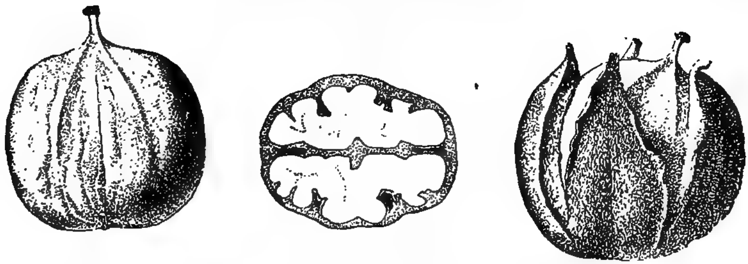

FIG. 7. The pig-nut hickory (*Hickoria glabra*); the whole nut, a cross section of same, and the nut in its hulls (after Mayo).

occupy space in the corner of the barnyard or in the fencerow, and there, relieved of competition, shows what it can do in the way of producing large and regular crops. But the nuts are wild. There has been but little selection for improved varieties and little scientific culture of nut-bearing trees. When we consider the abundance and value of their product, the permanence of their occupation of the ground, the slight cost in labor of their maintenance, and the conservation of the soil which they promote, this neglect of nut crops among us seems unfortunate.

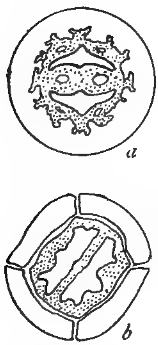

FIG. 8. Cross sections of two types of nuts in their hulls: (*a*) walnut with non-splitting hull; (*b*) hickory nut with four-valved hull.

Two families of plants furnish most of our valuable nuts: the hickory family and the oak family. The former includes the more valuable kinds of nuts; besides true hickories, these are pecans, butter-nuts and walnuts. In all these there is a bony shell, enclosing the four-lobed and wrinkled edible seed. The oak family includes besides the acorns (few of which are valuable as human food) the chestnuts, the filberts, the hazels and the beech nuts. In these there is a horny shell enclosing the smooth but compact seed. Certain other members of the oak family, as the hornbeams, produce nuts that are too small to be worthy of our consideration as

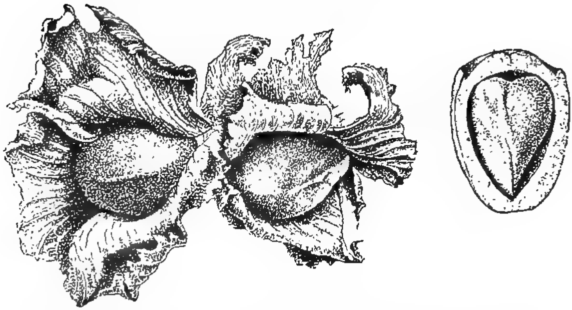

FIG. 9. The hazel nut (*Corylus americanus*); nuts in the hull, and a kernel in the half-shell (after Mayo).

food. A few stray members of other families produce edible nuts. Those of the linden are very well flavored, although minute. Those of the wild lotus of the swamps are very palatable and were regularly gathered by the Indians for food. They resemble small acorns in size and shape. Then there are nuts of large size and promising appearance that are wholly inedible. Such are the horse-chestnut and the buckeye, which contain a bitter and narcotic principle.

Certain nuts of large size and fine quality, like the king hickory, have not found much popular favor, because their shells are thick and close-fitting. They are hard to crack and the kernels are freed with much difficulty. Such selection as has been practiced with Persian walnuts and pecans is in the direction of thin, loose-fitting shells.

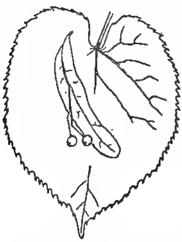

Fig. 10. Leaf outline and nutlets of the linden.

Nuts are unusually well protected during development by hard shells and thick hulls of acrid flavor; yet they have not escaped enemies. Wormy nuts are frequent. The most important of the "worms" living inside the hulls and feeding on the kernels are the larvæ of the nut-weevils. These are snout-beetles that live exclusively upon nuts and are very finely adapted for such a life. The snout or rostrum of the beetle is excessively elongated, especially in the female

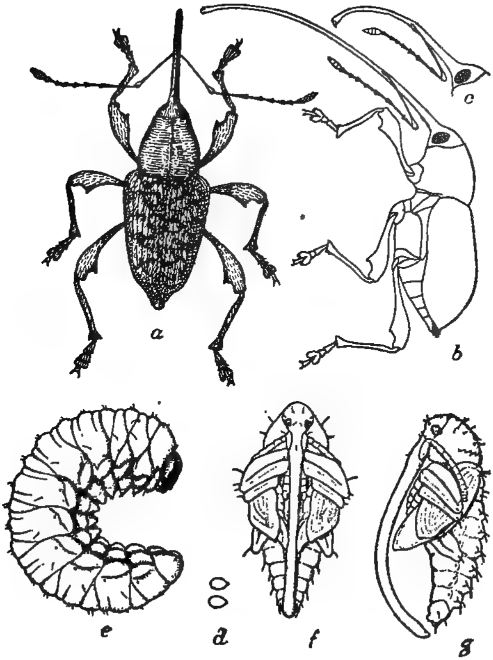

FIG. 11. The chestnut-weevil (*Balaninus proboscideus*): *a*, adult; *b*, same, from side–female; *c*, head of male, with its shorter beak; *d*, eggs; *e*, larva; *f* and *g*, pupa from front and from the side (from Bureau of Entomology of the U. S. Department of Agriculture).

beetle. The jaws are at its tip. It is used for boring deep holes through the thick hulls, down to the kernel. The egg is then inserted into the hole, and the larva hatching

PLANTS PRODUCING

Name	Kind of Plant[1]	Height in feet[2]	LEAVES		
			Form[3]	Size[4]	Margin[3]
Shellbark Hickory					
Pignut "					
Bitternut "					
Butternut					
Walnut					
Chestnut					
Beechnut					
Hazelnut					
White Oak					
Chestnut Oak					
Red Oak					
Linden					
Buckeye					

[1] Tree, shrub, or herb. [2] Full, approximate. [3] Diagram.
[4] Width by length in inches; of a single leaflet, if compound.

WILD NUTS AND ACORNS.

NUTS: Character of			Animals eating it[5]	Quality[6]
Hulls	Shells	Kernel		

[5] Specify whether foraging on it or living within

[6] Palatability, oiliness, starchiness, acridity, etc.

from the egg finds there a ready-made passage down to its food. The larvæ have done their destructive work when the nuts fall. They are full-grown and are ready to leave the nuts and enter the ground, there to complete their transformations. An easy way to get the larvæ, and at the same time to learn the extent of their infestation, would be to gather a few quarts of chestnuts or acorns freshly fallen from the trees, and put them in glass jars to stand awhile. The larvæ leaving the nuts (emerging through remarkably small holes which they gnaw through the shell) will descend to the bottoms of the jars and remain there, where readily seen. They will begin to emerge at once, and in less than a fortnight all will be out, and may be counted. These, and twig-pruners and bark-beetles, etc., all have to be reckoned with in the orchard where nuts are cultivated. In this study we will give our attention to the nuts, noting the infesting animals only incidentally.

Study 3. The Nuts of the Farm

There is but a short period of a week to ten days about the time of the first hard frost, when the work here outlined can best be done. Take advantage of it, shifting the date of other studies, if need be. The tools needed will be hammers for cracking the shells, and pocket knives for cutting the soft parts of the nuts; also, containers for taking specimens home. The use of lineman's climbers and of beating-sticks in the tree-tops is permissible to a careful and experienced person; but the use of hooks on light poles for drawing down horizontal boughs within reach from the ground is safer, and has the advantage that all members of the class can see what is going on.

The program of the work will include a visit to the nut-bearing trees and an examination of their crop, first on the tree, then in the hulls, then shelled, then cracked; then an examination of the quality of the kernels.

The record of this study will consist in:

1. A table prepared with column headings as indicated on pages 28 and 29, and filled out from the study of the specimens.

2. Simple sectional diagrams, showing the structure of such diverse forms as the following:

(a) A butternut or walnut.
(b) A hickory nut or pecan.
(c) An acorn.
(d) A beechnut or chestnut.
(e) A linden nutlet.

IV. THE FARM STREAM

"All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again."

—Ecclesiastes 1:7.

There was a time when the streams of our "well-watered country" were more highly prized than now. They were storehouses of food. They were highways of travel. They were channels of transportation. Several things happened to divert interest landward. The good timber along the valleys was all cut and there were no more logs to be floated down-stream to mill. The American plow was invented, making possible the tillage of vastly increased areas of ground. More cereals could be grown and more forage for cattle. The fishes of the streams became less necessary for food; and with the phenomenally rapid increase of population which followed, the fishing failed. It became easier and cheaper to raise cattle for food than to get it by fishing. Then came the railroads, providing more direct and speedy transportation and travel; and the streams were abandoned. Indeed, what happened to them was worse than neglect. The regularity of their supply of water was interfered with as the water-holding forest cover was destroyed and springs dried up. They became dumping places for the refuse of all sorts of establishments along their banks. Not even their beauty was cared for—their singular beauty of mirroring surfaces and sinuous banks of broad bordering meadows, backed by wooded headlands. The pioneer was not so blind to the grander beauties of nature. Go through the country and mark where the first settlements were made. You will find them not far from the waterside, but situated where the ample beauties of land and water, hill and vale, are spread out to view. Our predecessors would not have been satisfied with a seven-by-nine lot, a bit of lawn with a peony in the front yard, and a view of an asphalt pavement.

Before the surveyor came along, lines were laid down according to the law of gravity. The land was divided and subdivided, not by fences, but by streams.

Chief among the agencies that have shaped our farms is the power of moving water. By it the soils have been mixed and sifted and spread out. Water runs down hill, and the soils move ever with it. With every flood, a portion is carried a little way, to be dropped again as the current slackens, and another portion is carried farther, to mix with soils from various distant sources and form new fields at lower levels. Small fields are forming now in the beds and borders of every stream. And there, even as on land, some of them are exposed, shifting and barren, and others are sheltered and settled and productive.

The rain descends upon the fields and starts down every slope, gathering the loosened soil particles, collecting in rills, increasing in volume, and cutting gullies and picking up loosened stones, and pouring its mixture of mud and stones into the creek at the foot of the slope. Then what does the creek do with this flood-time burden? Go down to its banks and see. See where it has dropped the stones in tumbled heaps at the foot of the rapids; the gravel, in loose beds just below; the sand, in bars where the current slackens; the mud in broad beds where the water is still; for its carrying power lessens as its flow slackens, and it holds the finest particles longest in suspension.

It will be evident that, of all these deposits, the mud flats are least subject to further disturbance by later floods. Here, then, plants may grow, least endangered by the impact of stones and gravel and sand in later floods or by the out-going ice in spring. So here are the creek's pleasant fields of green, its submerged meadows, whereas the beds where the current runs swiftly appear comparatively barren.

THE PLANT LIFE OF THE STREAM

FIG. 12. Spray of riverweed (*Potamogeton crispus*). From a drawing by Miss Emmeline Moore.

The rapids are by no means destitute of life. Given natural waters, a temperature above freezing, light and air, plants will grow anywhere: here, they must be such plants as can withstand the shower of stones that every flood brings down upon them. They must be simply organized plants, that are not killed when their cell masses are broken asunder. Such plants are the algae; and these abound in the swiftest waters. They form a thin stratum of vegetation covering the surfaces of rocks and timbers. Its prevailing color is brown, not green. Its dominant plants are diatoms. These form a soft, gelatinous, and very slippery coating over the stones. Individually they are too small to be recognized without a microscope, but collectively, by reason of their nutritive value and their rapid rate of increase, they constitute the fundamental forage supply for a host of animals dwelling in the stream bed with them.

There are green algæ also in the rapids. The most conspicuous of these is Cladophora, which grows in soft trailing masses of microscopic filaments, fringing the edges of stones in the swiftest current, or trailing down the ledges in the waterfall, or encircling the piling where the waves wash it constantly. It is of a bright green color. There are apt to be various other algæ also, some forming spots and blotches of blue-green color on the surfaces of rocks, where partly exposed at low water, and others forming little brownish gelatinous lumps like peas lying on the stream bed. Of the higher plants there will be hardly any present in the rapids: perhaps, a few trailing mosses or other creepers rooted in the crevices at the edge of the current, and just escaping annihilation at every flood.

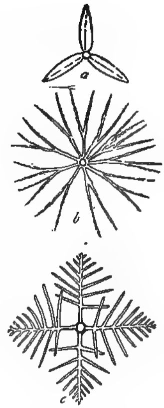

FIG. 13. Leaf-form in three common submerged plants whose leaves grow in whorls surrounding the stem at the nodes: *a*, the common water-weed (*Elodea canadensis* or *Philotria canadensis*); *b*, the water hornwort (*Ceratophyllum demersum*); *c*, the water milfoil (*Myriophyllum*).

In quiet waters covering muddy shoals the vegetation is richer and more varied. The dominant plants are seed plants. Some of these (such as are shown in Figs. 12 and 13) grow wholly submerged. A few grow rooted to the bottom, but have broad leaves (Fig. 14) that rest upon the surface. A few small plants (Fig. 15) float free upon the surface in the more sheltered openings. And there are many rooted in the

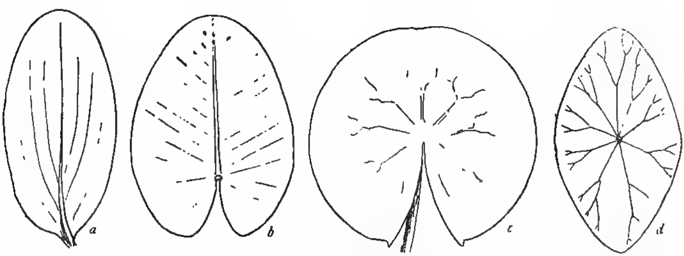

FIG. 14. Outlines of four common kinds of floating leaves: *a*, the floating riverweed (*Potamogeton natans*); *b*, the spatter-dock (*Nymphæa advena*); *c*, the white waterlily (*Castaillia odorata*); *d*, the water shield (*Brasenia peltata*).

FIG. 15. Floating plants: *a*, duckweeds; *b*, the floating liverwort (*Ricciocarpus natans*).

mud at the bottom, that stand erect and emergent with their tops above the water. A few of the more striking and characteristic of these are shown in Figure 16. Algæ are common enough here also. Brown coatings of diatom ooze overspread the submerged stems, and flocculent green mats of "blanket algae" lie in sheltered openings, often buoyed to the surface on bubbles of oxygen.

THE ANIMAL LIFE OF THE STREAM

The animals that live in the rapids are small in size, but most interesting in the adaptations by means of which they are enabled to withstand the on-rush of the waters. One of them at least, the black-fly larva, occurs in such numbers as to form conspicuous black patches in most exposed places—on the very edge of the stones that form the brink of waterfalls and on the sides of obstructions in the current. Individually these larvae are small (half an inch long), with bag-shaped bodies, swollen toward the rear end, where attached by a single sucking disc to the supporting surface. Attached in thousands side by side, they often thickly cover and blacken several square feet of surface. They sway gently in the current as they hang with heads down stream.

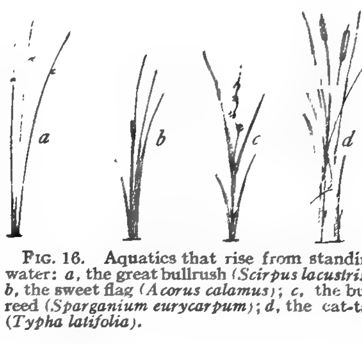

FIG. 16. Aquatics that rise from standing water: *a*, the great bullrush (*Scirpus lacustris*); *b*, the sweet flag (*Acorus calamus*); *c*, the bur-reed (*Sparganium eurycarpum*); *d*, the cat-tail (*Typha latifolia*).

These larvae spin attachment threads by means of which they may change location. The

FIG. 17. The larva of the black-fly (*Simulium*).

thread is exuded at the mouth (as a liquid which hardens on contact with the water), attached to the stone and spun out to the desired length. The larva, with disc loosened, swings free upon the thread, reversed in position and hanging with head upstream. After a time it will fasten itself by its sucker again. By using a very short thread and its sucker alternately, the larva may move short distances over the supporting surface in a series of loopings, its position being reversed at each attachment in a new place. Black-fly larvae are excellent food for fishes, but they live for the most part in places that are to fishes wholly inaccessible. They feed upon microscopic organisms and refuse adrift in the stream, and they gather their food out of the passing current by means of a pair of fan-like strainers, located on the front of the head near the mouth. Adult black-flies of certain species bite fiercely in northern forests. Other species, known as "buffalo-gnats" and "turkey-gnats", are important pests of live stock. Other species are harmless.

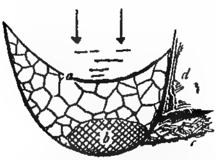

FIG. 18. Diagram of a seine-making caddis-worm's fishing apparatus and his dwelling; arrows indicate the direction of the current over the stream bed; *a*, the front edge of the distended seine through which the water is strained; *b*, the catching surface of finer mesh at the bottom of the seine and adjacent to the door of the tube, *c*, in which the larva dwells, in the shelter of the rock, *d*. (After an unpublished drawing by Miss Alice A. Noyes).

In the same situations with the black-fly larvae, the neat little food-traps of the seine-making caddis-worms may always be found. Each is a little, transparent, funnel-shaped net, half an inch wide, opening always upstream, and tapering downward into a silken tube, lodged in some sheltering crevice, in which the greenish, gill-bearing caddis-worm that makes it dwells.

Then there is a group of diverse insect larvae found habitually in the rapids clinging to stones, that agree in being flattened and more or less

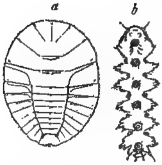

FIG. 19. Two insect larvae that stick to stones in rapid water: *a*, the flat riffle-beetle (*Psephenus lecontei*); *b*, the net-veined midge (*Blepharocera*).

limpet-shaped. Two of these are shown in Figure 19. In all of them flaring margins of the body fit down closely to the stone and deflect the water, so that it presses them against their support.

In still water the deep pools are the special home of the larger fishes. We shall return to them in the next study. In the shoaler parts and in the midst of the aquatic vegetation are the lesser fishes and many other familiar vertebrates, frogs and their tadpoles, salamanders, turtles, etc., of uncertain occurrence. Much more generally distributed and constantly present are a few molluscs and crustaceans, such as are shown in Figure 20. There are a few adult insects (fig. 21) and many insects in immature stages (figs. 22, 23) and 24. Some help toward the recognition of these may be had from the table on pages 40 and 41, which contains brief hints, also, of the situation they occupy in the water and the role they play in the food consumption.

There are leeches, and fresh-water sponges and bryozoans, and a host of lesser forms of many groups, mostly too small to

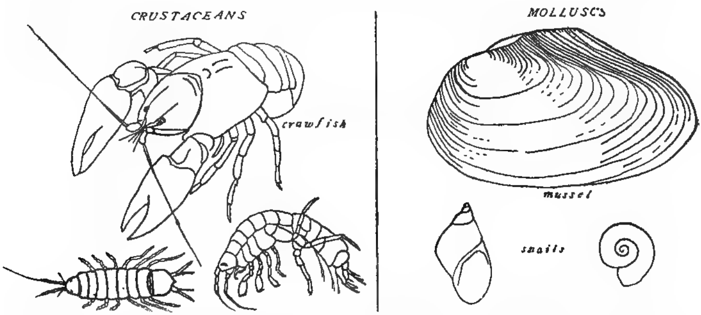

FIG. 20. Some common crustaceans and molluscs: crawfish, with the asellus at the left and the scud (*Gammarus*) at the right;—also, a mussel and two snails; (*Limnæa*, on the left, and *Planorbis* on the right).

be seen without a lens and too numerous even to be mentioned here. The water is like another world of life, containing a few forms that are directly useful to us and many more that furnish forage for these; containing a few that are noxious when adults, such as black-flies, horse-flies and mosquitoes, and a host of other forms, all of interest to the naturalist, but not known to be of practical importance. They are all a part of the native population of the stream, and each has a share in carrying on its natural social functions.

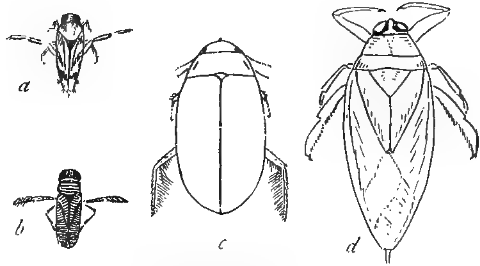

FIG. 21. Adult aquatic insects: *a*, the back-swimmer (*Notonecta*); *b*, the water-boatman (*Corixa*); *c*, a diving-beetle (*Dytiscus*); *d*, a giant water-bug (*Benacus*).

In the water as on land, green plants represent the great producing class, while animals and parasitic plants are the consumers. And among the animals there are herbivores and carnivores, parasites and scavengers.

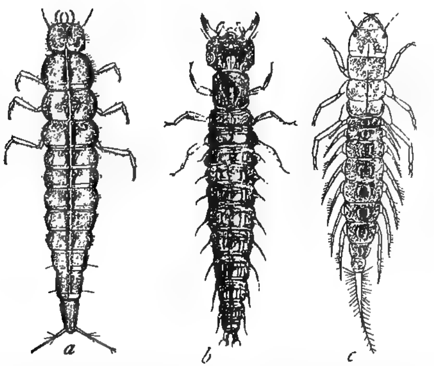

FIG. 22. Aquatic insect larvae: *a*, a diving-beetle, *Coptotomus* (after Helen Williamson Lyman); *b*, a dobson larva, or hellgrammite, *Corydalis cornuta* (after Lintner); *c*, an orl-fly larva, *Sialis* (after Maude H. Anthony).

One who but casually examines the animal life of the stream is apt to see chiefly carnivorous forms; for these are most in evidence: and here, as elsewhere, herbivores, being poorly

Single distinctive characters

1. Forms in which the immature stages (commonly known as *nymphs*) and are plainly visible upon the back.

COMMON NAME	ORDER	FORM	TAILS
Stone-flies	Plecoptera	depressed	2, long
May-flies	Ephemerida	elongate, variable	3, long: (rarely 2)
Damsel-flies	Odonata	slender, tapering rearward	see gills
Dragon-flies	Odonata	stout, variable	very short, spinelike
Water-bugs	Hemiptera	short, stout, very like adults	variable

2. Forms in which the immature stages differ very greatly from the adults internally and not visible from the outside, and having the legs shorter, rudi-

COMMON NAME	ORDER	LEGS	GILLS
Water-moths	Lepidoptera	3 pairs of minute jointed legs followed by a number of pairs of fleshy prolegs	of numerous soft white filaments, or entirely wanting
Caddis-worms	Trichoptera	3 pairs rather long	variable or wanting
Orl-flies	Neuroptera	3 pairs shorter	7 pairs of long, lateral filaments
Dobsons	Neuroptera	3 pairs	tufted at base of lateral filaments, or wanting
Water-beetles	Coleoptera	3 pairs	usually wanting
True flies	Diptera	*wanting*	usually only a bunch of retractile anal gills

3. Further characters of some common dipterous larvae. These are distin-

COMMON NAME	FAMILY	HEAD	TAIL
Crane-flies	Tipulidae	retracted and invisible	a respiratory disc bordered with fleshy appendages
Net-veined midges	Blepharoceridae	tapering into body	wanting
Mosquitoes	Culicidae	free	with swimming fin of fringed hairs
Black-flies	Simuliidae	free	with caudal ventral *attachment disk*
True midges	Chironomidae	free	tufts of hairs
Soldier-flies	Stratiomyiidae	small, free	floating hairs
Horse-flies	Tabanidae	acutely tapering	tapering body
Snipe-flies	Leptidae	tapering, retractile	with two short tapering tails
Syrphus-flies	Syrphidae	minute	extensile process as long as the body
Muscid flies	Muscoidea	rudimentary	truncated

are printed in italics.

are not remarkably different from the adults. The wings develop externally

Gills	Other Peculiarities	Habitat	Food-Habits
many, minute, around bases of the legs	....	rapids	mainly carnivorous
7 pairs *on back*	....	all waters	mainly herbivorous
3 leaflike *caudal gill-plates*	immense grasping lower lip	slow and stagnant waters	carnivorous
internal gill chamber at end of body	immense grasping lower lip	slow and stagnant waters	carnivorous
wanting	*jointed beak* for puncturing and sucking	all waters	carnivorous

of the same species, being more or less wormlike, having wings developed mentary, or even wanting (*larvae proper*).

Rear End of Body	Other Peculiarities	Habitat	Food Habits
a pair of fleshy pro-legs with numerous claws on them	....	still waters	herbivorous
do., with paired larger hooks at tip	mostly living in portable cases	all waters	mostly herbivorous
a long tapering tail	....	gravelly beds	carnivorous
paired hooked claws	....	all waters	carnivorous
variable	....	slow or stagnant waters	carnivorous
see next table	head small, often apparently wanting	all waters	see next table

guished from aquatic larvae of other groups by the absence of true legs.

Fleshy Legs, or Pro-legs	Other Peculiarities	Habitat	Food Habits
variable	....	shoals	herbivorous mostly
wanting	flat *lobed body* with *row of ventral suckers*	rocks in falls	diatoms, etc.
wanting	*swollen thoracic segments*	pools (at surface)	herbivorous
one beneath the mouth	"*fans*" on head for food-gathering	rocks in rapids	herbivorous
1 in front, 2 at rear end of body	live mostly in soft tubes	all waters	herbivorous
wanting	depressed form	still water (at surface)	herbivorous
wanting	tubercle covered *spindle-shaped body*	beds in pools	carnivorous
stout paired beneath	....	rapids under stones	carnivorous
wanting	....	shallow pools	
usually wanting	....	....	....

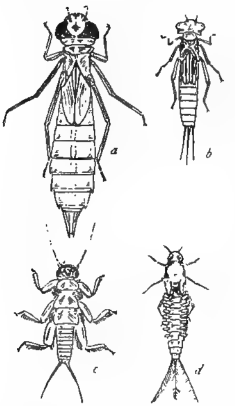

FIG. 23. Immature stages of four common neuropterous insects: *a*, a dragon-fly (*Anax junius*); *b*, a damsel-fly (*Amphiagrion amphion*); *c*, a stone-fly (*Acroneuria sp?*); *d*, a may-fly (*Callibætis sp?*).

equipped for fighting, cannot afford to be conspicuous. But if one will reflect that carnivores can not maintain themselves indefinitely by eating one another, and will look a little more closely, he will find plenty of the herbivorous forms. These are they whose economic function is that of "turning grass into flesh, in order that carnivorous Goths and Vandals may subsist also, and in their turn proclaim 'All flesh is grass'" (*Coues*). The most widespread, abundant, and important of the herbivores of the stream are apt to be the scuds (Fig. 20), the may-fly nymphs (Fig. 23,*d*), and the larvæ of midges (Fig. 24,*d*).

Study 4. The Farm Stream

This study assumes that there is accessible some creek, or large brook or small river, having rapids and shoals and pools and reed-grown bays in it, all easy of access. If the banks where the work is to be done are too soft, rubber boots for wading, or temporary walks that will make wading unnecessary, will have to be provided. Each student should be provided with a dip-net for catching specimens, a shallow dish in which to examine them, a lifter with which to transfer them, and a few vials in which small specimens may be examined with a lens.

A normal condition of the stream is necessary; high water and great turbidity will render the work unsatisfactory.

Program—Go over the area marked for examination, beginning with the pools having mud bottom, and proceeding to the rapids. Note the extent of mud, sand, gravel, rubble, and flat-stone bottom, and their relation to slope and current. Note also the physical conditions that organisms have to meet in each situation.

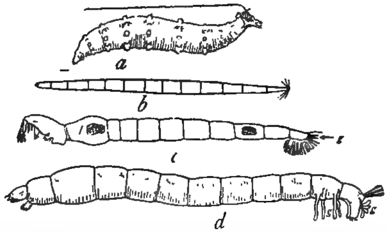

FIG. 24. The larvae of four two-winged flies (*Diptera*): *a*, the swale-fly (*Sepedon*), withdrawing beneath the surface film of the water; *b*, the punkie (*Ceratopogon*); *c*, the phantom midge larva (*Corethra*); and *d*, the common midge (*Chironomus*).

Collect and examine the commoner plants and animals, first of the rapids and then of the still water, omitting the fishes, (except to note where they are seen.)

The Record of this study will consist of:

I. A map, on which are indicated as clearly as possible:

1. Waterfalls and riffles.
2. The extent of each sort of bottom.
3. The principal plant beds.
4. The fish pools.

II. List of all the water plants observed, arranged in a table with column headings as follows:

Name (this will be supplied by the instructor).
Grows where (that is, in which of the situations examined).
Depth of water (approximate).
Growth-habit (simple or branched, erect or trailing, stemless, leafless, etc.).
Remarks.

III. List of all the water animals observed, arranged in a table with column headings as follows:

Name (this will be supplied by instructor, if needed).
Lives where (in which of the situations examined).

At what depth (approximate).

Eats what (your own specific observations rather than general data taken from table).

Habits of locomotion (walking, swimming, looping, etc.).

Remarks.

IV. A summary and comparison of the chief differences between the several situations, and of the differences in abundance and kind of plant and animal inhabitants.

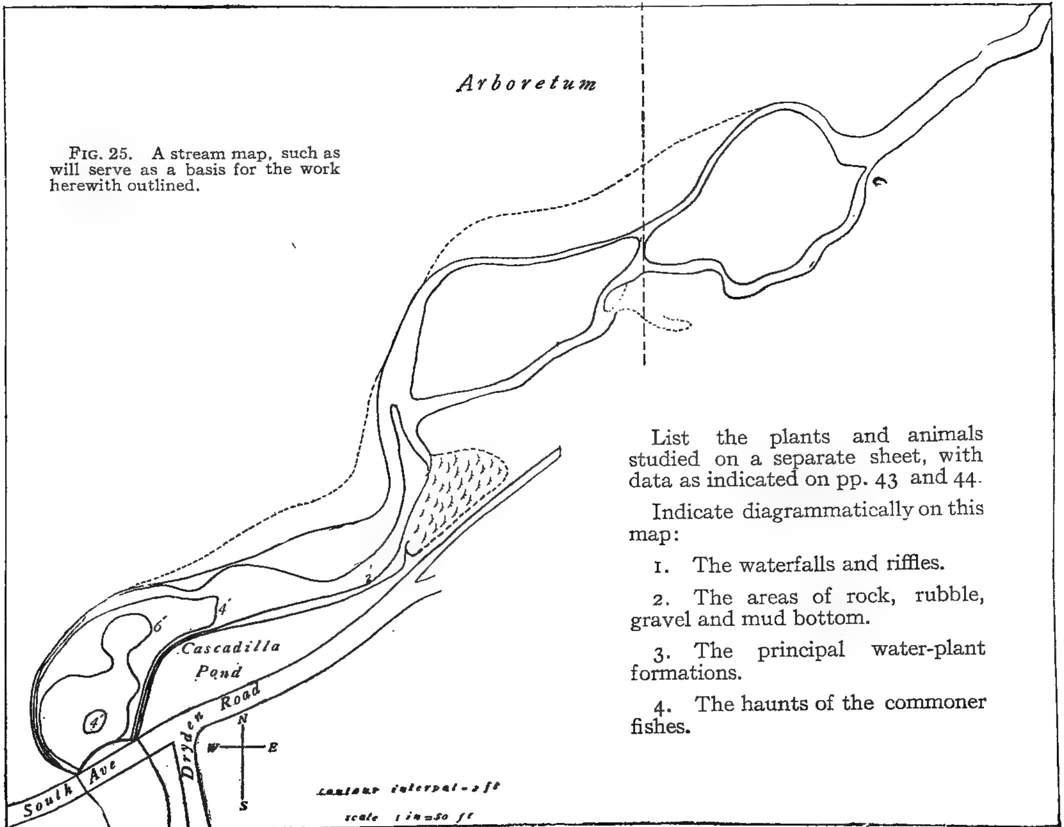

FIG. 25. A stream map, such as will serve as a basis for the work herewith outlined.

List the plants and animals studied on a separate sheet, with data as indicated on pp. 43 and 44.

Indicate diagrammatically on this map:

1. The waterfalls and riffles.

2. The areas of rock, rubble, gravel and mud bottom.

3. The principal water-plant formations.

4. The haunts of the commoner fishes.

V. THE FISHES OF THE FARM STREAM

"To dangle your legs where the fishing is good
Can't you arrange to come down?"

—Riley (*To the Judge*).

Before the days of husbandry, man's supply of animal food consisted of fish and game. Edible things found running on land were game: if found in the water, they were fish. So we have the names shellfish, crawfish, cuttlefish, etc., still applied to things that are not fishes at all. The true fishes were, and probably always will be, the chief staple crop of the water.

While waters were plenty and men were few, fishes furnished the most constant and dependable supply of animal food. The streams teemed with them. There were many kinds. They were easily procured. Before there were utensils, fishes were spitted over an open fire, or roasted in the coals. But ancient and important as the fish supply has been to us, we have not taken measures adequate to its preservation. We have cared for the crops of the field and the

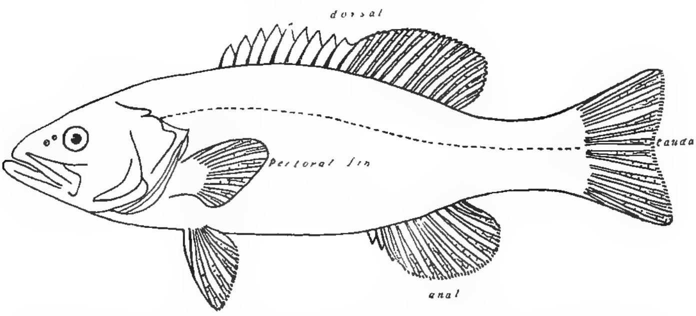

FIG. 26. Diagram of a fish (the black bass) with the fins named on the diagram: *ventral fin* is also called *pelvic*. Drawing by Miss Dorothy Curtis.

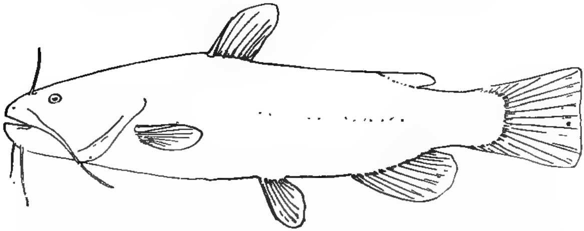

FIG. 27. The common bullhead. A race of short-horned bullheads is much to be desired.

garden, and have neglected most of the others. The backward state of fish culture among us may be expressed by saying that we have developed no means of growing natural forage for fishes or of managing them in ordinary waters in pure cultures under control, and we have hardly any valuable cultural varieties.

Many of our wild fishes, however, are excellent: the basses, and the perches, and the catfishes, for example. And for the most part they are very hardy and are widely distributed in our inland waters. If the fish fauna of any considerable stream be carefully explored, doubtless a number of good, bad, and indifferent kinds of fishes will be found. Bullheads and sunfishes are nearly everywhere in permanent fresh water; and what excellent materials for selection they offer! True, the bullheads are nearly all head and horns, but what flesh they have is excellent quality. What we need is to develop a race of shorthorns among them. If such improvement of them were made by selection and care as has been made with cattle and hogs, what fine table fishes we should have; and everybody might have them in his own water garden.

Fishes are the dominant animal forms in all fresh waters: in powers of locomotion they surpass all other aquatic creatures. Their fighting powers are good. Consequently we find them in full possession of the open waters, while most

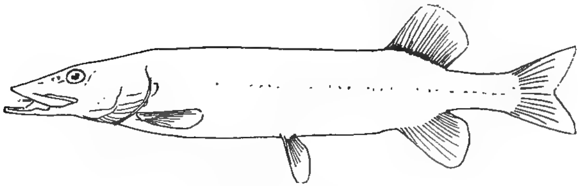

FIG. 28. The pike.

other dwellers in the stream are restricted to the shoals and to the shelter of rocks or of vegetation. Certain of them like the pike (fig. 28) are specialized for feeding at the surface: others, like the sucker (fig. 29), for feeding at the bottom; and the mouth is turned up or down accordingly. The best of them are carnivorous and eat habitually other smaller fishes. The rock bass seems to prefer crawfishes as food. Most of them eat the larvæ of may-flies and midges, though the pikes demand bigger game. The sheepshead eats molluscs, crushing the shells with its flat-topped molarlike teeth.

Fishes are among the most beautiful of living things. Their colors are splendid. Their motions are all easy and graceful. Their habits are most interesting and varied. Nearly all the common forms are included in six or seven families: the catfishes, the trouts, the pikes (including the pickerel), the suckers, the minnows (including the huge carp), the perches, and the sunfishes (including the basses). It is the purpose of the following study to promote acquaintance with some of these.

Study 5. Creek Fishes

A representative lot of a dozen or more of the larger common fishes should be available for this exercise. It were better to have most of them collected in advance and kept alive for examination. A seine may be drawn, or traps taken up, as a part of the exercise, but often there are uncertainties as to the catch, which are to be avoided. The living fishes may be displayed in aquaria set up on high benches, or the fishes may be strung singly to stakes in the shore and drawn forth for examination.

The program will consist (1) in whatever fishing is made a part of the class exercise; (2) then in a careful examination of the fishes of each species and a writing of their recognition characters in a table prepared after the manner indicated on pages 50 and 51.

The record of this study will consist in the completed table, together with notes on the places where each species was taken and the method of its capture.

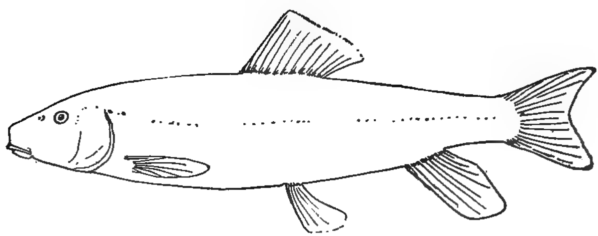

FIG. 29. The sucker.

Name	Size		Form[3]	Scales[4]	Mouth[5]
	Length[1]	Ratio[2]			

[1] Length (when grown) in inches.
[2] Ratio of depth to length.
[3] Cylindrical, depressed, or compressed.
[4] Large or small or wanting.
[5] Large or small, terminal or inferior.

FINS			REMARKS
Dorsal[6]	Caudal[6]	Pelvic[7]	

[6] Diagram side view. [7] Thoracic or abdominal.

VI. PASTURE PLANTS

"Thou crownest the year with thy goodness; and thy paths drop fatness.
They drop upon the pastures of the wilderness: and the little hills rejoice on every side.
The pastures are clothed with flocks; the valleys also are covered over with corn; they shout for joy, they also sing."

—A Psalm of David (Psalm 65:11–13).

Before there were tilled fields, there were green pastures. The grazing animals made them. They cropped the tall vegetation and trampled the succulent herbage, and pasture grasses sprang up and flourished in their stead. Wherever there were pieces of level ground frequented by wild cattle, there pastures developed.

Pasture plants have seeds that are readily carried about and distributed by the muddy feet of cattle. They also have good staying qualities: once rooted in the soil, they will live long even where they can grow but little. So we find them growing everywhere, flourishing in the light, hanging on in the shadow, as if waiting for a chance—even in the deep shadow of the woods. Cut down the trees, and the grasses appear. Keep all the taller plants cut down, and the grasses spread and form a meadow. Brush-covered hills are sometimes changed into pastures simply by cutting them clean and turning in sheep. More sheep are kept on them than can find good forage; so, they are reduced to eating every green thing. It is hard on the sheep, but the grasses, relieved of the competition of the taller plants, spread in spite of very close cropping. After two or three seasons, the hills are turf-covered: the woody plants are gone. This is a crude method of pasture making, and one that is coming to be practiced in our day more often with goats than with sheep, goats having a wider range of diet; but it illustrates some fundamental conditions. Keep almost any weed patch mown, and it soon will be grass-covered.

The valuable pasture plants are all low-growing perennials, that spread over or through the soil and take root widely, and that are uninjured by the removal of their tops. Wherefore, an amount of browsing and trampling that is sufficient to destroy their competitors, leaves them uninjured and in possession of the soil. We raise some of these pasture grasses on our lawns. We crop them with a lawn mower to make them spread, and we compress the soil about them with a heavy roller, and a turf results. But these operations are performed in nature by means of muzzles and hoofs.

If you would understand the conditions pasture plants have to meet you can hardly do better than to cultivate friendly relations with some gentle old cow, and follow her awhile about the pasture watching the action of her muzzle and hoofs. Watch her crop the grass. See how she closes on it, and swings forward and upward, drawing it taut across the edges of her incisors (these being in her lower jaw). Hear the grass break at the joints, and tear and squeak as internodes are withdrawn from their sheaths. Then pull some grass by hand, and observe that while single leaves may break anywhere, the stems for the most part break at the joints, which are so formed that little injury to the plant results. The parts necessary for re-growth remain attached to the soil and uninjured. Then try the tops of any common garden weeds, and observe that, for the most part, they pull bodily out of the ground. Herein appears one of the characteristics of good pasture plants: they must be able to withstand cropping—even close cropping.

Then watch the old cow's hoofs as she walks about over the turf. See how they spread when she steps in a soft place. Look at her tracks and see how the sharp edges of her hoofs have divided the turf and spread the roots and underground stems of the grass asunder. If broken, take up the pieces and observe that each is provided with its own roots. Thus, a moderate amount of trampling only serves to push the grasses into new territory. Think how disastrous in comparison would be the descent of this bovine's hoofs upon the balsams and cabbages of the garden.


FIG. 30. The wire rush (*Juncus tenuis*).

So, the chief perils to plants in the pasture are of three sorts. The danger of death from being eaten, from being pulled up and from being trampled. To be sure, both browsing and trampling may easily be overdone, and the hardiest of plants may be exterminated. This occurs in the places where the herds habitually stand in the shade of trees. Furthermore, mere hardiness will not qualify a plant to be a good member of the pasture society. The first requisite of all is that it shall be palatable and nutritious. The little wire rush (Fig. 30) is among the hardiest of pasture plants, growing habitually in the very edges of the path, but it is well nigh worthless as forage.

The most valuable plants for permanent pastures are all grasses. Indeed, the very best of them are native grasses that exist today just as they came to us from the hand of nature. The only selection that has been practiced on them is the natural selection that through long ages has eliminated such sorts as are not equipped to meet the requirements set.

Under certain conditions white clover and some other plants are useful members of permanent sod.

There are many other plants in the pasture, which we consider undesirable there, and hence call weeds. They mostly produce abundant seed and have excellent means of giving it wide dispersal. Many seeds find openings among the grasses.

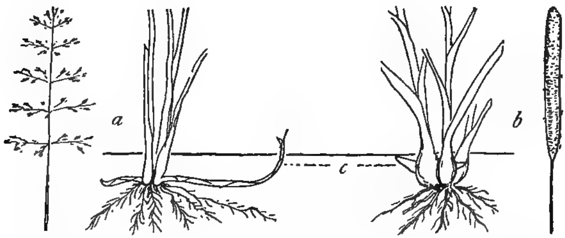

Fig. 31. Blue-grass (*a*) and timothy (*b*): flowering spikes and roots; with the two modes of producing new shoots underground shown at (*c*).

A few of these plants survive by virtue of the same qualities that save the grasses. Some like the thistles and the teasel are spiny, and able to ward off destroyers. Many, like the mullein, the buttercup, the daisy and the yarrow, are unpalatable and are not sought by the cattle. Many grow well underground with only their leaves exposed to danger of trampling. If some leaves are cut off, new ones will promptly grow. Then, after a long season of growth, they suddenly shoot up flower stalks into the air, and quickly mature fruit. They do this, too, at the season of abundant grasses, when their exposed shoots are least endangered by close cropping. Some, like the dandelions and the plantains, produce so many flower stalks that they can survive the loss of some of them. Finally there are some, like the speedwells and the chickweeds, so small that they are inconsequential. They merely fill the chinks between the others.

There is one tree that regularly invades our neglected pastures. It is the hawthorn. The cattle browse on it, but they leave a remnant of new growth every year. So its increase is very slow until it gets beyond their reach—slow but sure. All the while its dense cone of stubs is shaped smoothly as in a lathe. But once emancipated from their browsing, it suddenly expands upward into the normal form of the spreading hawthorn tree.

Study 6. Pasture Plants

Any old pasture will do for this: the more neglected, the more interesting its population is likely to be. The equipment needed is merely something to dig with. Let all the work be done individually.

The program of work will consist in digging up one by one, first the forage plants and then the weeds, and examining them, root and branch. Give special study to the forage plants—the grasses and the clovers. Dig them up and pull them up. Find their predetermined breaking points. Observe their mode of spreading through the soil. Trample them, especially with the heels of your shoes. Observe their preparedness for the rooting of dismembered parts. Observe in the weeds also the various ways in which they avoid being pulled up or eaten or trampled out of existence. Also stake out a square yard of typical pasture and take a census of its plant population.

The record of this study will consist in:

1. Annotated lists of:
   (a) Forage plants.
   (b) Weeds (further classified if desired), with indications of size, duration (whether annual, biennial, or perennial), mode of seed dispersal (whether by wind or water or carried by animals on their feet or in their wool). Vegetative

modes of increase, such as stolons, runners, offsets, suckers, etc.; noting also special fitness for pasture conditions, as indicated above.

2. Diagram a vertical section of the soil and on it show form and growth-habit of half a dozen of the more typical pasture plants, such as the following:

(a) A grass that spreads by underground branches, like a bluegrass.
(b) A bulbous grass, like timothy.
(c) A creeping plant, rooting along the branches, like white clover.
(d) A rosette-forming, tall, single-stemmed biennial, like teasel or dock.
(e) A rosette-forming, tap-rooted dwarf, like dandelion.
(f) A fibrous-rooted perennial, like the daisy, or buttercup, or yarrow.

3. A complete census of the plant population of a single square yard of old pasture: names of plants and numbers of individuals. It will be necessary to state how you have counted individuals of the multiple-rooted forms.

VII. THE EDIBLE WILD ROOTS OF THE FARM

"The sunshine floods the fertile fields
Where shining seeds are sown,
And lo, a miracle is wrought;
For plants with leaves wind-blown,
By magic of the sunbeam's touch
Take from the rain and dew
And earth and air, the things of life
To mingle them anew,
And store them safe in guarding earth
To meet man's hunger-need.

Then lo, the wonder grows complete;
The germ within the seed
Becomes a sermon or a song,
A kiss or kindly deed."

—Dean Albert W. Smith.

Nature sometimes caches her stores of provisions—hides them underground. She puts them up in mold-proof packages, and stows them away in the earth, where, protected from sudden changes of temperature, they keep for along time. It is chiefly a few of the mammals that are the recipients of this bounty—those that can burrow in the soil and those that can root. The burrowers are numerous, and of very different sorts. They all have stout claws on their fore feet. The rooters are few: only the pigs and their nearest allies. These have a most unique and beautiful digging apparatus, happily placed on the end of the nose, where it is backed by all the pushing power of a stout body, and where it is directed in its operations by the aid of very keen olfactories. This is a most efficient equipment for digging. If any-

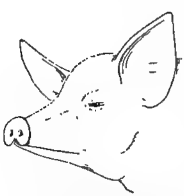

FIG. 32. Nature's most efficient implement of tillage. But, alas! a little bit of metal ring thrust into the sensitive base of the "rooter" renders this beautiful contrivance inoperative, reduces the efficiency of his pigship to the common level of mammalian kind, and leaves him endowed only with his appetite.

thing good to eat is buried in the earth, trust to a normal pig to find it. The wild ruminants also dig to a certain extent with the hoofs of their fore feet.

Digging for roots has been in all ages an important and necessary occupation of mankind. Once it was done by everybody. For ages it was the work of women, while men, in the division of labor, assumed the more dangerous and more exciting tasks of hunting and fighting. Now it is coming to be the work of machinery, handled by men. Once all the roots were wild roots, and they were used in very great variety. Now comparatively few, which have been selected and improved, are cultivated. The majority of those that have served as human food are neglected. But they may still be found in the wildwood. Nature made them hardy and fit. They are still with us unimproved—and unsubdued.

These roots, which are nature's underground food stores, are, many of them, botanically speaking, not true roots at all: they are merely the underground parts of plants, that have been developed as food reserves: and they are primarily for the benefit of the plant species producing them. They are the products of the growth of one season, stored up to be used in promoting the growth of new individuals the next season. Some, like the potato and other tubers, are modified underground stems; others, like the onion, are bulbs. They contain food products far more watery and less concentrated than the nuts and the grains. Their flavors are less choice than those of the fruits; they are of the earth, earthy. There are few of them that we consider palatable without cooking. Many abound in starch, like the potato, and some, in sugar, like certain beets.

Of true roots that are fleshy, there are many to be found wild, but few of these are edible. The wild carrots and parsnips are insignificant as compared with cultivated varieties: the fleshy roots of weeds like the docks are inedible, and a few like the water hemlock (Fig. 33) are very poisonous. All the cultivated sorts, radishes, beets, turnips, carrots, parsnips, chicory, etc., are natives of the old world. The last named, where cultivated, is chiefly used to make an adulterant for coffee, and has scarcely any nutritive value.

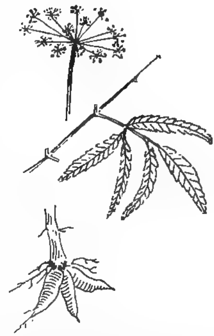

FIG. 33. The poison hemlock: portions of flower cluster, leaf and root.

American tubers are much more valuable. Indeed, the most valuable root crop in the world is the potato. The potato crop stands among our crops second only to the wheat crop in cash value. And an acre of potatoes may produce as much human food as ten acres of wheat. The only other native tuber that is extensively cultivated is that of the artichoke (*Helianthus tuberosus*) which maintains itself wild in great patches in many a rich bottomland thicket. The artichoke is able to win out over the other herbaceous perennials by reason of its sheer vegetative vigor: it overtops them all and gets the sunlight. And when it blooms, it overspreads the thicket with a blaze of yellow sunflowers in late summer. There is another native tuber, however, of great promise: it has higher nutritive value than the potato and is very palatable; it is the so-called groundnut (*Apios tuberosa*). The plant is a vine, that grows in moist thickets and clambers over low bushes. It bears brownish purple, violet-scented, papilionaceous flowers in dense clusters in midsummer. The tubers are borne on slender underground stems, often a number in a row, and are roundish or pear-shaped, very solid, and when cut, exude a milky juice, like a sweet potato. Doubtless, this valuable plant, which furnished the Indians with a dependable part of their living, would have received more attention among us had it been adapted by nature to ordinary field conditions. But it grows in moist or even wet soil and in partial shade. The Indian cucumber-root (Fig. 34) bears another sort of tuber that might well qualify it for a place among our salad plants, were the plant adapted to fields; but it grows in leaf mold in the shade of dense thickets.

The wild bulbs of the scaly sort that are edible, are the wild onion and a few of its relatives, the wild leeks and garlics. These are valued not for nutritive value, but for flavoring. Here, again, the cultivated exotic varieties are superior to the wild native ones.

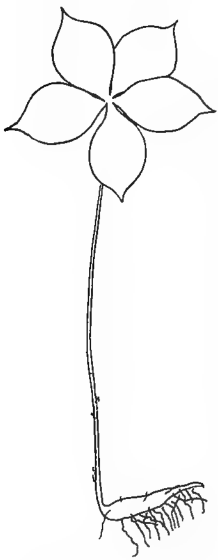

FIG. 34. Indian cucumber-root (*Medeola*), an excellent salad plant.

There are a number of interesting wild aroids, producing solid bulbs or corms, which were food for the red man, but which we do not use. They grow mostly in wet soil. They are the arrow arum, the skunk cabbage, the Jack-in-the-pulpit, etc. The related taro is a valuable food plant in the Hawaiian Islands and throughout the South Seas. Like these, it is somewhat coarse, and does not keep well after gathering. So it gets into our markets only after being dried and ground into flour. The fierce acridity of the Jack-in-the-pulpit, which renders it inedible when raw, is entirely removed by cooking.

Among the aroids is another that is worthy to be mentioned not as a food plant, but as one that has been valued for its pungency, and for the magic powers widely believed to inhere in its root. It is the sweet flag (*Acorus calamus*,

Fig. 16,*b*); its charmed product, "calamus root." Dried it is often nibbled by school children, and it is candied by their mothers, especially in New England, and served as a condiment.

There are a number of other native "roots" of semi-aquatic plants that were eaten by the aborigines. The biggest "root" of all was the rhizome of the spatter-dock—several feet long and often six inches thick, coarse and spongy, and full of starch. The rootstocks of the lotus and of several other members of the water-lily family are edible; also, the subterranean offsets of the cattail. These were and are favorite foods of the muskrat, too. The red man ate also the rootstocks of the arrowhead and the underground stems of the false Solomon's seal. Then if we count the exotic, cultivated peanut in its pod a root crop, we shall have to count the native hog peanut (*Amphicarpæa monoica*, Fig. 36), with its more fleshy and root-like subterranean pod, also as one.

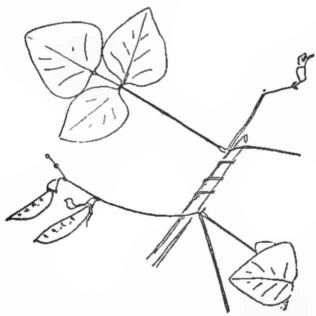

Fig. 35. A portion of a vine of the hog peanut, bearing both flowers and seed pods.

It is a most interesting plant. It grows as a slender twining vine on low bushes in the edges of thickets. It produces pale blue flowers in racemes along the upper part of the stem, followed by small, beanlike pods. It develops also scattered, colorless, self-fertilizing flowers on short branches at the surface of the soil. These are very fertile. They push into the soil and produce there mostly one-seeded, roundish, fleshy pods about half an inch in diameter. These are the hog peanuts.

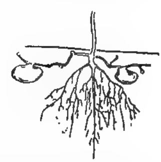

Fig. 36. The root and the underground "nuts" of the hog peanut.

So, if we go out to examine the plants producing nature's root crops, we shall find them a mixed lot of solanums, legumes, aroids, etc., growing in all kinds of situations, wet and dry, in sun and in shade, and producing food reserves that have little in common either in character or in content.

Study 7. Wild Root Crops of the Farm

This study will consist in an examination of the edible and the poisonous roots found growing wild on the farm. Such exotics as parsnip, carrot and chicory will be found growing as weeds in the field. The native root crops will have to be sought in the woods and thickets and in swampy places.

The equipment needed will be a knife, a bag and a stout digging tool of some sort.

The program of work will consist of a trip to selected places where the wild roots may be found in abundance, the examination of them one by one as to all their parts, measuring of the roots, slicing of them, tasting of them, testing of them, etc., and recording their characters.

The record will consist of:

1. A table prepared with headings as indicated on pages 64 and 65 and carefully filled out for about a dozen species.

2. Simple sectional diagrams representing the structure of (1) some wild tuber; (2) a scaly bulb; (3) a solid bulb or corm; (4) a fleshy rhizome; and (5) a true fleshy root.

FIG. 37. *Apios Tuberosa.* (Drawn by C. P. Alexander)

NAME	Kind of Plant[1]	Grows Where	Nature of "Root"[2]

[1]Tree, shrub, herb. vine, etc aquatic, climbing, etc.
[2]Root, tuber, bulb, corm, rhizome, offset, etc.

	Form[3] and Size[4]	Qualities	Uses	Remarks

[3] Diagram. [4] Length × width in mm.

VIII. THE NOVEMBER SEED-CROP

"'Tis all a myth that Autumn grieves
For, list the wind among the sheaves;
Far sweeter than the breath of May."

—Samuel M. Peck (*Autumn's Mirth*).

November, in our latitude, is nature's season of plenty. Her work of crop production is done. Living is easy for all her creatures. The improvident may have their choice of fruits, or may eat only of the seeds that are best liked and most easily gathered. The frugal and foresighted may gather winter stores. It was no mere arbitrary impulse of our Puritan pioneers that settled upon November as the season of special Thanksgiving.

Nature's prodigality of seed production is for the benefit of her animal population. She gives them the excess. They in their turn are very wasteful in their handling of the seed. They never eat all that they gather, but scatter and lose some of it in places favorable for growth next season. Thus they aid in distributing and in planting the seed. The sleek and surfeited meadow mice scatter grains along their runways and never find them again, and these lost seeds are favorably situated for growth at the proper season. It is only a remnant of them that will escape the more careful search of the beasts when the hunger of the lean season is on, but so great is the excess of production, that this remnant is, in the nice balance of nature, sufficient to keep the species going.

It is a long, lean season that follows on November in our latitude, and the seed-crop, though abundant, is not sufficient to feed all the wild animal population. So nature takes various measures to eke it out. She puts to sleep in hibernation the great majority of animals. These include nearly all of the lesser animals and a few even of the larger ones, like the woodchuck, now fat and drowsy. She removes the greater number of the birds by migration to feed in summer climes. There remain to be fed through the winter only a small proportion of the birds and a larger proportion of the mammals, including ourselves. All these are by nature improvident—given to eating to excess when there is plenty, forgetting future needs. So, she makes it impossible that any lusty foragers, or all of them put together, shall be able to dissipate and waste her patrimony. She keeps it in a considerable part from them against the hour of need. If she grows luscious fruits which, when ripe, will fall into their mouths she, also grows roots underground, and imposes the labor of digging to get them. If some of her seeds ripen all at once and fall readily, others ripen at intervals, and are held tightly in their husks. It takes labor to get them. The animals that eat in winter have to work their way.

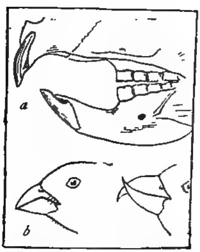

FIG. 38. Specialized seed-handling apparatus: *a*, the teeth of a porcupine; *b*, the beak of a finch; *c*, the beak of a crossbill, adapted for extracting the seeds of pine cones.

Nature's population is suited to her products. Her seed-eating rodents are all armed with stout chisellike teeth, adapted for cutting anything, from the nutshells to chaff. Her seed-eating birds are armed with stout, seed-cracking, husk-opening beaks. Her little birds are agile, and can cling with their feet to swaying twigs, and ravage the loaded seed-cones pendent upon them. The beaks of the crossbills are especially adapted to extracting the seeds from the cones of our evergreen trees.

The seeds we cultivate for food are cereals and lentils. With the exception of maize they came with our ancestors from other climes. Some of the native cereals have heavier seeds, but we have not learned their culture. We have been satisfied with the grains and pulse of our agricultural tradition. Wild rice is marketed locally at fancy prices; but it is still wild rice, gathered where nature produces it in the old way. There is no culture of it worthy of the name.

The cereals are mainly the edible seeds of grasses (*Gramineae*): the seeds of sedges (*Cyperaceae*), if edible, should perhaps be included; and there is one seed of very different botanical character, the buckwheat, a member of the jointweed family (*Polygonaceae*), commonly rated a cereal. We can find wild seeds of all these groups growing about us, some of them of good size and quality, but most of them far too small to be of possible value to us. The lentils are all members of the pulse family (*Leguminosae*), and their more or less beanlike seeds grow in two-valved pods. A few sorts of these protein-rich seeds will be found hanging in autumn. So great is the diversity according to climate, situation, and locality, that it is not possible to indicate what sorts of seeds are to be expected.

Besides the cereals and lentils there are other wild seeds, allied to those we cultivate, for minor uses: for their flavors, for the oils they contain, for their medicinal properties, etc. And there are many others that are of interest to us solely on account of the very special ways in which they contribute to the preservation of the species, by providing for their own dispersal. Some are armed with hooks or barbs that catch in the wool of animals (as indeed they do also in our own clothing), and thus they steal a ride, which may end in some new and unoccupied locality. These grow at low elevations—not higher than the backs of the larger quadrupeds. Some lightweight seeds develop soaring hairs, which catch the wind and by it are carried about. Some of the larger dry seeds of trees develop parachutes by means of which they are able to glide to a considerable distance from the place in which they grow.

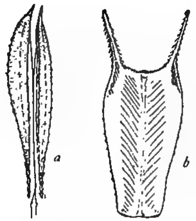

FIG. 39. Two "seeds" that often steal a ride with us: *a*, sweet cicely (*Osmorhiza*); *b*, pitchforks (*Bidens*).

Some take a ride by water, and to aid their navigation, develop water-repellant seed-coats, boat-shaped forms, corky floats, etc. Finally, some develop automatic ejectors like the capsules of the touch-me-not or jewel-weed, which collapse with explosive violence; or like the close-pinching hulls of witch-hazel, which shoot out the seeds to a distance of several yards. But most seeds are featureless, as regards means of dispersal. They merely fall, singly or in clusters, and are moved about only with the chance removal of the soil with which they mix.

Among the curious devices for securing the aid of amimals in seed-distribution none are more curious and interesting than those shown by the common umbelwort known as sweet cicely. The seeds (in their containers) are suspended in pairs at the end of two slender stalks, their sharp points directed downward, close to the stem. There are blunter points directed outward, but the barbs all over the surface appear to be directed the wrong way, as if to prevent getting caught in wool. But when a furry coat pushes against the outer end of a pair of these seeds, the blunt ends aided by the opposing barbs catch just deeply enough to turn the seeds end for end: in such position the long points enter deeply, the barbs hold securely and the attachment at the tip of the slender stalks is readily broken. This device needs, but to be seen in use to be appreciated.

Of wild seeds there is no end. It should be the object of the following study to survey a small area to find the wild allies of our cultivated seed crops, to observe the differences in size and containers, and, form the means of dispersal of as many as possible of the others.

NOTE:—In this book we speak of seeds not in the botanical sense of the term, but in the sense of it as used by the seedsman, and as understood by the general public. What we call seeds may, therefore, be true seeds (ripened ovules) like beans, or dry fruits (ripened pistils) like pitchforks (fig. 39), or dry fruits in their husks like oats.

Study 8. The November Seed-Crop

The program of this study will cover the exploration of a small area well overgrown with herbage. The variety of forms found will be greater if diverse situations, wet and dry, in sun and in shade, are included. Collect seeds of all kinds as encountered (omitting fleshy fruits and nuts), and note what sort of plant produces each kind. It will be well to take specimens of the seeds in their containers for closer examination at home.

The apparatus needed, besides knife and lens, will be a supply of envelopes, large and small, to hold the specimens collected, with names and data.

The record of this study will consist of annotated and illustrated lists of the seeds examined, arranged under as many categories as desired, such as: Cereals, Lentils, Seeds with hairs for air-drifting, etc. Let the list include such data as, kind of plant, size of seed (give measurements in millimeters: if very small, lay enough seeds, in line and touching each other, upon a metric rule—such as Fig. 1 on p. 12—to reach one centimeter, and divide for average diameter), characters affecting dispersal, characters of hull affecting its release, animals observed to feed upon it or to live within it, etc. Let the illustrations be simple outline sketches. As to names, if you do not know them, save time by asking an instructor or someone who does know them.

IX. THE DECIDUOUS TREES IN WINTER

"*Yet lower bows the storm. The leafless trees*
Lash their lithe limbs, and with majestic voice
Call to each other through the deepening gloom."
—J. G. Holland (*Bitter-sweet*).

Largest of living things, and longest of life are the trees. They have dominated the life of the greater part of the habitable earth by the sheer vigor of their growth. They have gone far toward making the world a fit place for us to live in. Our ancestors were woodsmen. The forests provided them homes and shelter and food. The plants we now raise in fields, and the animals we keep in stock pens, they found growing or running wild in and about the borders of the woods. The pioneers of our race in America were woodsmen. When they entered the states of the upper Mississippi Valley, they passed by the rich prairies and settled in the less fertile lands of the wooded hills. They wanted fuel and shelter and water. They sought for trees and springs: finding these, they trusted to find with them all else needful for a living.

The trees themselves contributed largely of the materials needed for the beginnings of human culture. A club for a weapon, a sharpened stick for an instrument of tillage, a hollowed log for a boat, and a sheet of bark for a roof—these were among the earliest of the agencies employed by man in mollifying and bettering his environment. It is a far cry from these few crude tree products to the numberless manufactured products of the present day. Our need of tree products has multiplied inordinately, but our ways of getting these have become circuitous. When an implement or a utensil of wood is placed in our hand, all shaped and polished and varnished, we scarcely think of the trees as its source.

The trees have not changed, but our relations with them have become remote. Let us renew acquaintance with a few at least of those that are native to our soil. Let us go out and stand among them, and feel, as our ancestors felt, their vigor, their majestic stature and their venerable age. To the ancients they stood as symbols of strength, of longevity, and of peace. Our poets love to celebrate the grace of the birch, the beauty of the beech, the lofty bearing of the pine and the rugged strength of the oak.

In winter, when the boughs are bare and stand out sharply against the background of the sky, the structural characteristics that best distinguish tree species are most readily seen. The forking and the taper and the grouping of the branches, the size and stoutness and position of the twigs, that are obscured by summer foliage, are now evident. By noting such characters as these we may learn to recognize the trees. The woodsman, who learns them unconsciously, knows them as wholes, and knows them without analysis by the complex of characters they present. But most of us will have to make their acquaintance by careful comparison of their characters separately. A few suggestions to that end here follow.

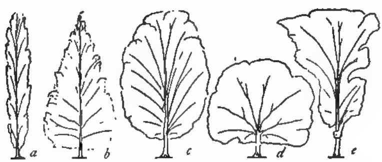

FIG. 40. Diagram illustrating the characteristics of form in some common trees: *a*, Lombardy poplar; *b*, white birch; *c*, sugar maple; *d*, apple; *e*, American elm.

There are a few deciduous trees that are instantly recognizable in winter by their color. Such are the white birch and the sycamore. The former is pure white on the trunk and larger branches: the latter is flecked with greenish white on the boughs, where the outer bark is shed in patches. The light satiny gray of the smooth beech trunks, and the mat gray of the rough white oak trunks, also help, although less distinctive to an unpracticed eye. Then there are tints of yellow in the twigs of certain willows, and of red in the twigs of the red maple and in the swollen buds of the linden.

Trees grown in the open develop a characteristic form and are recognizable by their general outline. Most strict and cylindric is the Lombardy poplar; most inclined and spread out upward into vaselike form is the beautiful and stately American elm. Most smoothly oval is the sugar maple and most nearly hemispherical is the apple. The soft maple and the hickories and many others take on an irregular and ragged outline. It is to be noted at once that in their youth these trees are all much more alike in form; also, that in the forest, close crowding reduces every kind of tree to a tall and slender trunk holding aloft as a crown the few branches that have been able to reach the light.

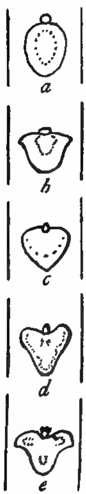

FIG. 41. Diagram of forms of leaf scar, and of grouping of bundle scars on twigs of: *a*, catalpa; *b*, black ash; *c*, horse chestnut; *d*, mockernut hickory; *e*, black walnut.

Much more dependable recognition characters are found in the structure of the tree-top. The trunk may tend to form a single axis as in the birch, or to split up early into long main branches as in the elms. The boughs may be short and stocky as in an old chestnut, or long and slender as in a beech. The twigs may be long or short stout or slender, and in position ascending, horizontal, or drooping. The bark may present many characteristic differences on trunk and bough and twigs, all of which need to be seen to be appreciated. But most positive of all the structural differences by which we may distinguish trees are some of the lesser characters in bud and leaf scar, a few of which are indicated in figure 41. The size

NAME	Growth Habit	Bark (mature)			Diam.[3]
		Color	Fissures[1]	Surface Layers[2]	
Oak, White					
Oak, Red					
Hickory[9]					
Chestnut					
Butternut					
Beech					
Birch[9]					
Maple[9]					
Elm[9]					
Ash[9]					
Basswood					
Sycamore					
Tulip Tree					
≠					
≠					

[1] Vertical or horizontal, simple or forking, deep or shallow, narrow or wide, etc.
[2] Hard or soft, adherent or loose, shedding in strips or in bits, etc.
[3] Smallest diameter of an average twig in mm.
[9] Specify which kind.
≠ Another kind of tree of your own selection.

Twigs	Buds				
Misc.[4]	Color	Form	Arrangement[6]	Leaf Scars[7]	Other Peculiarities[8]

[4] Peculiarities of form and color, lenticels, pith, etc.
[5] Sketch in simple outline.
[6] Opposite or alternate.
[7] Diagram, including bundle scars and stipule scars.
[8] Taste and smell, persistent leaves, nuts, fruit, stalks, etc.; also, flower, buds, etc. for next season.

and structure and color of the pith will often furnish good characters.

One who is learning them should employ his senses of touch, taste and smell as well as his sight. The toughness and pliancy of hickory twigs are revealed to our fingers. By biting twigs, distinctive flavors may be discerned in most twigs. Tulip tree is bitter, and sweet birch is deliciously aromatic. The buds of linden are mucilaginous when chewed. The twigs of walnut and sassafras have a smell that is instantly recognizable. There is no difficulty at all about knowing the principal kinds of trees if one will take the trouble to note their characteristics.

Study 9. Recognition Characters of Deciduous Trees in Winter

The object of this study is to learn to recognize a dozen or more common native trees. The apparatus needed by the student is only a lens and a knife: collective use may perhaps be made of an axe or a hooked pole.

The program of work should consist of a short excursion among the trees, first where growing in the open, to observe their outlines, and later, into the woods. The species selected for examination will be studied as to the characters indicated by the column headings of the table on pages 74 and 75.

The record of this study will consist in:

1. The completed tabulation.
2. Simple outline sketches of twigs:
   (a) Of ash and birch or elm.
   (b) Longitudinal sections of walnut or butternut.
   (c) Cross sections of oak and linden.

X. THE FARM WOOD-LOT

Much can they praise the trees so straight and high,
The sailing pine; the cedar proud and tall;
The vine-prop elm; the poplar never dry;
The builder oak, sole king of forests all;
The aspen good for staves; the cypress funeral;
The laurel, meed of mighty conquerors
And poets sage; the fir that weepeth still;
The willow, worn of forlorn paramours;
The yew, obedient to the bender's will;
The birch for shafts; the sallow for the mill;
The myrrh sweet-bleeding in the bitter wound;
The warlike beech; the ash for nothing ill;
The fruitful olive; and the platane round;
The carver holme; the maple, seldom inward sound.

—Spenser (*Faery Queen*).

When we know the trees by sight, then we may profit by an inquiry as to what kind of associations they form with one another. The farm wood-lot will be a good place for this, especially if it be, as it usually is, a remnant of the original forest cover. We will assume a small piece of wildwood not too closely or too recently cut over, with small areas, at least, of forest cover, and with a goodly remnant of brushwood. There are openings even in primeval forest, where giant trees have fallen, letting in a flood of light. In such places the trees of the undergrowth lift their heads and bushes flourish for a few years, rearing a generation and sending forth their seeds before a new growth of trees of the forest cover overtakes and overtops them. All about the borders of the wood-lot will be found such a growth of lesser trees and shrubs, massed against the light, and backed up against the wall of the forest.

Within the wood, where the larger trees are growing closely, their crowns touching each other, there will be found but a scanty growth beneath them of spindling small trees and of straggling shrubs. These will often show a fairly distinct stratification of their crowns at two levels, with scattering low shrubs nearer to the ground. This is the way in which, left to themselves, each "finds its level" and its proper situation. Too much interference of the axe may keep down some of them and may make unusual opportunities for others; but it does not change the nature or needs of any of them.

The groupings of the trees of different kinds will be seen to differ obviously, according to their several modes of reproduction. Copses of young trees, clustered about old ones, will be found springing up as "suckers" from the spreading roots of beech and choke-cherry and nanny-berry. Thickets composed of a mixture of tree-species spring up as seedlings in the place where a giant of the woods has fallen, leaving a good site temporarily unoccupied. In such a place the struggle for existence is apt to be severe. Groups of a few trees on a common root result from the growth of sprouts from stumps. Some trees, like the chestnut, when cut will come again unfailingly, and replanting is unnecessary for their maintenance. Others, like the white pine, rarely sprout from the base when cut down, and are renewed only from seed. Most trees sprout more freely if cut (or burned) when young. Dozens of sprouts will promptly spring from a healthy stump of oak or elm, but only a few of them—two or three or four as a rule—can grow to full stature: the others are gradually eliminated in the competition for light and standing room. The changes in composition of the wood-lot that follow in the wake of the ax are not so great as one would at first suppose; for nature, if unhindered by fires or by grazing, has her own ways of keeping a place for each of her wild species.

Let us study the wood-lot first to see what nature is trying to do with it, and to find out what kinds of woody plants she is endeavoring to maintain there. There will be time enough later to find out which of them are the best producers of fuels, posts and timbers, and which are the "weed species."

Study 10. An Examination of the Farm Wood-Lot

This study presupposes sufficient acquaintance with the superficial characters of trees, so that the principal kinds may readily be recognized. A small piece of woodland not more than a few acres in extent, with both forest cover and brushwood undergrowth remaining, should be mapped out and the map subdivided into a number of plots. The boundaries of the lot and of its subdivisions should be plainly marked out. The accompanying diagram indicates such preparation for a wood-lot study made on the Cornell University farm. There, the boundaries of the plots were made plain by white twine strung across the area at shoulder height. The tools needed will be a lens and a pocketknife.

The program of this study will consist in a slow trip over the wood-lot, and a careful examination of its population of woody plants:

1. To see what they are.
2. To see their relative abundance. (and)
3. To see what relations they bear to one another in the adjustment of the place.

The record of this study will consist in:

1. An annotated list of all the woody plants present, with notes on their size, relative abundance, and manner and place of growth.
2. Indications on the map of the dominant kinds of trees and shrubs in each plat.
3. A diagram of a vertical section of the forest cover (in some place to be designated by the instructor) showing a few characteristic plants of the several foliage strata present.

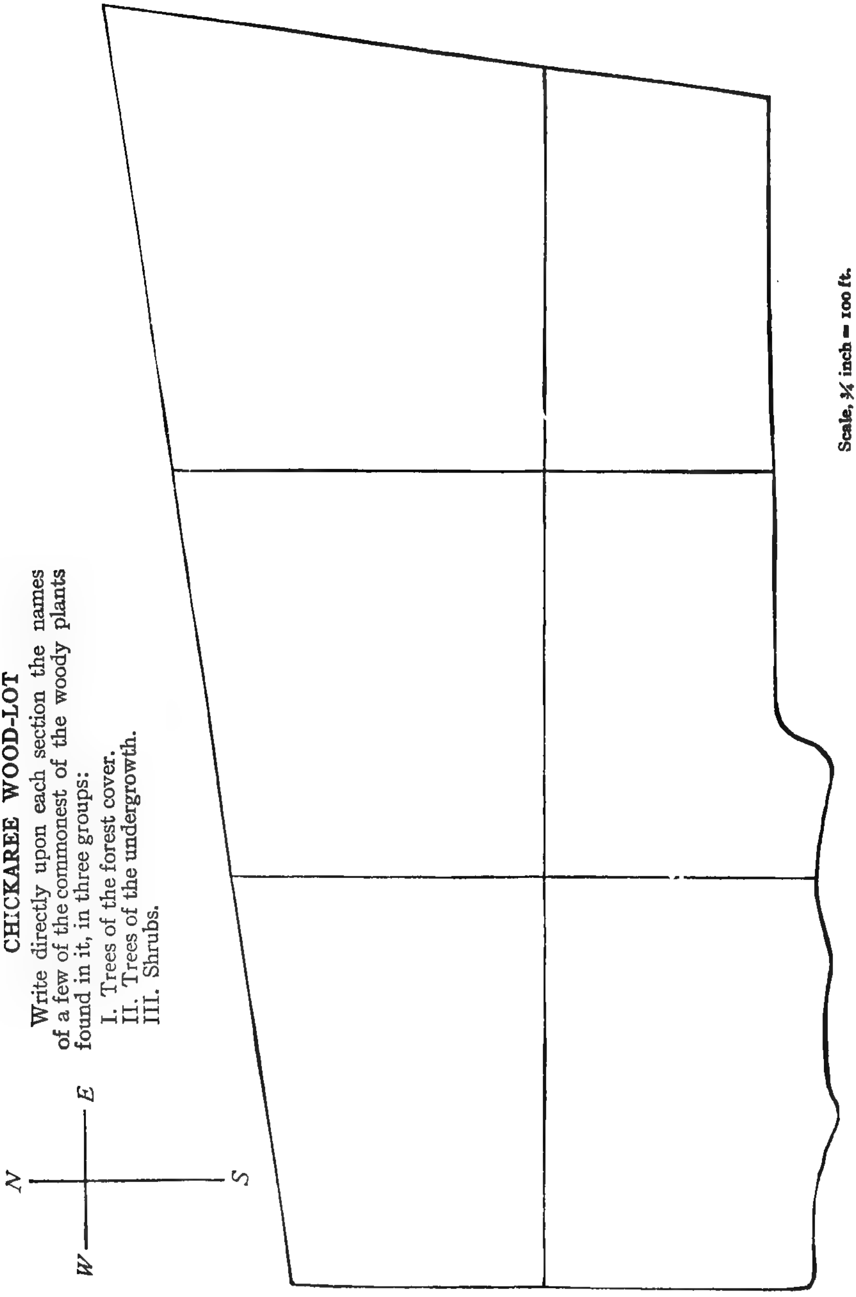

FIG. 42. A simple outline map with instructions for use in this study.

XI. THE FUEL-WOODS OF THE FARM

"We piled with care our nightly stack
Of wood against the chimney back,—
The oaken log, green, huge, and thick,
And on its top the stout back-stick;
The knotty fore-stick laid apart
And filled between with curious art
The ragged brush; then hovering near
We watched the first red blaze appear,
Heard the sharp crackle, caught the gleam
On whitewashed wall and sagging beam,
Until the old rude-fashioned room
Burst flower-like into rosy bloom."

—Whittier (*Snow-Bound*).

One of the first of the resources of nature to be brought into human service was fire. Lightning and other causes set wild fires going, and the savage following in their wake, found that they had done certain useful work for him. They had cut pieces of timber into lengths and shapes that were convenient to his hand. They had roasted wild roots and green fruits, and the flesh of wild animals overtaken, and had made them much more palatable. They had left piles of glowing embers beside which on a chill day he warmed himself. So he took a hint from nature, added a few sticks to the live embers, and kept the fire going. Strange that no other animal has done this simple thing! Afterwards he found out how to start a fire by rubbing wooden sticks, later by striking flint on steel, and still later by friction matches. The wonder of the savage has become commonplace.

Since cooking began, the word fireside has been synonymous with home. Fire has been the indispensable agent of many comforts, and womankind have been the keepers of it. The wildwood has furnished the fuel. In the wood there is great variety of it: fine twigs and coarse, and bark and splinters, all ready for use; and dead trees down, and green trees standing, needing cutting. Fire was the cutting agent first employed. Trees were burned down by building fires about their bases, and then by similar process they were cut in sections. It was only for long-keeping fires that such fuel was needed: there was always excess of kindling-stuffs available for making quick fires.

All wood will burn and give forth heat, but one who knows woods will not use all kinds: it is only the degenerate

FIG. 43. Western yellow pine dismantled and ignited by lightning (U. S. Bureau of Forestry).

modern, who will do that—who will go to the telephone and order a cord of wood without further specifications. Heavy, close-grained, hard woods as a rule burn more slowly and yield more heat than the lighter, more open-textured soft woods. Combustible resins vary the rate of burning, and the amount of heat produced: but the greatest differences in burning qualities are due to the amount of water present. A punky old log that when dry will burn like tinder, will soak up water like a sponge and, becoming "water-logged," will not burn at all. The modern householder, who keeps his fuels under cover, can get along without knowing about woods; much that it was essential the savage should know.

Building a camp fire in the rain is a task that takes one back again to the point where he needs to know wood fuels as nature furnishes them. Certain trees, like the yellow birch, produce the needed kindling material. Strip the loose "curl" from the outside bark, resin-filled and waterproof; shake the adherent water from it, and you can ignite it with a match. Go to the birch also or to the hemlock for dry kindling wood: the dead branches remaining on the trunks make the best of fagots, and are enclosed in waterproof bark. Splinter them and put them on the hot flame from the "birch curl", increase their size as the heat rises, and soon you have a fire that will defy a moderate rain. If you want to get much heat out of a little fire, feed it with thick strips of resinous hemlock bark, or with pine knots.

These are special materials, the presence of which often determines camp sites; though excellent, they are not essential. Any ready-burning dry wood may be kindled if splintered fine enough. Skill in fire-making consists not alone in the selection of suitable materials. They must be gradually increased in size as the heat increases, but not fed larger than can be quickly brought to the igniting point. Air must be admitted to combustion as well as wood; and as the heated air rises, the sticks must be so placed as to admit fresh air freely below. It is easy to smother a nascent fire. The sticks must be so placed that as the centers are burned, the remaining portions will be fed automatically into the coals. It is easy to so pile the fuel that a big central flame will be quickly followed by a black hollow central cavity, walled in by excellent but unavailable fuel. A well built fire does not suffer sudden relapses. The qualities of a good fire are: (1) a rapid increase to the desired size, and (2) steady burning (with no great excess of heat) thereafter.

FIG. 44. Dan Beard's famous fire of four pine knots: *a*, the preparation of one of the knots; *b*, the placing and igniting of them.

Dan Beard's famous camp-fire of four pine knots illustrates well the principles of fire making. Each knot is cleft in tapering shavings, which, ignited at their tips, gradually increase in size as the fire runs along them and the heat increases. They are set with thick ends upward and bases outspread, admitting air freely below. They are leaned against one another, and as they burn, they automatically come closer together.

The "top-fire" of the Adirondack woodsmen illustrates excellently a long-keeping fire, that is based on a discriminating knowledge of fuel values. Figure 45*a*, illustrates its construction at the start. Two water-logged chunks of hemlock that will not burn out, serve as "andirons" to hold up the sides and insure a continuous air supply from below. A smooth platform of freshly cut yellow birch poles is laid upon these. The yellow birch, even when green, has good fire-keeping qualities. Hickory would serve the purpose. An ordinary fire is then built upon the top of the birch platform by means of kindling and fagots and

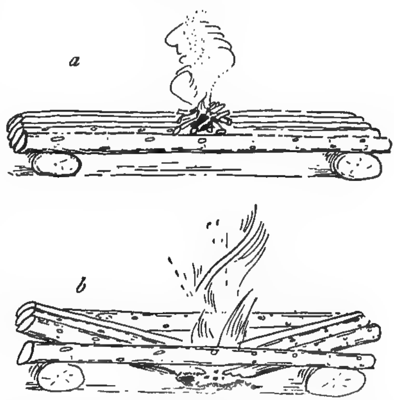

FIG. 45. A woodsman's long-keeping "top-fire" *a*, beginning; *b*, well under way and ready for the rolling on of the side logs.

rungs. As live coals form, the birch poles are burned through in the middle and fall in the midst of the coals and keep on burning. The extension of the fire outward is promoted by the upward inclination of their ends. A fire of this sort, properly begun, will continue to burn steadily through the greater part of the night, without excess of heat at the beginning, and without any further attention.

A woodsman knows there are certain fuels that burn well enough but must be avoided in camp: hemlock, for example, whose confined combustion-gases explode noisily, throwing live coals in all directions. One does not want his blankets burned full of holes. And even the householder who sits by his fireplace should know that there are woods like hickory and sassafras that burn with the fragrance of incense; woods like sumach that crackle and sing; woods like knotty pitch pine that flare and sputter and run low, and give off flames with tints as variable and as delightful as their shapes are fantastic. One who has burned knots observantly, will never order from his fuel-dealer for an open fire "clear straight-grained wood," even though he have to split it himself.

It has been the wasteful American way to pile and burn the tree-tops in the woods for riddance of them, and then to split kindling at home. With a wood famine at hand we ought to be less wasteful. Half the wood produced by a tree is in its branches. Some trees hold their branches long after they are killed by overhead shading. Others, with less resistant bark, drop them early and in an advanced stage of decay. Fagots gathered in the forest are, therefore, quite as different in their burning qualities as is the wood of the trunks. It should be the object of the following study to learn at first hand what these differences are.

Study 11. Fuel-woods of the Farm

The work of this study should be conducted in the wood-lot or in a bit of native forest, where there is a great variety of woody plants, big and little, living and dead. There should be found a few trees fallen and rotting; a few, broken by storms or shattered by lightning; some, diseased by fungi or eaten by beetles or ants; dead snags, tunneled by woodpeckers; old boles tattooed by sapsuckers; sprouting stumps; and scattered weaklings smothered by lustier competitors—in short, the usual wildwood mixture of sorts and conditions.

The tools needed will be a pocket knife and a hatchet or a brick-hammer to split and splinter with. The modern convenience of matches will be allowed to all. A few axes and cross-cut saws may be taken for common use. To save the axes from certain abuse, chopping blocks should be provided in advance.

The program of work will consist of: (1) a gathering of fuel stuffs from the wood-lot; and (2) a testing of them in fire-making.

1. The wood-lot should first be explored for fire-making materials. Quick-kindling stuff will be wanted chiefly for this brief exercise. These are of several categories: (a) "dead and down" stuffs in the woods, the result of nature's pruning and thinning. Nature has placed good fire-making materials handy. As you collect, observe what kinds of trees hold their dead branches longest and preserve them most free from decay. If there are shattered trunks within reach, knock off the shattered ends and try them for kindling. Compare splintering with chopping as a means of preparing kindling-stuff from dry softwood.

(b) Resinous stuffs, such as the "curl" of the outer bark of the yellow birch, the bark strips from hemlock and other conifers, pine knots from rotted logs, etc. These will be the more needed in the rain. If there be many kinds of materials available, some sort of division of labor may be arranged for the collecting of it.

2. The materials gathered should be carried out to an open space on the lee side of the woods, and tried out in fire-making. Let the fires be so arranged as to secure a minimum of inconvenience from smoke. Each student should make a small fire (not over 18 inches in diameter), using one kind of material only. Let those more experienced at fire-making try more difficult materials—say green elm, for a climax. Let each effort result in a fire and not a smudge: it should catch quickly and burn up steadily and clearly with little smoke. To this end materials should be selected of proper kind and proper size for ready ignition, must be so arranged as to admit air below, must "feed" inward as the center burns out and must not be increased in size faster than the increasing heat warrants.

Fig. 46. A simple rack of bent wire suitable for the block-testing outlined in this study.

With the individual fires burning steadily, let observations be made on the readiness of ignition of other woods, green and dead, wet and dry, sound and punk. Different kinds of bark will show interesting differences in readiness of ignition.

Demonstrations: At a common fire of larger size a number of demonstrations may be made.

1. The long-burning qualities of different kinds of wood may be roughly shown by placing pieces cut to like size and form on a wire rack such as is shown in figure 46, setting the rack upon a broad uniform bed of coals, and noting the time at which each piece is completely consumed.

2. The fire-holding qualities of the same kinds of wood may be shown by like treatment of a similar lot up to the point of their complete ignition—then removing them from the fire

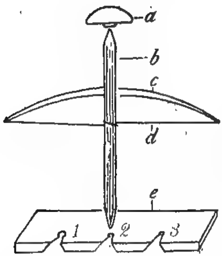

FIG. 47. Rubbing sticks for fire-making: *a*, drill-socket, to which pressure is applied with the left hand (a pine knot with a shallow hole in it will do for this); *b*, the drill, an octagonal hardwood stick about fifteen inches long; the top should work smoothly in the drill socket; *c*, inelastic bow for rotating drill. It is moved horizontally back and forth with the right hand; its cord, *d*, is a leather thong with enough slack to tightly encircle the drill once; *e*, fire board of dry balsam fir, or of cottonwood root, or even of basswood. Observe how the notches are cut with sides flaring downward; a little pit to receive the point of the fire drill is at the apex of each one; *1* is a used-out notch; *2* is yet in use; *3* is a new unused notch. The rotating of the drill with pressure from above rubs off a brownish wood powder which falls beneath the notch and smokes, and then, with gentle fanning, ignites. A dry piece of punk should be placed beneath the notch to catch it, and some fine tinder (such as may be readily made by scraping fine, dry cedar wood) should be added to catch the first flames,

and timing the disappearance first of flame, and then of red glow.

3. The burning quality of the same kind of wood in different conditions, green and dead, sapwood and heartwood; dead wood wet and dry, sound and punk; pieces from knot and from straight-grained portions, etc., may be tested as in paragraph 1.

4. Ancient methods of starting a fire may be demonstrated in the intervals while waiting for the pieces used n 1, 2, and 3 to burn out. With the apparatus shown in figure 47 anyone can start a fire by friction of one piece of wood upon another and carefully nursing the first resulting spark. Flint and steel and tinder may also be tried.

5. Some interesting peculiarities of certain woods may be shown at a common fire:

(a) By having green chunks burning at one end, the liquids in the wood may be made visible. Green elm will exude water at the other end; red maple will froth; hickory will exude a very limited quantity of delicious "hickory honey."

(b) By burning pieces of chestnut, sumach, etc., the crackling of woods may be demonstrated; also the ember-throwing habit of hemlock. A shower of sparks may be had by throwing on green and leafy boughs of hemlock and balsam.

The record of this study will consist in:

1. An annotated list of the kindling woods found, with notes on their occurrence, natural characters, and burning qualities. Names, if needed, will be furnished by instructors.

2. A sketch showing your own preferred construction of a fire, with pieces properly graded in size for ready ignition, and properly placed for admission of air.

3. A brief statement of the results of the demonstrations made at the common fire.

XII. WINTER VERDURE OF THE FARM

"The damsel donned her kirtle sheen;
The hall was dressed with holly green;
Forth to the wood did merry-men go
To gather in the mistletoe."

—Walter Scott (***Marmion***).

In winter when the fields are brown, the pastures deserted, the birds flown, and the deciduous trees stark as though dead, the evergreens preserve for us the chief signs of life in the out-of-doors. They mollify the bleakness of the landscape. So we cover with them the bleakest slopes, we line them up for windbreaks, and we plant them cosily about our homes.

Nature has used the larger coniferous evergreens on a grand scale, covering vast areas of the earth with them and developing a whole population to dwell among them. Two species of pine have been among the most important of our country's natural resources: the white pine at the North and the pitch pine at the South; and these two have conditioned the settlement of the regions in which they occur. Both have been ruthlessly sacrificed, and we have but a poor and shabby remnant of them left. At the North the white pine was cut first; then the spruce, and then the hemlock. This was the order of their usefulness to us. Old fences made of enduring pine stumps surround fields where there are no living pine trees to be seen, bearing silent testimony to their size and their aforetime abundance.

Our evergreens, broadly considered, fall into two groups of very different character. These are the narrow-leaved evergreens (the leaves we call "needles"), mostly conifers, and the broad-leaved evergreens. The former are mostly trees of the forest cover; the latter are mostly underlings. The former are mostly valuable timber trees; the latter have little practical importance. The former are plants of an archaic type that bear naked seeds in cones and have inconspicuous flowers. The latter are of more recent origin and have mostly very showy flowers. So great are these differences that we may better consider the two groups separately.

The larger conifers all have one habit of growth: they shoot upward straight as an arrow. Most of them have their branches arranged in whorls about the slender tapering trunk, and extended horizontally. Thus, under their winter burden of ice and snow, they may bend down uninjured until they rest on branches below, or on the ground. Given plenty of room, the pines grow in ragged outlines; the spruces, hemlock and balsam are beautifully tapering and conical; the arborvitæ and the taller cedars approach cylindric form. In color the white pine is the darkest green; the pitch pine is yellowish green. The balsams and certain spruces and cedars have a bluish cast. Arborvitæ is a chameleon, that changes its color with the season, being rather dull and unattractive in midwinter, but making up for it by the liveliness of its tints a little later. In texture the pines are loosest, their long needles being arranged in bundles. The balsams and spruces have a sleek, furry aspect. The hemlock is soft and fine: indeed, of all foliage masses, there are none more beautiful than those of well-grown hemlock. And the closest textures of all are wrought out of the minute, close-laid leaves of the cedars and the arborvitæ. The red cedar is not among the largest of the conifers, but it is a valuable one, because of the fine aromatic fragrance and the enduring quality of its wood. The yews and the junipers are the underlings of this group: they are low, sprawling shrubs that grow on the forest floor in the shade, or on stony and barren slopes.

This exceedingly important group of trees furnishes us with a great variety of products: timber, fuel, tannin, turpentine, rosin, etc.; but it furnished the red man with many additional, not the least important of which was cordage. The Indian made binding thongs from the tough roots of hemlock, cedar and yew.

Our broad-leaved evergreens are mostly low shrubs, and trailing ground-cover herbs. One of the finest of them, in the freshness of its winter greenery and in beauty of its summer flowers, is the mountain laurel. In the woods on the ground there are clumps of evergreen ferns, and partridge berry and wintergreen, and tufts of perennial mosses, and considerable areas are often overspread with the bright and shining verdure of the blue myrtle, or, in dry places, with the gray-green of the moss-pink. Many of our scattered herbs like alum-root and wild strawberry remain green over winter if not too much exposed. Even the grasses of our lawns remain green, with a little protection.

Study 12. Evergreens of the Farm

An examination of all the commoner and more interesting evergreens of the farm, with a view to learning their earmarks, is the object of this study. The apparatus needed will be a lens and a pocket knife.

The program of the work will include a trip about the lawns where specimen trees grown in the open may be found,* and a visit to the woods to see the evergreens of the forest cover and the forest floor. The species are to be examined carefully, one by one, and their salient characters noted. The conifers are to be written up in a table prepared with headings as indicated on pages 94 and 95. The more heterogeneous broad-leaved evergreens are to be listed, with brief notes as to their characters and habits.

*Often the most available living collection of evergreens will be found in a neighboring cemetery or park.

The record of this study will consist in:

1. The table of conifers above mentioned filled out so far as data are available.

2. An annotated list of the broad-leaved evergreens, with notes on size, growth-habits, situation preferred, character of foliage, etc.

NAME	Growth Habit[1]	Kind of Bark[2]	Leaves	
			Size[3]	Form[4]

[1] Diagram.
[2] Note color, content, manner of shedding, etc.
[3] Length × width in mm.
[4] Cylindric, flat, keeled, grooved, etc.

		Fruit		
Position[5]	Arrangement[6]	Kind[7]	Form[8]	Miscellaneous

[5] Appressed or divergent, etc.

[6] Solitary or in bundles: if solitary, are they opposite or alternate, 2-ranked or scattered: if in bundles, how many leaves per bundle.

[7] Cone, berry, drupe, etc.

[8] Diagram of distinctive features.

XIII. THE WILD MAMMALS OF THE FARM

"I'm truly sorry man's dominion
Has broken Nature's social union,
An' justifies that ill opinion,
Which makes thee startle,
At me, thy poor earth-born companion
An' fellow-mortal!

—Robert Burns (*To a mouse, on turning her up in her nest with the plough*).

Aboriginal society in America was largely based on the native wild beasts. They were more essential to the red man than our flocks and herds are to us. His dependence upon them was more direct and absolute. They furnished him food and clothing and shelter and tools. His clothing was made of skins; his eating and drinking vessels were of horn and hide and bone. His knife was a beaver tooth. Sinews, teeth, hair, hide, hoofs, intestines and bones all served him. Out of them he got hammers and wedges and drills and scrapers and clamps; threads and thongs and boxes and bags; tools and supplies for all purposes. He made textiles of hair and of quills, and in them wrought the expression of his esthetic ideals.

The Indian was conquered and driven out in part by direct assault, but in a far larger part by the destruction of his resources in furs and game. Losing these, he became dependent. Armed resistance by the eastern Indians ceased with the passing of the beaver; by the Plains Indians, with the passing of the buffalo.

The earliest white settlements in America were supported mainly by hunting and trapping and the sale of furs. Missionary zeal and desire for extension of empire promoted the founding of colonies, but peltries provided the necessary revenues for their maintenance. The fur trade was intimately associated with our early colonial development and even with early social affairs and military enterprises. The beaver and the badger and the wolverine and the bison rightly occupy a place on the seals of certain of our states.

These fine quadrupeds, once so abundant, are gone from our settled country. Save for a remnant, preserved in reservations, largely as a result of private enterprise, the bison is entirely gone. The others are crowded to the far northern frontier. We have fur-bearers still, and also a fur trade: indeed, more money is spent for furs nowadays than ever before in the country's history. But our furs are now derived from animals which but a generation ago were mainly considered hardly worth skinning. The four native mammals which now chiefly supply the market are, in their respective order, muskrat, skunk, opossum and raccoon, with the mink still furnishing a lesser proportion of much more valuable skins. These are obtained in considerable numbers from all parts of the country still, but the getting of them is no longer a man's work. It is rather the recreation of the enterprising farm boy.

The white man brought with him to America all the different kinds of mammals that he now uses. He found none domesticated here. The Indian was a hunter, not a husbandman. The white man was a more ruthless hunter, equipped with better weapons. The Indian would no more kill off all the beaver and otter on his range, than the stockman would dispose of all his herd. He kept a portion to breed and renew the supply. But the white man, having his domesticated animals to fall back on, slaughtered the wild ones ruthlessly without regard for the future. Indeed, the wantonness of the slaughter of some of them—notably of the bison—is a disgraceful chapter in our country's history.

The mammals that are of great importance to man fall in three groups: hoofed animals, beasts of prey and rodents. There were some fine native hoofed animals in North America.

Besides the bison, "noblest of American quadrupeds," there were deer and elk and moose, of wide distribution; in the Rockies were mountain sheep and goats; and in their foothills, the graceful pronghorn. Of these, the red deer remains where given protection; indeed, though never domesticated, it seems to thrive on the borders of civilization. Recently in New England, farmers have had to kill off wild deer in order to save their crops.

FIG. 48. A pronghorn buck.

Of the beasts of prey, all the larger species, bears and pumas and lynxes and wolves, have been killed or driven out; and probably most of us would be well enough satisfied to have all those that remain, confined in zoological parks. Foxes linger in the larger wooded tracts. Skunks are probably more abundant than in primeval times; for there is more food available and they are not hunted very eagerly by most of us. Minks and weasels and raccoons haunt the swamps and marshes, and being both small and alert, maintain themselves very well.

The rodents have fared better under agricultural conditions than the two preceding groups. The destruction of the beasts of prey removed their most dangerous natural enemies, and the growing of crops in the fields increased their available food. It is altogether probable, therefore, that where special measures are not taken by man to destroy them, such rodents as the woodchucks, gophers, meadow mice and rabbits are more abundant now than in primeval times. At any rate, we can, by taking proper measures, find plenty of them.

Then there are a few little insect-eating mammals, like the moles and the shrews in their burrows in the soil, and the bats in the air, that perhaps are not greatly affected by the changed conditions. Southward, there is the interesting marsupial, the opossum, nocturnal, wary and elusive, holding its own.

The group of mammals includes those animals that are most like us in structure and habits and mode of development. Among them are our best servants, our best producers of bodily comforts, our most direct competitors and our most dangerous enemies. We have gathered the more docile of those useful to us about our homes, and have made them our more immediate servants. We have exploited their untamable allies to the limit of our powers. So long as there remained a toothsome body or a prized pelt, we spared not. Our enemies and competitors we killed. At first it was done in self-defense: of late, it has been done in sheer and wanton love of slaughter. Improved weapons of destruction have placed the larger beasts completely at our mercy, and we have had no mercy. There remain with us one that we avoid, a few that are too small to be deemed worthy of pursuit, and a few that are able to elude us. At our approach the squirrels hide from us in the trees; the gophers and their kind drop into their burrows, the swamp-dwellers slip into the water, and the wily foxes watch us from the thickets. Eternal vigilance is the price of their safety. We may see little of them when we walk in the woods or by the streamside, but there are many pairs of sharp little eyes always watching us.

Before the final disappearance of the larger species, it is well that we are taking measures to keep a remnant of them in game preserves: our descendants will want to know what the native fauna of their native land was like. We do well, also, to consider that each species we destroy is a final product of the evolution of the ages. It is the outcome of the toil and pains of countless generations; and when once swept away it can never be recovered.

By the care of our flocks we have become more sympathetic towards tame animals. By taking thought for the welfare of the remnant of our wild animals, we shall become more sympathetic toward them, more appreciative of their fine powers and their esthetic values. We shall become more civilized; for, as the late Professor Shaler assured us, "The sense of duty which mastery of the earth gives, is to be one of the moral gifts of modern learning."

Study 13. The Wild Mammals of the Farm

This study includes a little trapping expedition, and some examination of captured wild animals and observations of their haunts and habits. The tools needed will be pocket knives, an individual supply of small mouse traps and bait (rolled oats will do for bait), and some cord and fine wire for snares. Since members of the class will be able to capture only a few of the over-abundant little rodents, others should be available in captivity. Woodchucks, chipmunks, etc., may be kept buried in a box in hibernation, if obtained in autumn. Raccoons, opossums, etc., may be purchased from dealers. They may often be borrowed from persons in the neighborhood who keep them as pets.

The program of work will consist of:

1. A trip along some meadow fence-row and about the grassy borders of a wood, taking up a line of traps (that should have been set the day before and marked as to location), removing the catch and again baiting them. They should be set in the runways of meadow mice, wood mice, shrews, moles, etc. Little "Zip" traps, or others of the guillotine type, are lightest and cheapest (three cents or less apiece in quantities), and are quite efficient. They are baited by sprinkling some flakes of oats about the trigger. They are best covered by a

sheltering piece of bark or a flat stone, supported an inch or more, allowing easy access. A few snares of the simple sort illustrated in fig. 49 (or of some better sort known to any member of the class) may be set in the briar patch in the runways of rabbits or in the mouths of their burrows.

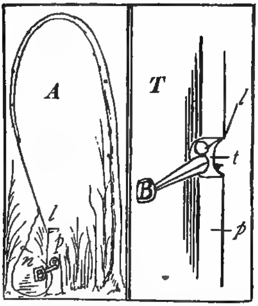

FIG. 49. Spring pole and snare: *A*, its setting; the pole is a lithe sapling, trimmed and bent, its top held down by a line, *l*, attached to a trigger in a hole in the post, *p*. Fast to the line is the slip-noose, *n* (most quickly made of small annealed brass wire), which is set across the rabbit's path in such a position that the rabbit will push his head through it when reaching the bait, B. *T* illustrates how the trigger *t* is set in a ⅝ inch hole in the post. The slightest movement of the bait-stick rolls the ball, releases the line, *l*, and liberates the pole to draw the noose.

2. Such animals as the traps contain, together with such others as are provided, living or dead or represented by tanned skins, are to be compared and their characters are to be written in a table prepared with headings as indicated on pages 102 and 103. Fill out the table in full, but distinguish in it between original observations and borrowed data.

The record of this study will consist in:

1. The completed table, as indicated above.

2. A map of the farm, with the location of typical haunts of the different species studied indicated upon it.

	NAME	Weight	Length: Body	Length: Tail	Color and Markings[1]
RODENTIA	1. Woodchuck				
	2. Chipmunk				
	3. Red squirrel				
	4. Deer mouse				
	5. Meadow mouse				
	6. Short-tailed shrew				
	7. Mole				
CARNIVORA	8. Skunk				
	9. Mink				
	10. Weasel				
	11. Raccoon				
	12. Bat				

[1] In brief.

Fur		Feeding Habits[1]	Economy[2]	Miscellaneous
Quality[1]	Market Price			

[2] How does it affect our interests.

XIV. THE DOMESTICATED MAMMALS OF THE FARM

"One of the best features of agricultural life consists in the great amount of care-taking which it imposes upon its followers. The ordinary farmer has to enter into more or less sympathetic relations with half a score of animal species and many kinds of plants. His life, indeed, is devoted to ceaseless friendly relations with these creatures, which live or die at his will. In this task ancient savage impulses are slowly worn away and in their place comes the enduring kindliness of cultivated men. . . To this perhaps more than to any other one cause, we must attribute the civilizable and the civilized state of mind."

—Shaler (*Domesticated Animals, p. 222*).

Our chief needs in life are things to eat, things to wear, and things to have fun with. Our mammalian allies provide all these things to a remarkable degree. Agriculture tends to increase the things that minister to our bodily comforts; but it is probable that animals were first domesticated to serve the needs of our minds; for the first animal to be domesticated appears to have been the dog, and he, to furnish, not food, nor raiment, but companionship. The dog was docile and friendly and cheerful and in every way responsive to his master's moods. His mind was of a singularly human-like quality. He could interpret his master's commands, and was eager to obey them. He could appreciate praise or blame. He could profit by instruction; and he lent to primitive man the inestimable aid of his sharp teeth, his swift feet, his keen ears and nose, and, above all, his courage and his fealty. He shared his master's hovel and ate of the leavings from his table until he came to prefer his master's society to that of his own kind, staying with him through poverty and want, often indeed, in the face of penury and abuse. He became a willing slave, and the "completest conquest man has made in all the animal kingdom." In all this he was a companion and a helper. Rarely among the tribes of men has the dog been considered a source of food supply, except in times of famine.

And our dealings with the other domesticated beasts, that nowadays seem so utilitarian, were not in the beginning so very different. It is probable that the first of them to be brought into human association were captured young and kept at home as pets. The desire of their captors was probably not to eat them, nor to wear their skins, but to see more of their interesting ways. The frisking calf or colt or lamb was a new playmate for the children of the household. So, all sorts of wild animals are gathered about the homes of primitive people everywhere, even today. So, they are played with and tamed, and such as prove harmless and docile are allowed increasing liberty about the place. There are few of them indeed, that, when free and fully grown, will not desert the homes of their captors for their native wilds. Some such have been found in times long past, and from these have descended our domesticated animals. Doubtless the savage youth who first captured a few wild calves, and tamed and reared and bred them and started a herd, little realized the far-reaching influence of his venture upon the development of human civilization.

In attaching the more useful wild animals to his home, savage man attached himself there. It became easier to raise food and clothing than to get them by the uncertainties of the chase. As a keeper of flocks and herds his substance increased; his living became better assured; his sympathies and interests were broadened; his forethought grew.

The dog has been of chief value to the hunter and the husbandman. He was by nature a superb scout; vigilant, keen, able to take care of himself, and quick to learn ways of coöperating with his master. He could be taught what to do, and—yet more remarkable—what not to do, even to the curbing of his natural appetites. From eating sheep and fowls he came with education to be the protector and shepherd of them. He could be taught to work also, tho too small to be of value where large beasts of burden are available; yet that stocky dog, the turnspit, was developed to operate the treadmill. He is a draft animal in arctic lands; there his flesh also serves to tide over many a famine, and his furry coat is used for clothing. It is only in our cities, where removed from the ways of nature, and subject to too much coddling, and developed in freak varieties, that he has become a stupid and useless nuisance.

Dogs are subservient to their masters in both sexes; while the males of the larger domesticated beasts, after centuries of care and training, remain dangerous beasts still.

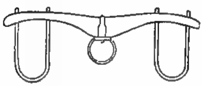

FIG. 50. Ox yoke: our chief symbol of servitude.

One of the greatest advances in agriculture came with the domestication of the cattle-kind, and their use as draft animals. Turning the soil with a sharpened stick was, to the early planter, a sore task, and a slow one. When the stick was exchanged for a plow, and the great strength of the ox was set to draw it, then tillage began on a larger scale. Then settled homes, and property in land, began to be developed. Nature equipped the cattle kind to serve us in many ways. She made them excellent producers of flesh and of milk, of hides and of horn. She made them hardy, and adaptable to a great variety of climate and of artificial conditions of life. She made them to live on such herbage as any meadow, wild or tame, offers. In no other beasts has she so combined usefulness in labor, docility, and productiveness.

The horse has been one of man's chief helpers along the road of progress. Next to the dog he has been man's most intimate associate. He was admirably adapted by nature to supplement man's physical powers. He was of the right size: not too small to carry a rider and not too large nor too obstinate to be manageable. His back was a natural saddle, behind the sloping shoulder blades, and his well-knit frame was well braced and fitted for carrying a rider easily His rounded muscular hams gave power to his hind legs and made them efficient organs of propulsion. His lengthened foot bones gave length of stride. His solid hoofs were well cushioned and admirably adapted for travel over solid ground. His gait was more easy and graceful than that of any other beast of burden. The structure of his mouth would seem to have invited the use of a bridle-bit for his guidance and control. The whole horse invited a rider; and doubtless many a savage youth, who had captured an orphaned colt and reared it by hand, felt moved to accept the invitation. At first he doubtless rode bareback, and with only a cord halter for control. Later, he invented a saddle and a bridle. To a strong horse, the weight of grown man is a lightsome burden. The saddle is not a symbol of labor, but of a pleasure that is mutual. The two participants seem complemental. The trained horse and the skilful rider make a unit in action: they make up such a powerful creature as the mythical Centaur was intended to portray. In the long struggles of past centuries during which incessant wars were waged in hand to hand encounter, the mounted soldier had a tremendous advantage. The horse lent him swiftness and strength and momentum in attack, and advantage of position in the fray. The mounted soldiery of the Aryan and Semitic peoples enabled them to overrun the earth.

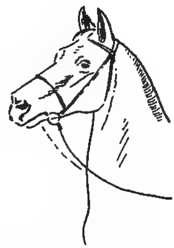

FIG. 51. The pleasure is mutual.

As the wealth of a people was measured of old by its herds of cattle, so its power was measured by its multitudes of war horses. All ancient art and literature testify abundantly to this. The horse was kept for use in war mainly. Some peculiarities of his mental make-up seem to fit him for the parade ground. He seems to love excitement. He enters into a race with great zest. He steps high in public and wears the trappings of war with all the proud disdainfulness of a Cavalier. He has given his name to one ostentatious period of our history, the Age of Chivalry.

To the Greeks we probably owe an invention of the first order, that has adapted the horse more fully to our needs: the iron shoe, to fit his foot for continuous travel over hard roads. The cloven foot of the ox could not be so equipped. It was adapted for soft ground and could not endure hard roads. The horse gradually took the place of the ox, first on the roads and later in the furrow. The horse was both swifter of foot and stronger. Do we not still measure the energy used for heavy work in horse-power?

To our welfare sheep have contributed of their flesh and their wool. The latter is their unique gift to us. Man's earlier clothing of skins was heavy and unadaptable and unhygienic. Sheep's wool is finely adapted to be spun into threads and woven into cloth; and, so treated, it makes the strongest and best of clothing. The discovery of this art wrought one of the greatest advances in the comforts of life for people in temperate climes. Sheep do not belong to the tropics. They are adapted to life in rough, hilly, semi-agricultural districts. They are less exacting as to forage than are cattle, and being strictly gregarious, the flocks are more easily herded and guarded from the attack of wild beasts. They are quicker of growth than cattle, and more prolific, and less capital is required to make a beginning at sheep-raising.

The pig has served us mainly as a supplementary food supply. He puts on flesh quickly and is very prolific. Hence, the meat supply can be more quickly increased by raising pigs than by raising sheep or cattle. In our late Civil War, hogs early became the main reliance for meat supply for the soldiers on both sides. The quantity of pork in the country at any given time may, by raising hogs, be doubled in eighteen months. Hogs are well nigh omnivorous and are gifted by nature with a keen sense of smell, with the aid of which they are able to find food that cattle and horses waste. So they are usually allowed to run after cattle to convert the waste into pork. The pig is not naturally a very dirty animal, when given a chance to be clean, nor is he hopelessly stupid. He can be taught more tricks than many animals that have a higher reputation for cleverness. His manners, however, are bad.

FIG. 52. A quick-growing meat supply.

These five animals, dog, horse, ox, sheep and pig are as yet our main dependence. There are others more or less widely kept, like the cat and the ass and the goat and the rabbit; but these five are most necessary to us. These illustrate well the phenomena of domestication: the many different purposes served by different beasts, the great differences among them in size, in strength, in speed, in habits, in disposition, and in products. We do not treat any two kinds of them alike, nor in speaking to them, do we use the same words.

They have affected our sympathies and our habits, enriched our language, and conditioned our progress. How individual they are: how well known and characteristic are their voices. Dogs bark and whine and howl: cats purr and mew and yowl: horses whinny and neigh: bulls bellow and cows bawl: pigs grunt and squeal: sheep bleat: donkeys bray. How characteristic their actions are, also. They furnish our most graphic figures of speech. Often in politics or in business we hear men accused of shying, of balking, of getting their bristles up, or of having the fur rubbed the wrong way; of barking up the wrong tree. Ethnologists tell us that half the words in any primitive language are derived from association with animals.

They have been long and intimately associated with mankind. They have learned some things from us, but we have learned vastly more from them. We have learned fidelity from the dog, chivalry from the horse, gentleness from the cow, parental affection and coöperation and sympathy from all of them. To our minds, the dog stands for fealty; he represents many private virtues. The horse stands for courage; he represents rather the public virtues. The ox stands for docility. The sheep represents our commonest social, the pig, our commonest personal shortcomings.

How much we have been influenced in our dealings with them by their mental characteristics is well shown by the horse: his flesh is excellent, but the thought of eating it is repugnant to us. The milk of mares is good, but who would drink it? In lands where certain cattle are regarded as sacred, their flesh is not considered good to eat. Their availability as food is not determined by our judgment, but by our sympathies. Furthermore, the mule, considered from a purely utilitarian standpoint, has much to commend him to our favor. Though he is a hybrid between the horse and the ass, he is stronger than either parent. He will live on coarser food than the horse, and needs less careful handling. But he is a sterile hybrid; his voice is a bray, his ears are long, he is inelegant in outline and in his bearing, and his manners lack all the pleasing little playful capers of the horse. He has taken no hold on our affections.

The domestication of all our important live stock antedates history. Of the five most important mammals discussed in the preceding pages, the ancestor of only the pig is known. It is the wild boar of Europe. Selection has done its proper work on all of them, and as many types of each of them have been evolved as there were purposes to be served. Selection began with dogs, and has proceeded farthest with them. They have served the greatest variety of purposes. There are sledging dogs for the arctic fields, and turnspits for the tread mills, and bulldogs to guard the door, and shepherd dogs to guard the flocks, and besides these, and more numerous than all these, are the hunting dogs: for hunting was the occupation that dogs could best aid. There were developed, to meet the various conditions of the chase, harriers and beagles and pointers and setters and terriers, etc., and, to follow particular kinds of game, bloodhounds and foxhounds to run by smell, and greyhounds and staghounds to run by sight; and so on, dogs without end. The case is much simpler with the other mammals. Horses are bred mainly for speed or for draft, tho there are many kinds of horses, and ponies for children's use besides. Cattle are bred mainly for beef or for milk production; sheep for mutton or for wool; pigs for lard or for bacon, etc. In the following study we shall have opportunity to study a number of the important breeds. Let us do it without forgetting that the reasons for their value to us have lain and yet lie in their natural history.

Study 14. The Domesticated Mammals of the Farm

The object of this study is an acquaintance with the live stock of the farm: their number, location, characteristics and uses.

The program of work will consist of a trip to all the barns where domesticated mammals are kept: (1) a preliminary examination will be made of a typical representative of each species, and then (2) a more detailed examination of the varieties of a few species.

The record of this study will be in two parts:

1. The student will write up brief notes on the dog, horse, cow, sheep, pig, etc., concerning those points in their natural history determining their availability for purposes of domestication as follows: their size and weight (average); rate of growth; reproductive capacity; foods and feeding habits; voice and social habits; weapons and fighting habits; for what use fit; and general attractiveness or unattractiveness of make-up and behavior. These notes should include only personal observations.

2. The record of the second part of this study, the comparison of breeds, may conveniently be incorporated into tables, one for each species studied, with column headings indicating the more obvious points of structure and of productiveness and habits in which the breeds differ from one another. For example, a table for the breeds of cattle might have the column headings as follows:

Name of breed (as Holstein, Ayrshire, etc.).
Average weight (adult)
Average milk production (get data from dairy record).
Color and markings.
Horns.
Muzzle.
Feet.
Other peculiarities.
Number kept.
Kept where.
Average market value.

XV. THE FOWLS OF THE FARM

"No longer now the winged habitants,
That in the woods their sweet lives sing away,
Flee from the form of man; but gather round,
And prune their sunny feathers on the hands
Which little children stretch in friendly sport
Towards these dreadless partners of their play."

—Shelley (*Daemon of the World*).

In that day, not so long gone in America, when all men were huntsmen, and when game was all-important animal food, wild fowls were abundant everywhere. The feathered game was the most toothsome and wholesome of animal foods. The waterfowl, fattened on wild rice and on wild celery, and the turkeys and pigeons, fattened on mast, acquired a flavor that is a tradition among our epicures. Eggs, also, and feathers were their further contribution to human needs.

These wild fowl, altho mainly different species from those we have domesticated, represent the same bird groups that are used by mankind the world over: land fowl, and waterfowl, and pigeons. There were also a good many lesser edible birds of no great importance, such as the snipe of the shores, the woodcock of the swamps, and the rails of the marshes. Comparatively few birds were big enough to be worthy of consideration as food for man. Of large land fowl the most noteworthy were wild turkeys and grouse and quail. Of large waterfowl there were swans and geese and ducks. Of tree-dwelling fowl there were wild pigeons.

To learn how abundant these were we need go back only a little to the records of the pioneers. Father Raffeix, the Jesuit missionary who was one of the first white men to dwell beside "Cayuga's waters," wrote thus of the abundance of game in the Cayuga basin: "Every year in the vicinity of Cayuga more than a thousand deers are killed. Four leagues distant from here on the brink of the river (the Seneca) are eight or ten fine salt fountains in a small space. It is there that nets are spread for pigeons, and from seven to eight hundred are often taken at a single stroke of the net. Lake Tiohero (Cayuga), one of the two which joins our canton, is fully fourteen leagues long and one or two broad. It abounds in swans and geese all winter, and in spring one sees a continuous cloud of all sorts of game. The river which rises in the lake soon divides into different channels enclosed by prairies, with here and there fine attractive bays of considerable extent, excellent places for hunting." (*Jesuit Relations* for 1671–72).

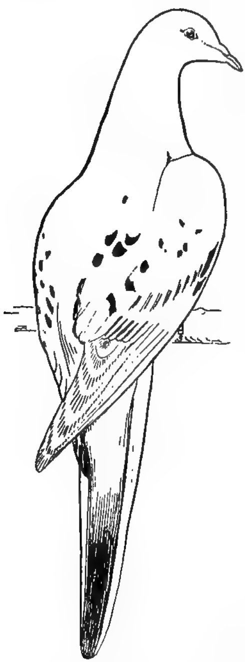

FIG. 53. The wild passenger pigeon.

Of our fine native fowl, one, the turkey, has been domesticated; one, the wild pigeon has been wholly exterminated; and most of the others have been hunted almost to the point of extinction. Game laws have served in the past merely to prolong a little their slaughter. If there be any hope of preserving unto future generations the remnant of those game birds that still survive, it would seem to lie in the permanent reservations that are being established north and south, for their protection.

The wild pigeon was the first of our fine game birds to disappear. Its social habits were its undoing, when once guns were brought to its pursuit. It flew in great flocks which were conspicuous and noisy, and which the hunter could follow by eye and ear, and mow down with shot at every resting place. One generation of Americans found the pigeons in "inexhaustible supply:" the next saw them vanish—vanish, so quickly that few museums even sought to keep specimens of their skins or their nests or their eggs; the third generation (which we represent) marvels at the true tales of their aforetime abundance, and at the swiftness of their passing; and it allows the process of extermination to go on only a little more slowly, with other fine native species.

The waterfowl have fared a little better. Their migratory habits have kept most of them, except at the season of their coming and going, out of the way of the pot-hunter. In their summer breeding grounds in the far north, and in their winter feeding grounds in the far south they have been exposed mainly to those natural enemies with which they were fitted to cope. Yet, before the fusillade of lead that has followed their every flight across our borders their ranks have steadily thinned. Their size and conspicuousness (and consequent ability to gratify the hunter's zeal for big game) seem to be determining the order of their passing. The swans have disappeared: the geese are nearly gone: rarely do we hear their *honk, honk* overhead in springtime; and the wild ducks appear in our Cayuga skies in ever-lessening numbers. Who that has grown up in a land of abundant wild fowl, has known them as heralds of summer and winter, has seen them coming out of the north and disappearing into the south, has not marvelled at the swiftness, strength and endurance of their flight, and been uplifted with enthusiasm as he watched their well-drilled V-shaped companies, cleaving the sky in lines of perfect alignment and spacing. Our literature testifies abundantly to the inspiration of this phenomenon. How much poorer will our posterity be if these signs are to disappear from our zodiac!

The terrestrial wild fowl have vanished also; especially those that, like the wild turkey, were large enough to be

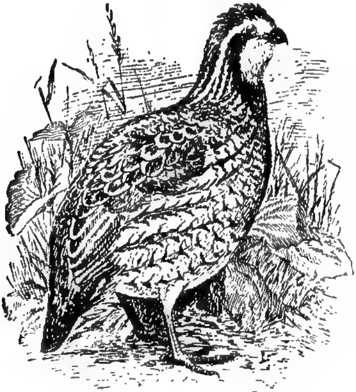

FIG. 54. Bob-white (after Seton).

trophies to the hunter; or those, like the bob-white, that were social in habits; or those, like the prairie hen, that flew in the open and could be followed by the eye to cover. Our woods-loving ruffed grouse has fared a little better. Wherever sufficient forest cover remains, it has been able to maintain itself in spite of well-armed pursuers. It is alert. It is solitary. Its protective coloration is well nigh perfection. Its flight is swift; and when flushed from cover, it goes off with a startling suddenness and whirring of wings that disconcerts the average hunter and delays his fire until a safe escape has been made. Moreover, the hunter, by killing off some of its worst enemies among the beasts of prey, has unwittingly helped the grouse to hold its place. So it remains with us, by virtue of its superb natural endowment, notwithstanding it is truly a hunter's prize. Fattened on the wild cereals of the woodland swales, and flavored with the aromatic buds of the sweet birch, there is no more toothsome game bird in the world than this one.

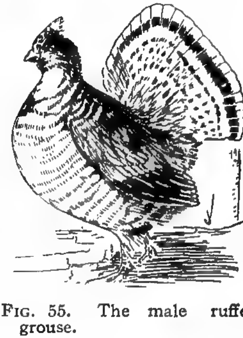

FIG. 55. The male ruffed grouse.

Among the curious sounds made by male birds, the calls of our native land birds are most unique. The ludicrous gobble of the turkey, the thrilling whistle of the bob-white, the muffled drumming of the ruffed grouse, are sounds unmatched in nature and inimitable; so also are the antics that accompany their utterance.

FIG. 56. The sora rail (*Porzana carolina.*)

The day of abundance of wild fowl in this country is forever past. The most that may be hoped for by the bird-lover is that a few may be saved here and there, wherever fit homes for them remain. The pigeon is gone; the turkey is a captive; but let us hope that a few wild places will be preserved where those who come after us may hear the call of the bob-white and the grouse in our vales: let us hope they may be uplifted with the sight of some of our fine wild waterfowl, traversing the equinoctial skies.

Our ancestors brought with them to America fowls that had been domesticated in earlier times and in far distant lands: chickens, ducks, geese, pigeons, guineafowl, peafowl, etc. These, doubtless, came into domestication largely by way of the barnyard. Are they not called barnyard fowl, and so distinguished from wild fowl? They may have lingered about the stalls of the cattle and horses in primeval times to find the grain wasted by these animals, and to feed upon it. It is a noteworthy fact that of all birds, the ones most useful to us are those that are best equipped by nature for working-over the barnyard litter and securing the grain left in it; the gallinaceous birds by scratching with their feet; the waterfowl by dabbling with their beaks. They consumed what would otherwise have been wasted, and turned it into a reserve meat supply; so they were encouraged to remain. With growing familiarity they made their nests in the hay-mow and among the fodder, where their eggs could be more easily found than in the woods. Here was another reason for encouraging intimacy. Nests were made for them; at first, as nearly as might be, after their own models. Then shelters were erected over their roosts; then pens were built to keep them from their enemies. So, by some such easy stages, poultry husbandry probably began.

The most valuable fowls are those that furnish eggs as well as meat. Eggs are pure food, containing no refuse. Among animal foods they are nature's choicest product. They are edible without cooking and are at their best when most simply prepared for the table. All the world eats eggs; and in any land to which one may travel, whatever its culinary offerings, one may eat eggs, and live.

Among domesticated fowls, chickens hold first place. The obvious practical reasons for this are the excellent quality of their flesh, the rapidity of their growth, their productivity of eggs, and their hardiness and ready adaptability to the artificial conditions under which we keep them. The less obvious, but none the less real reason, is that we like chickens for their interesting ways. They are eminently social creatures, endowed with a wonderful variety of voice and signs for social converse. Their beauty strongly appeals to us. We are interested in the arrogant complacency of the cock, in his cheerful pugnacity, his lusty crowing, his watchfulness over his flock, his warning call when a hawk appears in the sky, and his great gallantry toward the hens. How ostentatiously he calls them when he finds a choice morsel of food (tho he may absent-mindedly swallow it himself). We like the hen for her gentle demeanor, her cheerful, tho unmelodious song; her diligence and capability in all her daily tasks; her fine maternal instincts and self-sacrificing devotion to her brood. The chicks also appeal to us by their downy plumpness of form, their cheerful sociability and their soft conversation, and playfulness. Contrast with this the peafowl: it is of good quality and large size and effulgent showiness, but it has a raucous voice and bad social manners, and it has never taken any hold on the affections of human kind. There can be no doubt that in the beginning—in those prehistoric days during which all our important conquests of animated nature were made—when association with domestic animals was much more intimate than now, animals were selected, as other associates are selected, on the basis of pleasing personal characteristics.

Study 15. The Fowls of the Farm

Few observations by a class on wild fowl are possible: hence, this study assumes a few such forms as grouse, bobwhites and pheasants in pens, and available domesticated breeds of the various kinds of poultry. The information obtainable in the pens may be supplemented by exhibits of skins, nests, and eggs, by photographs and lantern slides. Two things are here proposed to be undertaken:

1. A general comparison of fowl species, wild and tame, as to those qualities that determine availability for domestication; and

2. A comparison and census of the breeds of the more important kinds of poultry maintained on the farm.

The program of work will include a visit to at least one pen of each kind (species, not breed) of fowl, with note-taking as indicated below, followed by a more careful examination of the breeds of one or more kinds.

The record of the first part may consist of an annotated list of all the kinds of fowls studied, with notes on such points as relative size and weight, rate of growth, reproductive capacity, foods and feeding habits, eggs and nesting habits, broods and breeding habits, voice and social habits, weapons and fighting habits, and their general attractiveness or unattractiveness of make-up and behavior. In these notes distinguish between original observations and secondhand information.

The record of the second part of this study, the comparison of breeds, may conveniently be made in the form of a table, provided with column headings as follows:

Name of breed (Plymouth Rock, bantam, etc., if a table of common fowl).

Average weight.

Average egg production (get data from poultry-yard records).

General color.

Special ornamentation.

Comb (make a simple diagram of it).

Feet (size, color, spurs, feathering, etc.).

Peculiarities of behavior.

Other peculiarities.

Number males kept.

Number females.

Kept where.

XVI. FARM LANDSCAPES

"I do not own an inch of land—
But all I see is mine—
The orchard and the mowing-fields,
The lawns and gardens fine.
The winds my tax collectors are,
They bring me tithes divine."

—Lucy Larcom (*A Strip of Blue*).

Agriculture is the one great branch of human industry that does not necessarily spoil the face of nature. It does not leave the land covered with slash, or heaped with culm, or smeared with sludge, or buried in smoke. It alters and rearranges, but it keeps the world green and beautiful. It changes wild pastures into tame ones, and substitutes orchards for woodlands. Its crops and its herds are good to look upon. The beautiful plant or animal is the one that is well grown; and farm plants and animals must be well grown to be profitable; otherwise there is no good farming. Nature nourishes impartially wild and tame, and crowns them equally with her opulent graces of form and color. The farmer has at hand all the materials that nature uses to make on the earth an Eden.

Fortunately, there are some features of the beauty of the country that may not be misused. The blue sky overhead, and the incomparable beauty of the clouds, are out of reach and cannot be marred. Hills and vales, also, and lakes and streams, and uplands and lowlands, have all been shaped by the titanic forces of nature, and are beyond man's puny power to change. These are the major features of the landscape. It is only the minor features that are, to any appreciable extent, within our control: mainly, the living things that are the finishings and furnishings of one's immediate environment. These, however, always fill the foreground, giving it life and interest. With these one may do much to alter the setting of his labors.

Besides furnishing the farmer with all the materials used in her landscape compositions, nature surrounds him with good models, from the study of which he may learn their use. If he looks to the wildwood about him he will be able to find scenes that disclose the elements of landscape beauty. He will find sheltering nooks that invite him to come and rest in their seclusion; sinuous streams and curving paths whose gracefully sweeping lines invite his imagination to wander; broad levels, whereon his eye rests with pleasure, bordered by cumulous masses of shrubbery; tree-covered slopes, with the leafage climbing to the summits, here advancing, there retreating, everywhere varied with infinite tuftings, full of lights and shadows; irregular skylines, punctuated by not too many nor too prominent forms of individuality; and all organized and unified and harmonizing as component parts of the border of the valley of some stream or lake.

Now the farm is not a natural unit of this larger landscape, but only a small section arbitrarily marked out by the surveyor. With the larger landscape the best one can do is to locate, if he may, where the prospect is good. Moreover, the curving lines of nature's pictures and the merging masses of her plantings, are not practically applicable to the growing of crops. The beauty of the fields must be that of an exhibit, the beauty of things isolated, and well grown.

The unity of the farm plan should center about the place where the farmer dwells and where others come and go. It will be better for him if the outlook from his window is pleasing; it will be better for his community if the inlook toward his door from the public road is pleasing.

About the house the suggestions from nature's models may be freely applied. The lawn may furnish the broad, restful, level stretch of green verdure; over its recesses shapely trees may cast their inviting shadows; a border of gracefully merging masses of shrubbery may inclose the sides and give it an aspect of privacy; evergreens may be planted to shut out the view of unsightly objects; and the wood-lot may be left to cover the distant rocky slope. Fruit trees may be used for ornament as well as service; they will grow and bloom and bear fruit just as well where they contribute to the beauty of the place as where they block the view. And if the roads and fences be not made too conspicuous where they transgress natural contour lines, and if buildings be not set up where they hide the more pleasing distant prospects, nor painted in alarming hues—then one may look at the place without lamenting that it has been "improved." The most pleasing of homesteads usually are not those that have the greatest advantage of location, or that have had the most money lavished upon them. But they are the places that fit their environment most perfectly, and that are planned and planted most simply.

Much bad taste has been imported into our country houses from the cities of late. In almost any locality in the eastern United States, it is the older houses that have the most pleasing setting. They are not exposed on bare hilltops, but nestle among great trees with always an outlook across levels of green toward distant hills or valleys or strips of blue water. They are sequestered a bit from the winds and from the public; and as Wordsworth said concerning the older homes of the lake country of England (Guide, p. 43), "Cottages so placed, by seeming to withdraw from the eye, are the more endeared to the feelings." Their decorative plantings are not sickly "novelties," leading a nursling existence, but the hardiest of the hardy plants, that grow and, in their season, bloom lustily. The houses are not tall and spindling, but low and contented and comfortable-looking. Their roofs are not cut up in figures to make an alarming sky line, but, broadly descending, they seem to have but the one simple function of keeping out the rain. Their colors are not—at least they were not—all the rainbow hues. Sir Joshua Reynolds used to say, "If you would fix upon the best color for your house, turn up a stone, or pluck up a handful of grass by the roots, and see what is the color of the soil where the house is to stand, and let that be your choice."

The trouble with many homesteads is that no thought has ever been taken of the gifts of nature near at hand; how rich they are, and how available for use in beautifying the home, is little realized. Vistas that would warm an artist's soul are shut out by sheds, unnoticed. The choicest of native plants are cut away as "brush." Buildings are set down helter-skelter, facing all ways, at all levels, up and down. The boundaries of fields are accidental. Roads happen. Efficiency and beauty are sacrificed together. Both demand that a homestead shall fit its environment. Both efficiency and beauty need a little planning and forethought. For both, a little study of what nature offers in materials and in models lies near the beginning of wisdom.

Study 16. A Comparison of the Outlook of Local Farm Homesteads

The program of work includes a visit to the front approach of half a dozen or more near-by farmsteads to see how they fit their environment; to see how their builders have treated the beauties of the larger landscape, and how they have used decorative materials in planting.

The record of this study may consist of notes on each one of the homesteads visited, arranged for each one as follows:

No. (If the name of the owner be not set down, it will matter less whether the remarks be always complimentary.)

Location. (This may, perhaps, best be shown by making a little sketch-map of the route, whereon all the places studied are shown in relation to the public highways and to the main hills and valleys).

1. **The natural setting;** note:

a) The pleasing views that have been preserved or lost in the planning.

b) The use of nature's materials to add beauty or hide ugliness, or to accomplish the converse.

2. **The artificial arrangements;** Note (in so far as visible from the approach):

c) Concerning buildings, whether they fit the situation, look comfortable, bespeak shelter and privacy, etc., and whether they are arranged with unity and harmony.

d) Concerning fields and stock-pens, whether they seem to belong to the place, and are harmonious with each other and convenient in location.

e) Concerning roads and fences, whether they are made to add to or to detract from the beauty of the place; whether harmonious or discordant in arrangement; etc.

A general summary and comparison of the places visited as to their attractiveness or unattractiveness, and the reasons therefor, should, in conclusion, be added.

Individual Exercises for the Fall Term

Five studies follow, which are intended to be used by the student, individually, and at his own convenience. The data called for may be picked up during the course of walks afield for air and exercise; but serial or extended observations, that cannot all be made in the course of a single class exercise, are in all cases demanded. Personal initiative is desired. An instructor may be asked to name plants or animals, but the student should learn by these exercises to consult nature independently. He should work alone, or with not more than one or two companions. A good idea of the continuity of nature's processes and of her limitless perseverence in carrying them forward can be gained only by oft-repeated serial observations.

Optional Study 1. A Student's Record of Farm Operations

It is the object of this study to discover how the farmer as an organism fits his environment. The student may learn that there is a natural history of the farmer as well as of the farm. He may see that the farmer's affairs, commercial, civic, social, and religious, all have their seasons, even as leaves have their time to fall; that light and temperature and rainfall condition his activities, as they do the growth and the labors of his plant and animal associates.

The work of this study will consist of weekly observations extending through the term or year. In such a table as is indicated on the next page, there is to be provided one column for the observations of each week. The student will need to be so situated that he may readily observe week by week what the farmers are doing; else he would better omit this study, for secondhand information is not desired.

Observed during the week beginning			Sept. 28th	Oct. 5th, etc.
Place of observation				
Relevant weather conditions				
Farmers observed doing what with	Cereals			
	Forage Crops			
	Root Crops			
	Fruits			
	Timber crops			
	Other crops			
	Live stock			
	Poultry			
	Other animals			
	Soils			
	Roads and fences			
	Domicile			
	Other activities	Business		
		Civic		
		Social		
		Misc.		

Footnotes:

Optional Study 2. Noteworthy Views of the Farm

The object of this study is merely to set the student to observing the beauties of his immediate environment. Let him not be troubled about artistic standards. Nature furnishes the artist with his models. Art grows, like agriculture, by the selection and intensifying of the best that nature offers. Let the student merely select and locate what appeals to him as being good to look upon. Let him record his choice in some such table as is outlined on pages 130 and 131, each view after its kind.

Optional Study 3. Noteworthy Trees of the Farm

One does not know trees until he knows individual trees; until he has compared them, and has noted their personal characteristics; has observed the superior crown of this one, the symmetrical branching of that one, the straight bole of the other one. There are trees that each of us know because accidental planting has placed them where we have found it convenient to rest in their grateful shade. There are fine trees made famous by their historical associations, and endeared thereby to a whole people; such is the Washington Elm at Cambridge, Massachusetts, the tree under which George Washington took charge of the colonial armies at the beginning of our war for independence. But there are yet finer trees remote from human abode and unknown to fame, standing in almost any original forest, that appeal as individuals to a naturalist. They are tree personages worth knowing. The work outlined in the table on page 129 will lead to acquaintance of this desirable kind. If the student does not already know the different kinds of trees by sight, this study should not be undertaken until after the work outlined in class exercise 9 on page 76 has been completed. A few subsequent rambles among the trees of the farm will then give opportunity for locating and getting acquainted with the fine specimens of each species.

		Name	Location: Map	Location: Situation	Chosen for†	Best viewed from
Best specimen I have seen	Conifers	White Pine				
		Hemlock				
		Cedar				
		Larch				
	Nut-bearing trees	Oak*				
		Hickory*				
		Chestnut				
		Butternut				
		Beech				
	Other trees	Birch*				
		Maple*				
		Elm*				
		Ash*				
		Basswood				
		Sycamore				
		Tulip tree				
		Hornbeam*				
		Flowering Dogwood				
					Remarks	
Best bit of woods		Pine Woods				
		Oak Woods				
		Elm Woods				
		Beech Woods				
		General Forest Cover				

*Any species, but specify which species.
†Symmetry, columnar trunk, type of branching, color, etc.

NOTEWORTHY VIEWS

	Kind of view	For what selected
1	A wide panorama	
2	A long vista	
3	A woodland aisle	
4	Undulating fields	
5	A small sheltered valley	
6	A crop in the field	
7	A meandering brook	
8	A pond scene	
9	A waterfall	
10	Rocky cliffs	
11	A foliage picture	
12	A scene with farm animals	
13	A snow scene	
14	A homestead	

Prints, sketches, or diagrams of the views selected

Location	Best seen from	At what time

may be added to the record, but are not required.

Optional Study 4. Autumnal Coloration and Leaf Fall

Probably the grandest phenomenon of nature that is peculiar to our northern latitude, is the coloration of the woods in autumn. All marvel at the display. Few observe it carefully. It is the object of this study to direct attention to some of the external features of it: the mechanical preparation of the leaf for its fall, the changing pigments of the residual leaf contents, and the relation of these changes to temperature and rainfall, etc. The whole process is a wonderful adaptation to meet winter conditions, and how admirably nature manages it! She first withdraws all food materials from the leaves into the stem and branches. Then she starts her wonderful display by elaborating bright pigments out of the residue. Then she casts the leaves off in an orderly fashion, developing breaking points at proper places. So she diminishes to a very small percentage the area of exposed evaporating surfaces, and thus she conserves moisture in the plant body through the long cold season. The changing hues of autumn are more or less accidental by-products of this process; but they are very beautiful.

The work of this study should include serial observations on a dozen or more of the more brilliantly colored species, continued from the first appearance of an autumn tint until the last of the leaves have fallen. The same trees should be observed day by day, account being taken of the relevant weather conditions. Hence, trees, shrubs and vines near at hand should be chosen. Those on the lawn are apt to be as good as any, since ornamental planting in our day takes careful forethought for the autumnal display.

Optional Study 5. A Calendar of Seed Dispersal

This study is intended to follow the class work of Study 8 (The November seed-crop, page 69), and to continue through the second half of the fall term. A dozen or more of the species of plants found at that time holding a full crop of seeds should be observed at least once a week during the remainder of the term. Thus, nature's method of conserving the supply, and of distributing it according to the needs of her population, may be seen. No great amount of time will be required if plants near to one's daily route to and from work be chosen. A specimen of each kind of seeds, inclosed in a small envelope and labelled, may be handed in with the record of this study, if desired, for greater certainty of determinations. The observations may conveniently be recorded in a table prepared with the following column headings:

Name (consult an instructor if you do not know the plant).
Kind of plant (tall herb, low herb, vine, trailer, etc.).
Seed cluster (illustrate by a simple diagram).

Seed dispersal:
- manner (seeds lost singly, in pairs, in clusters, etc.)
- agency (wind, water, animals, plant automatism, etc.)

Date of:
- seeds first out.
- maximum dispersal
- final dispersal.

Remarks

An additional optional study may be allowed to any student who desires to acquaint himself further with the local trees, by repeating Study 9 as an individual exercise with an entirely new list of tree species.

Name	Leaf-form[1]	Color						
		First tint	Mature tint	Date	Fading tints	First appearing		
						Where on leaf	Where on tree	In what situation[2]

[1]Diagram, including all leaflets if compound.
[2]Wet or dry ground, sun or shade, etc.

Condition of falling leaves[3]	Date of loss of leaves		Conditions[4] accompanying maximum fall	Remarks
	Maximum	Final		

[3]As to breakage into pieces, extent of withering, etc.
[4]Of frost, wind, rain, etc.

THE EXPOSITION

She and I went to it, the Big Fair.
We were the whole Attendance.
It was all under one roof which was called The
Sky.
Every day this was rehued by invisible brushes,
gloriously,
And at night all lit by countless lights, star-
shaped,
And arranged curiously in the form of Dippers
and things.
It must have cost a fortune in some kind of rare
coin
To do it that way.
By day the place was vast and very beautiful.
The far edge of it, all around, was called the
Horizon.
Each morning, out of the East,
A huge golden disk came
And swung itself slowly up along the arch of the
sky-roof
And settled to the Westward, leaving numerous
glories behind.
There was a water-place there, a Lake, with an
Inlet and an Outlet.
It was not little and brown like those you see in
Madison Square Garden,
But big and blue and clean.
We splashed ourselves in it and laughed, like
children.
The Lake had trout in it;
I saw them leap when the water was still
And the golden disk was falling.

—*Richard Wightman.*

PART II

Studies for the Spring Term

XVII. THE LAY OF THE LAND

"*The hand that built the firmament hath heaved*
And smoothed these verdant swells, and sown their slopes
With herbage, planted them with island groves,
And hedged them round with forests. Fitting floor
For this magnificent temple of the sky—
With flowers whose glory and whose multitude
Rival the constellations."

—Bryant (*The Prairies*).

Chief of all land laws is the law of gravity.

The solid crust of the earth is overspread with a thin film of loose materials that collectively we call the soil. How thin a film it is as compared with the great mass of the earth! Yet it is the abode and the source of sustenance of all the life of the land. It enfolds and nourishes the roots of all the trees and herbage. It clothes itself with ever-renewing verdure. On it we live and move. From it we draw our sustenance. We usually mean this thin top layer when we speak of the land.

This film of soil covers the rocky earth-crust with great irregularity as to distribution and depth; for its materials are derived in the main from the weathering of the rocks. Alternating frost and sun have broken them to fragments; attrition and chemical action have progressively reduced the fragments to dust; wind and flood have mixed them and mingled with them the products of life and decay. Sun and frost and rain and wind and life and decay act intermittently, but gravity operates all the time. Weathering and gravity are the great factors in the modeling of the landscape. While weathering gleans the basic soil materials from the solid rock, gravity disposes of them: removes them almost as fast as formed from the vertical face of the cliff: lets them lie on the level summit: sweeps them down the slope: spreads them out over the flood plain, making level fields; or carries them far away with the rushing flood to dump them into the bottom of the sea, where, removed from light and air, they are lost to our use.

Thus the rugged and geologically ancient outlines of topography are softened by erosion and the more level places are overspread by a mantle of productive soil. Erosion rounds off the sharp edges of the headlands; silting fills the low places; delta building covers the shores about the mouths of streams; everywhere as time runs on, sinuous lines replace the sharp angles, and verdure replaces the gray pristine desolation.

Let us go to some good point of outlook, some hill-top or housetop or tower, and view the topography of our own neighborhood, to see how the land lies. We will let our eyes wander slowly from the near-by fields upward to the summit of the distant hills, and downward to the level of the valley; we will follow the stream that meanders across the valley floor, back to its more turbulent tributaries, and on to the little brooks that run among the hills. Upland and lowland levels, and intervening slopes:—these are the natural divisions of the land; and their boundaries are all laid down by gravity. Water runs down hill, and loosened soil materials move ever with it. They may glide unnoticed as tiny films of sediment trickling between the clods of the fields; or they may move in great masses of earth and stone as a landslide, scarring the face of the steep slope; but ever, with the aid of water, they move to lower levels, and slowly the form of the hill is changed. Flood-plains broaden: valleys are filled; the slope grows gentler; and the upland plains are narrowed by invading rills.

Outspread before us as we look abroad over the landscape, with its levels of checkered fields, its patched and pie-bald hills, its willow-bordered streams and reedy swales, is this blanket of soil, which seems so permanent, yet which is forever shifting to lower levels.

Water, descending, follows the lines of least resistance. Hence, from every high point, slopes fall away in all directions. Some are turned southward toward the sun, and are outspread in fields that are warm and dry; others face the north, and receive the sun's rays more obliquely, and are shadowy, moist, and cool. Some are exposed to the sweep of the prevailing wintry winds; others are sheltered therefrom. Some are high and dry; others are low and moist.

Nature has her own crops, suited to each situation; sedges where it is wet; grasses where it is dry; spike-nard in the shade; clovers in the sun. None of them alone (as we raise plants) nor in rectangular fields, but each commingled with others of like requirements, and each distributed according to conditions of soil, moisture and exposure. One may see how nature disposes them by comparing the life in wet marsh and dry upland; or that of sunny and shaded sides of a wooded glen.

Under natural conditions the soil of the gentler slopes remains in comparative rest, for it is held together by a network of roots of living plants; these never (except under the plow) let go all at once. One dies here and there, now and then, and adds its contribution of humus to the topmost soil layer. Under natural management, the fields are permanently occupied and never exhausted. The richness of the soil is ever increasing. Our stirring of the top soil enormously accelerates erosion. Our four-square fields and cross-lot tillage are well enough on the upland and lowland levels where conditions are fairly uniform and the loosened topsoil cannot slip away into the stream; but among the hills, they need to be adapted to suit the conditions found on the steeper slopes. To plow a fertile slope in furrows that run up and down its face is to invite the storm waters into prepared channels that they may carry the soil away. Too often the surveyor's lines take no account of the true boundaries of nature's fields, and the plowman knows not the existence of a law of gravity. Many a green hillside, fit to raise permanent crops in perpetuity, has been cleared and plowed and wasted in hardly more time than was necessary to kill the roots of the native vegetation. Fortunate is our outlook if the hills round about us are not scarred with fields that bear silent testimony to such abuse—fields that are gullied and barren, with their once rich top soil, the patrimony of the ages washed away,.

It is no small part of the glory of many charming inland valleys that is contributed by the noble woods that climb the side of its bordering steeps. The clearing of such land should never be allowed; for rightly managed, it will go on raising trees forever (and probably there is no better use for it), and the scenic beauty, the restfulness and charm which it contributes to the landscape is a valuable public asset. Steep slopes may be tilled permanently if the tiller of the soil will take a hint from nature and regard the law of gravity—if he will run his culture lines horizontally, break the slope with terraces, and hold the front of these with permanent plantings. Some of the most beautiful landscapes of the old world are found among terraced hills that have been cultivated for centuries. But the simpler method of holding the soil together by untilled crops—pastures and tree crops—is probably more suited to American conditions.

Fortunate is our outlook, also, if in the midst of thriving farms and forested hills, there be left a little bit of land here and there that has not been too much "improved." A bit of wildwood, where the brush is not cut nor the swamp drained—a place, preferably near the school, where the native life of the land may be found—a sanctuary for the wild birds and all the other wild things, plants and animals, to which the youth of the rising generations may go in order to see what the native life of his native land was like. The wild things are rapidly vanishing. Where would one find even now a bit of the rich unaltered wild prairie that once overspread the interior of this continent, with its tall, waving grasses and all its wealth of wild flowers?

The landscape belongs to all. Its smiling slopes, or their forlorn tatters, affect the public weal. It is good to dwell in a place where the environment breeds contentment; where peace and plenty grow out of the right use of nature's resources; where smiling fields yield golden harvests, and where well kept home-steads nestle amid embowering trees; where both the beauty and the bounty of nature are acknowledged, and wise measures are taken to improve her gifts, and to leave them unimpaired for the nurture of coming generations. Men have attained to profitable co-operation in many lines of enterprise. May the time come when they will be able to co-operate in organizing for their best use all features of the larger units of their environment; when they will preserve for public use the things that meet the common social needs; when they will begin to correct the ills that grow out of arbitrary and artificial boundaries, by following the lines of nature; when they will learn to put all fields to their best use, securing productiveness, convenience and beauty.

Study 17. The Natural Fields of the Farm

For the purposes of this study a somewhat diversified area should be selected, including bottomlands, large or small, bordering hills and level uplands, traversed by little streams. A map should be provided, showing soil types and all principal topographic and cultural features.

The tools needed will be a pocket compass for taking directions, and a 100-ft. line, a hand level, and a surveyor's rod for measuring gradients.

The program of work will consist in:

1. A trip across the uplands, slopes and flood plains, observing their exposure and measuring their gradients. Natural adaptations to particular crops, and to choice sites for burrows for particular animals, should be noted.

2. A comparison of the life and conditions in sunny and shaded slopes of a wooded ravine.

The record of this study may consist in:

1. The map with the natural fields roughly marked out in part—*i.e.*, the areas that are much alike in soil, gradient, exposure, etc., and that are, therefore, adapted to one kind of crop. Mark direction of slope and percentage of grade (roughly determined by measuring the descent per hundred feet with level, line, and rod at some average place) in each field. Mark also on the map the direction of the prevailing wind of the season that is most trying to vegetation.

2. A summary statement as to relative area of each exposure; also the maximum gradient found under cultivation, and the condition of its soil.

3. A comparison in word or diagram of the two sides of a wooded ravine having an East and West direction, as to, (a) tall plants, (b) undergrowth plants, (c) moisture, (d) accumulation of humus.

XVIII. THE DECIDUOUS SHRUBS OF THE FARM

"There the spice-bush lifts
Her leafy lances; the virburnum there,
Paler of foliage, to the sun holds up
Her circlet of green berries. In and out
The chipping sparrow, in her coat of brown,
Steals silently, lest I should mark her nest."

—Bryant (*The Fountains*).

The lesser woody plants of the farm have not been held in much favor by the farmer. They have not been very useful to him, and they have tended to overrun his fence-rows, to close up his roadways, and to fill every untilled opening in his woodlot with unusable and unsalable stuff. Next to the trees, they are, in new soils, the greatest impediment to tillage; and unlike the trees, they yield no valuable products to repay the labor of clearing the ground. What we call shrubs, the pioneer knew by the uncomplimentary name of "brush."

Still, shrubs have many uses, as every woodsman knows. An important use, once made of them by the redmen, is indicated by the surviving name, arrow-woods. Before the days of manufactured metal nicknacks, the farmer punched out the huge pith from pieces of elder and sumac and made sap-spouts for his sugar-trees; and in the same way his boys obtained tubes for pop-guns and squirt-guns and whistles. Annual shoots of willow—willow rods—have long been and are still the basis of a great basket industry. Many clean growing stems of shrubs make beautiful walking-sticks; but this is of no consequence, since few members of our species really need three legs to walk on. And there is one use, now almost obsolete, but once in high esteem—an educational use, that was supposed, by the disciplinarians of the old school, to be served by the straight "switches" of a number of shrubs, notably of the hazel. The writer well recalls a district school-room and a teacher's desk behind which stood a bunch of straight hazel rods. They were always ready. Their use once only was figuratively described a a "cup of hazel tea," and their continued use, as "a course in sprouts".

A number of our native shrubs produce edible berries, as noted in Study 2; such are currants, gooseberries, elder-berries, buffalo-berries, nannyberries, blueberries, etc. Hazels and filberts produce fine nuts. The best of these edible products have been so much improved by selection and care that the wild ones are no longer of much importance to us. The roots and bark of other shrubs, ninebark, spicebush, prickly ash, witch-hazel, etc., are used medicinally. The wood of sumach and prickly ash has ornamental uses because of the peculiar yellow color.

But if of no great economic value, these shrubs are very interesting to a naturalist. Some of them, like the wild rose and the azaleas, have splendid flowers, the flowers of the white swamp-azalea being deliciously fragrant; and the great clusters of minute flowers on elders, viburnums, spiræas and buttonbush are strikingly handsome. Even in winter, there is color in the bushes. The stems of the osier dogwood are of a lively red color; those of moosewood and the kerrias are light green; and the panicled dogwood gives to any bank it overspreads a fine soft purple tint. The persistent fruits of such shrubs as snowberry and winterberry add charming touches of color to the landscape in winter. The latter is especially effective when seen forming a band of scarlet around the border of a meadow.

As with the trees (Study 9), so with the shrubs, winter brings the characters of their stems into view. With the fall of the leaves, striking differences in the twigs appear. They are coarse and remote in sumach and elder and others that bear great compound leaves; they are slender and tangled in spiræa and blueberry and other small-leaved things. The twigs of azalea, witch-hazel, the hobble-bush, the spreading dogwood (*Cornus alternifolia*) and other shrubs of the shade tend to spread in horizontal strata; those of the New Jersey tea and of willow and others that grow in the sunshine, to rise erect. Buckthorn and prickly ash and brambles stand with all their naked thorniness revealed. There is the utmost diversity of habit, even among those near of kin. Among the

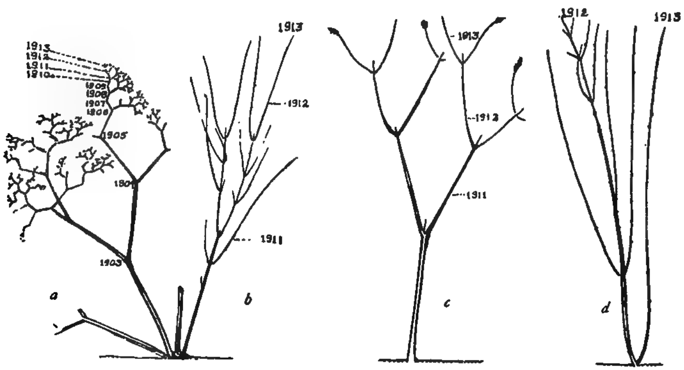

Fig. 57. Diagram of the growth of shrubs, showing annual increments. *a*, an old shoot of maple-leaved viburnum, *b*, a young shoot of the same. *c*, a four-year-old shoot of sumac. *d*, a two-year-old shoot of black-berried elder.

honeysuckles are arrant stragglers (*Lonicera sullivantii*) and compactly-growing bushy shrubs (*Lonicera canadensis*). Some shrubs, like azaleas and blueberries, attain their full stature by slowly-added annual increments, and others, like elder, shoot up stems to full height in a single season. In several genera of shrubs, such as blueberries and sumachs, there are both giants and dwarfs.

All shrubs are underlings; they cannot compete with the trees. Once in possession of the soil, they can keep trees out only by forming so dense a shade that no tree can get a start. Once an oak or a maple gets its head above the common level it has the advantage of them, and can suppress them with its shade. By the roadside and in the fence-row, where the farmer keeps the trees cut down, yet does not plow, there they find their best openings. And, indeed, it were better for the farmer to raise "brush" in his roadside than to kill the brush and raise weeds there to contaminate his fields; better to cover the bare and barren slope with soil-conserving shrubbery than to have its soil slipping away into the streams; better to fill the border of his lawn with these plants that are beautiful in foliage and flower and fruit, than to be forever mowing the whole of it.

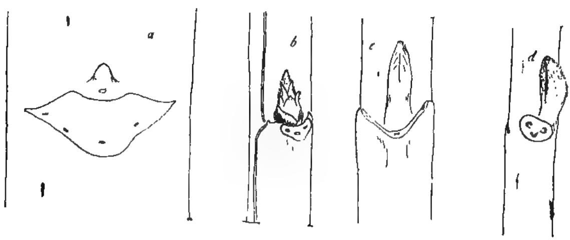

FIG. 58. Diagram of buds and leaf scars; *a*, in black-berried elder; *b*, in ninebark; *c*, in red osier dogwood and *d*, in witch-hazel.

The thing to do with the "brush" is first of all to study it a little, and find out what it is good for. If only by its shelter it provides nesting sites and keeps some useful and beautiful song-birds about the place, it may still be worth while. It may also provide food for the birds, if proper shrubs be chosen (see page 201). And if rightly used—if used in such ways and places as nature's plantings suggest—it adds much of interest and value to any property, in the beauty and grace of its flowers and foliage.

Study 18. The Deciduous Shrubs of the Farm

The program of work will consist of a trip for shrubs to the places where they grow best: borders of woods, fence-rows, or roadside. A dozen or more of the native species found should be carefully compared as to characters indicated by the headings of the table on pages 148 and 149.

The record of this study will consist of:

1. The completed table.

2. Contrasted diagrams of a few stems from clumps of (*a*) a quick-growing, and (*b*) a slow-growing shrub, the annual increments of growth to be marked with the years of their origin, as in figure 57. The end of each season's growth is usually evident by reason of the clustering of buds at the tip, if it be wholly hardy, or, by dead tips with each season's growth starting from lateral buds, if not all the growth be matured in any season. Untrimmed wild shrubs should be chosen for this.

3. An annotated list of all the wild shrubs found, arranged in the order of their relative abundance in the several situations visited as follows: *a*, shrubs of the woodland undergrowth; *b*, shrubs of the waterside; *c*, shrubs of the fencerow, and of other open sunny places, etc., listing thus separately the shrub-associations of the more typical situations visited in the course of the trip afield.

DECIDUOUS SHRUBS

NAME	Height	Annual[1] Shoots	Growth[2] Habit	Grows[3] Where	Twigs		
					Diameter[4]	Color	Misc[5]

[1] Maximum growth of one season in centimeters.
[2] Erect or spreading, slender, bushy, etc.
[3] In sun or shade, wet or dry ground, etc.
[4] Average diameter of an average twig in millimeters.
[5] Clustering of buds, hairiness, thorns, etc.

OF THE FARM

Buds				REMARKS[8]
Form[6]	Color	Arrangement[7]	Leaf-scars[6]	

[6] Diagram.
[7] Opposite, alternate or whorled.
[8] Note persistence of seed-pods, presence of flower-buds, winter-killing of tips, or other peculiarities not elsewhere noted.

XIX. WINTER ACTIVITIES OF WILD ANIMALS

"Of all beasts he learned the language,
Learned their names and all their secrets,
How the beavers built their lodges,
Where the squirrels hid their acorns,
How the reindeer ran so swiftly,
Why the rabbit was so timid,
Talked with them whene'er he met them,
Called them 'Hiawatha's brothers'."

—Longfellow (*Hiawatha's Childhood*).

In winter, Nature puts most of her animal population to sleep. In lodge and in burrow and under every sort of shelter, they hibernate. This saves food at the season when food is most scarce, and removes the less hardy, for a time, from the stress of competition. Numerically, it is a very small fraction of the total animal life that remains active during the winter: only a few birds and mammals. Most birds have gone far south, and many mammals lie, like the woodchucks, dormant in their burrows. But more than we are likely to see, unless we diligently seek them out, are active in our midst throughout the season.

After every snowfall, there is a new record made of the winter activity of animals; and anyone, who knows the signs, may read it. On the snow, as on a new white page, each animal prints its own indisputable narrative. Its footprints tell where and whence and how it ran. The leavings from its luncheon tell what and where and how it ate. The chips from its woodworkings, the scales from its huskings, or the earth from its diggings, tell how and where and why it labored. And if, by mischance, it fell a prey to some fierce foe, its blood-stained fur or feathers by the wayside tell how its little life ended in a tragedy.

On the soft snow we may find the "signs" of animals that we rarely meet. Where we have seen no rabbits, the brushwood may be overrun with their tracks. Where we have seen no snow-birds, the weed patch may be littered with the husks from their feeding. If we are beginners in woodcraft, we will need to see the animals that make the snow-records in order to identify them; but we may perhaps learn the difference between tracks of a skunk walking and of one running by trying out these gaits, and observing the results, with the family cat. Later, knowing what animals are to be expected,

FIG. 59. Tracks on the snow of mammals, walking. *a*, rabbit; *b*, skunk. (Drawn from photographs).

FIG. 60. The record of a morning excursion of a red squirrel in search of a breakfast. Arrow indicates direction taken; *h*, hole where a nut was obtained. (Drawn from a photograph).

we may identify some tracks by exclusion of the others which we have already learned. If the only large birds in a wood are grouse and crows, the tracks will differ plainly in the position of the foot and in the size of the print of the hind toe. Knowledge of number and length and freedom of toes, and a knowledge of gaits and postures of body, will be of great value in identifying all tracks.

The "signs" of animals that a woodsman knows are very numerous: footprints, tail prints, wing prints (as of a strutting turkey gobbler; or the outspread pinions of a bird taking flight), dung, marks of teeth in gnawings, bark, scales, chips, borings, diggings, detached feathers and hair caught on thorns, etc. Muskrat and deermouse drag their tails, leaving a groove on the surface of the snow between the double line of footprints. The crow drags his front toe, leaving a narrow trailing mark between his sole-prints. Tracks are the signs chiefly used by the woodsman, and next to tracks, are the evidences of feeding. Where the quadruped halts, there are apt to be found, gnawings of bark, or digging of roots, or descents into burrows, or ascents for scouting. The woodsman follows the animal's trail, and from such signs as these reads his successive doings like a book.

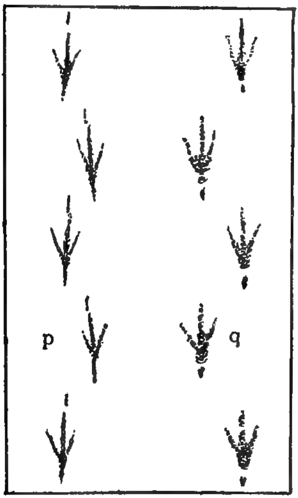

FIG. 61. Bird tracks; *p*, crow; *q*, ruffed grouse.

The trails that birds leave are less continuous, because betimes the birds betake themselves to the trackless air; but in a wood where crows feed, one may see such diverse things as the wastage from their pickings of sumach and poison-ivy berries, corncobs from ears brought from a neighboring field, leaves of cabbage stolen from some neighborhood garbage heap, and fragments of charcoal, which the crows have picked from a burnt stump, perhaps to use as a condiment, perhaps to improve their complexion. And the birds that work in the treetops leave the evidences of their feeding scattered about over the surface of the fresh snow beneath the trees.

Much pleasure may be derived from observing the winter activities of wild birds near at hand if one will feed them. It is easy to attract them to feeding places within view from one's window. Some of the more familiar little birds, such as chickadees, nut hatches and downy woodpeckers, will come to the window ledge for food in time of scarcity. The chief points to be observed in winter feeding of wild birds are these:

1. *To give them food they like*—things akin to their natural diet. Many birds like the leavings from our tables—crusts of bread, scraps of meat, boiled cabbage leaves, bananas, nuts, etc. Suet is very attractive to many arboreal birds, and if a piece be tacked to a convenient tree trunk under a piece of wide-meshed wire netting, the birds can get it a mouthful at a time and cannot fly away with the whole piece at once. A feeding shelf at one's window should have a rim around it to prevent the food from blowing away, and it may with advantage have a roof over it to keep off the snow.

2. *To place the food where birds will go to it.* Observe their natural feeding places. Grain for wild fowl should be scattered on the ground in covert places. Hollow "food-sticks" filled with fat and nailed up in the trees are irresistible to woodpeckers. Sparrows will not feed upon a swinging or an unstable support: hence, if they over-run a feeding shelf, suspend the food and they will leave it to other birds.

3. *To avoid unnecessary alarms*. The sight or smell of a cat will keep birds away from one's window. So, will excess of noise, or undue publicity. The back yard is better than the front yard, especially if fruit trees be near; and the feeding shelf will be doubly attractive if it be partially screened and sheltered by evergreen boughs, and have easy approach from neighboring trees.

At least one sort of winter feeding is of much practical importance. Rabbits and mice love to eat the green bark of young trees; especially, of apple trees. They girdle such trees and kill them. So the careful grower protects his trees by wrapping their trunks with something inedible, such as wire cloth or tarred paper. Towards the end of winter, one may often see such gnawings on the bases of young trees and shrubs in the woods. In maple woods, where porcupines run, much bark-stripping is often seen on young trees.

A large part of the joy of a tramp through winter woods lies in being able to interpret these signs and to know what is going on. To a naturalist, the woods never seem uninhabited; for every path is strewn with the evidences of the work and the play, the feasting and the struggles of the creatures that dwell therein.

Study 19. Winter Activities of Wild Animals

This study is for the time when snow lies an inch or two deep upon the ground, and one or more mild winter nights have intervened since its fall—such nights as tempt the nocturnal mammals to wander from their burrows. Soft snow is necessary for the making of distinctive footprints.

The program of work will consist of a tramp through the woods, studying the tracks of birds and mammals, following up their trails, determining their direction and speed, the cause or purpose of interruptions, etc.; also observing evidences of feeding and the nature of their food.

The record of this study will consist of two separate lists, one for the birds and one for the animals of which "signs" are discovered, with notes on the kinds of "signs," and the activities indicated by them, their relative abundance, food, etc. Both lists should be illustrated with simple diagrams of tracks, with direction and gait (whether walking or running) indicated.

XX. THE FIBER PRODUCTS OF THE FARM

"Give me of your roots, O Tamarack!
Of your fibrous roots, O Larch-Tree!
My canoe to bind together,
So to bind the ends together
That the water may not enter,
That the river may not wet me!"

—Longfellow (*Hiawatha's Sailing*).

Before the days of spinning, what did one do when he needed a string? Just what the country boy still does when out in the woods. If he has to tie something and lacks a string, he borrows one from nature. It may be a tough root of tamarack or elm, a twig of leatherwood or willow, a strip of willow peel or of the inner bark of basswood. Best of all barks is that of young pawpaw trees, which may be stripped upward from the base in bark-strings having great length and strength and pliancy.

From using single strips of plant tissues such as these (or of more valuable rawhide), transition is easy to the use of bundles of strips for tying. The harvestman binds his sheaves with a band of grain stems, drawn tightly, the ends overlapped, twisted together, and tucked under to form a knot. And if a mower wishes to bind up a large bundle of hay with short grass stems, he makes a virtue of necessity, and twists the short stems together, combining them into a "hay-rope" of any desired length, and binds his hay with that.

The hay-rope illustrates a fundamental operation on which all textile arts are based. It is elemental spinning—the twisting of fibres together to combine their length and strength.

"In Samoa, it is the work of women to make nets chiefly from the bark of the hibiscus. After the rough outer surface has been scraped off with a shell on a board, the remaining fibers are twisted with the palm of the hand across the bare thigh. As the good lady's cord lengthens, she fills her netting needle and works it into her net. . . . The example of one of the Samoan women twisting, without the aid of a spindle, strips of bark into cord is as near to the invention of spinning as we may hope to come."—Mason (*Woman's Share in Primitive Culture*, p. 68).

From the tightly twisted grass stems of the hay-rope, it is not a long step to binding-twine, made of long cleaned bast fibers; nor thence to rope, which is a compound of such twines; nor thence to cords and thread, made of shorter, softer and finer fibers of linen and of cotton. It is the twisting that grips the overlapped fibers together and holds them by

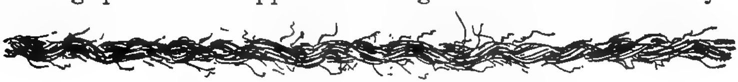

FIG. 62. Loosely twisted fibers of coarse twine.

mutual pressure. Braiding accomplishes the same result for a few fibers of uniform size, but even for these it has the disadvantage, as compared with spinning, that it bends the fibers more sharply, tending to break them, and yields a flat cord, having less pliancy. Both spinning and braiding were practised in all lands before the dawn of history. Everywhere man had need of strings, longer than any that nature offered ready-made. He gathered what he could find and combined them, first into coarse cordage, strong enough to fetter wild beasts or to bind up the poles of his primitive dwelling, and then into an endless variety of finer products, as progress was made in the art of spinning.

Sewing threads were long unspun, and differed in kinds in different parts of the earth. Horsehairs served our barbarian ancestors in Europe for their sewing: the shredded sinews of the deer served the Indians of the northeastern United States; and the fibers of the yucca, those of the south-west. Each yucca fiber terminates at the surface of the leaf in a spine which serves as a natural needle, permanently threaded; both horsehair and sinew-thread were thrust through punctures made with a bone awl—the antecedent of the sewing-needle. The stiffness of these fibres was therefore an advantage. Every land has its own fiber products, and these give character and individuality to its textile arts, notwithstanding that braiding and spinning are the same fundamental operations everywhere.

Simple as is the process of making a cord from loose fibers, spinning is one of the greatest of human inventions. Weaving, the making of cloth by the interlacing of cords thus spun, is its complemental art. Spindle and loom are symbols of modern civilization; they have done more than almost any other mechanical aids, to change the conditions of our living from that of our savage ancestry. Yet spindle and loom had humble and far-off beginnings. The primitive spindle was a smooth stick that could be fastened at one end to a mass of loose fibers, and twisted at the other with the fingers, winding the fibers into a thread as they were drawn out from the mass; or elsewhere it was a suspended whirling bob, that could be set in motion with the hand. The primitive loom was a low horizontal bough of a tree, with threads of the warp suspended from it. The threads of the woof were twined in and out by hand. With an equipment only a little more complicated than this, some of the finest products of the world's textile art have been produced.

Birds weave crudely, but they do not spin. They accept from nature and use in their nest building a great variety of fibers, but they have not attained to the art of lengthening their cordage by twisting short fibers together. This is a human art. The foundation of an oriole's nest (fig. 63), consisting of a few strands of cordage suspended from a twig, is not far removed. either in principle or in form, from the warp of a primitive loom, such as women of certain tribes use to-day. Into this warp the threads of the woof are woven, by the woman with her fingers (aided, perhaps, by a crude wooden shuttle), by the bird with its slender beak. If anyone think that the weaving of the oriole is not well done, let him sit down with an empty nest and try to unravel all its threads!

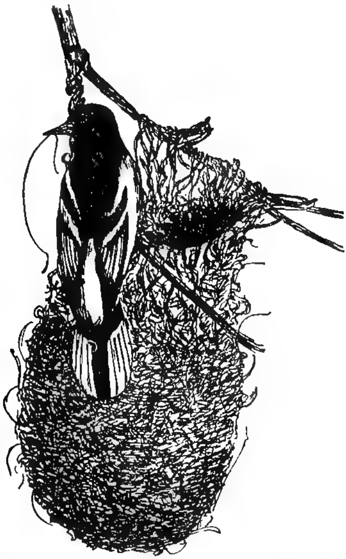

FIG. 63. An oriole at his nest, bringing a thread for the weaving.

The fiber products used by the oriole are such as were first used by man for textile work—strips of bark, strands of bast fibers, long hairs from the tails of horses and cattle, grass stems and leaves; in short, anything that nature offered, and that had sufficient length, strength and pliancy. In our day, this bird has adopted one of the products of our spindles, cotton-wrapping twine, for the warp of its nest, doubtless finding, just as we have found, that this is superior for the purpose to anything that nature offers ready-made. Perhaps we thus repay an unacknowledged debt we may be owing this bird-weaver; for possibly some poetic soul in an age long gone may have watched an oriole at his labors, as Lowell did:

"When oaken woods with buds are pink,

. . . .

Then from the honeysuckle gray
The oriole with experienced quest
Twitches the fibrous bark away
The cordage of his hammock-nest,"

and may have taken a hint. At any rate, the earliest of human textile products appear to have been hammocks and baskets and coarse bags.

Where did man find his first textile fibers? Doubtless, where the oriole found his. He saw the threads of bast flying in the wind from the stem of the tattered roadside reed. He plucked them and tested them and looked for more. He found such fibers were most easily separable from the stems that had lain rotting in the pool. So he took the hint, and threw other stems into the water to rot and yield their fiber. So he continues to do, even to this day. He immerses his flax stems to dissolve the plant gums that hold the fiber and the wood together; and after a week or two of soaking and softening, he removes them from the water, "breaks" them, "scutches" them to remove the broken bits of woody stem, "hackles" them to separate (by a combing process) the "tow" from the long, clean fiber, which is then available for spinning into linen thread and for weaving into cloth.

By similar treatment, bast fiber is obtained from hemp and jute and other plants having annual stems. Wild "Indian hemp" or dogbane (*Apocynum cannabinum*) furnished bast fiber to the aborigines in the northeastern United States before the coming of the white man. Other wild plants having good bast fibers are swamp milkweed (*Asclepias incarnata*), marshmallow (*Hibiscus moscheutos*), stampweed (*Abutilon avicennæ*), nettle (*Urtica gracilis*), burdock (*Arctium lappa*), sunflower (*Helianthus annuus*), etc. Many other plants produce good bast fibers, which vary much in length, strength, ease of separation and adaptability to manufacture. We have learned how to handle profitably a very few products among the many that nature offers.

This is even more true of the cottons, which grow as single-celled fibers upon the surfaces of seeds. One species only we have learned to spin, tho we know many others, such as cottonwood, thistle and milkweed, producing fiber abundantly.

The fiber products of the world's farms are exceeded in value only by the food products. The chief animal fibers are, in the order of value, wool, silk and hair: the chief plant fibers are cotton, flax and hemp. None of the plants or animals concerned is native to our soil. We have not found out how to use any of the native fiber products with profit. In this, as in so many other fields, the great discoveries of nature's material resources were made by our forefathers in other lands and in a far distant age, antedating history.

FIG. 64. Cotton-bearing seeds issuing from milkweed pods.

The chief use for fiber products is found in the making of textiles. After feeding people, the next sure good, according to Ruskin, is in clothing people; and this demands great quantities of textiles. The kinky fibers of wool lend themselves ideally to the spinning process. They will hang together in simple yarns which may be knit or woven into warm clothing for cold climates. The soft fibers of linen make clothing that is cool and that may readily be kept clean for summer use. The shorter and finer fibers of cotton, being produced in greatest abundance, make the cheapest of clothing and are used in the greatest variety of ways, alone and in combination with wool, flax and silk.

Next in importance is the making of cordage. Ropes and the coarser twines consume the longest and strongest of the fiber products, such as manila and sisal; and silk fibers are used to make the finest fishing-lines.

Next in importance are, probably, upholstering and stuffing fibers. Fibers for this use are such as do not lend themselves readily to the spinning process: horsehair, "Spanish moss" fiber, kapok, "tow" (separated in the hackling of flag from the better fiber), etc. The long, silky cotton of our common milkweeds, often used for filling fancy pillows, is an excellent example. Its fiber is too smooth and straight and brittle for spinning, but its lightness and elasticity make it excellent for filling pillows.

Another extensive use for fibers is found in the binding of plastering and mortar. Of old, straw was used in the making of huge bricks, to bind the clay and preserve their form while drying. On many cabins in the South today, there are stick-chimneys plastered with clay that is held together by "Spanish moss" fiber. The moss is fermented in heaps to lay bare the fiber, which is then washed clean and chopped in short lengths and kneaded into the clay before being applied to the inner walls of the chimney. The moss fiber helps to hold the clay in place when it is newly applied, and prevents its cracking later. For like reasons, cow-hair (which is too short and smooth for spinning) is commonly mixed with the "binding" coat of plaster that is first applied to the walls of our houses. The hair is cleansed of grease and evenly mixed with the mortar in such quantity that when the latter is lifted on a trowel, some of it will hang over the edges without falling off. Wood fiber is substituted for hair in some modern ready-mixed plasters. Short, straight and strong fibers, to which plaster will adhere closely, are demanded for this use.

It is interesting to note how the birds have anticipated us in all these uses of fibers. The oriole uses the longest fibers it can find for cordage. Many birds weave shorter fibers into the walls of their nests. Most birds find suitable upholstering fibers for cushioning the eggs—horsehair or feathers or thistledown. And the robin mixes grass blades and bast fibers with the clay out of which he builds his mud nest. The birds know how to find proper raw material in great variety. Let us in the following study examine some of these undeveloped fiber resources.

Study 20. Native fiber products

This is a study for the day when the weather is most unfavorable for field work; when the cold is too bitter or the blast too fierce for prolonged work outdoors. Then, certain fiber products may be gathered quickly and taken inside for examination; but a satisfactory range of materials for this work may be had only by gathering some of them in advance.

1. Nests of birds, especially of Baltimore orioles. These nests are easy to find in winter, being suspended conspicuously from elm boughs high above the roads, but they are not easy to reach. The twigs bearing them may be clipped off with a long-handled pruner.

2. Nests of mice, especially of deer mice. These are built in the branches of bushes in the woods.

3. Cotton-bearing seeds of milkweed, etc., should be gathered in autumn at the ripening of their pods.

4. Herbaceous stems may be gathered for their bast fiber at any time after maturing, and some, such as dogbane and milkweed, should be gathered as a part of this exercise; but in order to obtain the bast readily, the stems should have been gathered earlier and "retted" for a week or more (as necessary, according to species) in water.

5. Coarser fibrous materials in variety. The bast strips of linden are obtained by stripping the bark from young trees in midsummer, when full of sap, and drying it thor-

oughly. Thereafter, at any time after soaking in water, the soft inner strands separate readily. Another fiber of unique sort is found in the skeleton cords of the rootstock of bracken fern. These may be separated from freshly dug rhizomes, by breaking with a hammer and stripping the cords clean.

The program of work for this study may consist of:

1. An examination of the fibers used in the nest-building of birds and animals.

2. An examination of the fiber products collected and prepared from native plants and animals, and comparisons with the fibers that are used in staple commercial products, such as ropes, yarns and twines. The actual use of some of these fiber products in spinning and weaving may be demonstrated, preferably with the simplest forms of apparatus, and products made therefrom may be shown.

The record of this study may consist of:

1. Notes on the kinds and character, and diagrams of the use, of fibers used by birds and animals in nest-building. Each species of bird or animal should be treated separately.

2. An annotated list of all the native fibers studied. The notes should state the source and nature of the fibers, their length, strength and other qualities, their uses and limitations, etc.

Another study on the coarse unspun materials for *Plaiting, Mat-making and Basketry*, may be made on similar lines, with similar lists of materials for its record. The things needed for this will be splints, withes, rods, reeds, sweet-grass, rushes, corn-husks, quills, thongs, etc. Suggestions may be had from the study of nests of birds and animals, and of the primitive products of the Indians of our own region. On the latter, *The Handbook of North American Indians* edited by Dr. F. W. Hodge (*Bull. 30, Bureau of Amer. Ethnology, 2 vols. Washington, 1912*) is a mine of information.

XXI. THE ICE-COAT ON THE TREES

"First there came down a thawing rain
And its dull drops froze on the boughs again;
Then there steamed up a freezing dew
Which to the drops of the thaw-rain grew;

And a northern whirlwind, wandering about
Like a wolf that had smelt a dead child out,
Shook the boughs thus laden and heavy and stiff,
And snapped them off with his rigid griff."

—Shelley (*The Sensitive Plant*).

Winter imposes some hard conditions upon tree life. In the "frozen north" there are no trees; and in our temperate clime there are only those that are able to withstand a long period of inactivity, a succession of freezings and thawings, and the heavy mechanical stresses imposed by high winds and snow and ice. The majority of our woody plants have met the difficulties of the situation by dropping their leaves on the approach of winter. Most of the tall conifers have adjusted themselves to bear winter's white burden. While retaining their leaves, they spread their branches horizontally in whorls around a single axis, and when the snow bends them, the higher branches rest upon the lower from top to bottom in mutual support. As John Burroughs poetically puts it, "The white pine and all its tribe look winter cheerily in the face, tossing the snow, masquerading in arctic livery, in fact, holding high carnival from fall to spring."

The severest test of the strength of a tree comes not from snow, but from ice; it comes not when the weather is coldest, but when there has been a thaw, and the thermometer is hovering around the freezing point. When the air is full of moisture, and the trees have been suddenly cooled by radiation, the water freezes to them, completely encasing them in ice. This usually happens toward nightfall; and if it continues long, the morning light discloses scenes of marvelous beauty. The orchard has become a veritable fairyland. Each slender stem is a column of crystal on which, at every bud and angle, is a prism dispensing rainbow colors. The drooping ice-encrusted sprays are like wreaths of sparkling jewels, and all the world is a-glitter with innumerable points of light.

But this brilliant display is a heavy burden on the trees; the stout twigs of sumach and elder bear it easily, but the slender twigs of birch and willow are bent prone, and matted together in a network of ice. Boughs, rightly placed for mutual support, become welded together by a common incrustation; but unsupported boughs are often broken by the sheer weight of the ice. And if to this burden, there be added the stress of rising winds, then great havoc may be wrought in the woods.

The thickness of the ice covering the stems is much affected by their character and position. Since the water condenses upon them and tends to gather in drops before it freezes, smooth erect stems gather less ice because the water slips away from them; while rough or horizontal stems acquire a thicker crust, and every downwardly directed point or angle is tipped with an icicle. Thus Roberts might write in his "Silver Show":

> "The silvered saplings bending
>   Flashed in a rain of gems . . .
> And amethysts and rubies
>   Adorned the bramble stems."

Slender twigs are usually tough and pliant and not easily broken: moreover they grow densely, and being more or less interlaced, they lend each other mutual support. The hedge becomes one long fenestrated wall of crystal, the twigs being encased and conjoined with ice in all directions. So joined, the ice supports the twigs; and not the twigs, the ice.

Since thawing begins at the top and liberates first the upper branches, little damage results unless winds arise to break the ice-supports. Yet the smallest of the woody plants, even those slender supple things, that may lie prone under such a burden and rise again afterward unharmed, are imperiled by the ice; for a passing foot may snap their stems when ice laden, instead of brushing them aside.

Fortunately, the ice-coat, tho it does much damage, always confers some benefits on the trees, It prunes them of dead branches. Rotting of the trunk begins wherever a dead branch persists too long. The ice greatly aids in their removal.

Study 21. Observations on the Ice-coat and Its Effects

This is a study to be made only when nature prepares the conditions. The ice-coat on the trees comes unannounced, and is often very transient: sometimes an hour's sunshine will dispel it. Sieze the opportunity, therefore, when it comes, shifting other studies if need be. The equipment needed will be a few pocket scales (spring balances) and some means of melting ice quickly, preferably a blow torch.

The program of work will consist of observations on the thickness, weight and distribution of the ice, and of its effects on trees and shrubs of different sorts. Measurements should be made of its thickness. Branches should be weighed, first laden with ice and again after the ice has been removed, to determine the load that the ice imposes. If a recent snow-fall cover the ground so that newly fallen twigs can be noted, gather the twigs under different kinds of trees, and note the relative number of dead and living, and which sorts of woody plants are most affected.

The record of this study must be made up in part to suit the conditions obtaining. If the ice be heavy or wind arise while it is on, the breakage of the trees should be recorded.

In any event, the results of the weighings and measurements above mentioned should be included and the beneficial effects in pruning of dead branches and twigs, and the harmful effects of breakage of twigs on trees of different sorts, should be recorded.

Specific assignments of work to be done is, therefore, left to the instructor.

An additional study on *The Snow-Coat of the Trees* may be made immediately after the fall of a soft heavy snow, before it is disturbed by either wind or sun. Many of the same phenomena noted in the preceding outline will be observable. There will be little damage to the trees observed; for the snow, loosely piled, is easily dislodged. It is heaped up on every possible support, and the differences in the aspect of the trees is due to the differences in the nature of the support for the snow that they offer. Horizontal boughs are continuously robed in white; erect boughs bear segregated snow masses in their forks. Every stub and angle and bud is snow-capped. Little hillocks of snow rest upon the upturned fruit clusters of sumach and wild carrot, and equally upon the pendent clusters of ninebarks and mountain ash. The bushy crown of close-growing shrubs are wholly enveloped in a meshwork of white; so, also, are the interlacing sprays of witch-hazel and spreading dogwood. Great masses of white rest upon the declining boughs of hemlocks and other evergreens; and each of these masses in the spruce terminates in blunt finger-like processes, and looks like a great clumsy glove backed with ermine. The color contrasts which the snow makes with the dark boughs of the oaks, with the red twigs of the osier dogwoods, and with the scarlet fruit of barberries, are charming. Observing and recording such things as these is a pleasant occupation for a still winter morning following a snowfall, when the out-of-doors is like a fairy land.

XXII. MAPLE SAP AND SUGAR

"I wonder if the sap is stirring yet,
If wintry birds are dreaming of a mate,
If frozen snowdrops feel as yet the sun
And crocus fires are kindling one by one:
Sing, robin, sing;
I still am sore in doubt concerning Spring"
—Christina C. Rossetti (*The First Spring Day*).

When our forefathers came to America, they found one branch of the world's sugar industry indigenous here. The making of both syrup and sugar from the sap of the maple tree had been practiced from time immemorial by the Indians. Maple sugar was the commonest delicacy in their rather plain and unattractive bill of fare. It appealed to the white man's palate, and, after furs and corn, it became one of the commonest articles of barter and of commerce. It was especially important to the early white traders along the St. Lawrence river, for that stream traverses the heart of the maple sugar region. The white man learned to make it, and soon it was used in all the households of the pioneers. In the northeastern part of the United States and in adjacent portions of Canada, maple sugar was for several generations the only sugar to be had.

The aboriginal sugar-maker cut a hole through the bark of the maple tree, and collected the sweet sap that flowed therefrom in vessels made of bark. Then he separated the water from the sugar, in part by freezing (removing the cakes of ice that formed on the surface of the vessel), and in part by evaporation. His methods were crude, and his product was dark colored and dirty; but it was sweet and wholesome. The dirt it contained was mostly clean dirt—bits of bark and chips and insects that fell into the sap, extracts from the bark containers, and decomposition products of the sugar itself.

Before the Indians, there were many animals that had discovered the springtime sugar supply of the maple trees: sap-suckers, that tap the trunks in the neatest and most methodical and least injurious way imaginable (fig. 65); and porcupines, that strip the bark disastrously from young trees, killing them outright; and red squirrels, that gnaw little basins in the upper surface of horizontal boughs and, when these fill with the sap, come to the basins for a soft drink (fig. 66). And when these larger creatures set the sap flowing, there are innumerable lesser creatures, mostly flies and beetles, that come in swarms to be partakers with them.

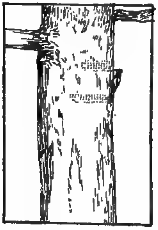

Fig. 65. A sap-sucker on a tree trunk, making lines of perforations.

This store of sweets is the accumulated food reserve of the preceding season. It is stored as starch when the leaves are active, to be transformed into sugar and dissolved in the sap in early spring. When, at the approach of warmer weather in February and March, the days are warm and bright and the nights clear and frosty, changes of pressure in the vessels of the trees, due to the great diurnal changes of temperature, set the sap flowing.

The warm sunshine on the treetops expand the air in the trunks and increases the internal pressure so that from any incis-

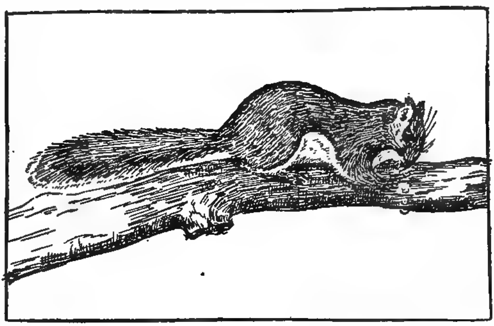

Fig. 66. A squirrel drinking sap as it exudes from a maple bough (after Cram).

ion made through the bark, from every wound or broken twig, the sap flows copiously. It flows first on the south side of the tree, where the sun shines, and it flows most copiously during the warmer part of the day. It ceases at night when the treetop is cooled and the pressure equalized. It slackens on cloudy days, and ceases altogether when the ground gets warmer. The longer the period of alternating bright sunshiny days and sharp frosty nights, the greater the amount of sap obtainable. The greater, also, is the drain of the food reserve of the tree: but the provident maples store more than they need, and they are not injured by the loss of such amounts as may be obtained by proper tapping. They often have to meet such losses through natural causes—such as the tappings of the sap-suckers, and the "bleeding" from the stubs of broken boughs.

Other deciduous woody plants lose their sap in similar ways. Every vine-grower knows that grape vines, trimmed at the time of abundant sap-flow, "bleed" profusely from the base of every branch removed—so profusely, indeed, that the plant may be weakened by such inopportune treatment. Ash and elm and beech and butternut and other deciduous trees will yield sap in its season, but only a few of the maples yield a sap that is sufficient in quantity, rich enough in sugar, and sufficiently well flavored to be important to us. The sugar maple is the best maple, both in yield and in quality of product: a variety of it known as the black maple, is especially esteemed by many growers. Red and silver maples yield a copious, but more watery sap. The Oregon maple is a western species from which a little sugar is made. The yield of the lesser maples and of the related box-elders is of no consequence. Most tree-saps, on evaporation, will yield some sort of a sweetish treacle; but only the maples yield palatable syrups and sugars, whose flavor is improved by the non-sugary natural substances present in the sap.

The tapping of a maple tree, besides draining it of sap, leaves an open wound in its trunk. It is essential to the continued welfare of the tree that the tapping be done so as to expose the interior as little as need be to the attack of fungi and insects. A small hole, that will heal over completely in a single season, is usually no more injurious than are the perforations of the sapsuckers. Such a hole is nowadays bored in the trunk with a sharp bit. It is slanted slightly upward, for easy drainage. It is bored through the sap-wood only, since the sap-flow comes from the outer layers and not from the heartwood. A galvanized iron sap-spout, having a hook to carry a pail, is driven into the hole and left there during the sap-gathering season. The sap collected is freed of its water by evaporation, and freed of various undesirable products by skimming the surface as they are raised by boiling. The owner of a "sugar bush" performs these operations in the great furnace-heated evaporating pans of his sugar house. The small boy does them on his mother's kitchen range; and if he knows the traditions of the sugar-camp, he is sure to try pouring some of his syrup, when it is thickening into sugar, out in little driblets upon the surface of clean snow, where it will harden into that most delicious confection known to the initiated as "maple wax."

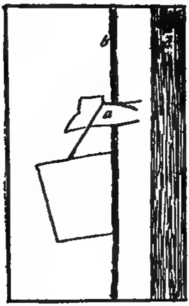

FIG. 67. Diagram to illustrate proper tapping of a maple tree. *a*, sap spout or "spile," in an augur hole, and supporting a pail; *b*, bark. The sap wood is white, the heart wood is shaded.

We live in a day of abundant sweets. Nature has always produced sugars in the juices of many plants, but we have only recently learned how to obtain them in quantity and how to purify them and prepare them for keeping and for use. New methods of manufacture and refining, and added sources of supply, have enormously increased and cheapened the product, and what was but recently a luxury in diet has become a necessity. The sugar increase has all come from herbaceous plants, that may be quickly grown—mainly sugar cane and sugar beets. Doubtless these have permanently occupied the field and maple sugar and syrup will never again be staple products. Once they were groceries: now they are confections.

Sugar-making has gone the way of all the home industries, and it is hard for the youth of to-day to realize with what keen interest and enthusiasm, all members of the household, entered into the operations of the sugar camp*. We know the sugar maple mainly as a shade tree, long-lived, hardy, clean, strong-growing, with beautiful heavy foliage. But the pioneer and the red man knew it as the source of his chief delicacies. Bound up with it are many fine traditions, both of our own race, and of our predecessors on this continent. If we could realize the poverty of sweets in the Indians' bill of fare, then we might understand why he counted the sugar maple one of the good gifts of the Great Spirit to his people; why he reverenced it and made it an object of his simple nature-worship.

Study 22. The Sap-flow and Its Beneficiaries

There is but a short time at the very beginning of spring, when nights are sharp and frosty and days bright and sunshiny, that an abundant flow of sap may be obtained from the trees. Take advantage of it, shifting other studies if need be.

The tools needed for the work will be a sharp half-inch bit and brace for tapping trees, a supply of galvanized metal sap-spouts to fit holes, and of pails (paraffined paper pails will do,

*Some suggestion of it may be obtained by reading Mrs. Comstock's excellent account of maple-sugar making in her *Handbook of Nature-Study*, pp. 739–741.

if water tight) to hang on the spouts and receive the sap; also a cyanide bottle (see p. 217): these tools are mainly for common use. Also little individual tin spoons or straws for use in tasting sap.

The program of work will consist of:

1. Tapping trees. Bore the holes with inclination slightly upward until heartwood appears in the chips. Tap all the different maples available and a few other trees as well, and collect and taste their saps. Tap one tree on north and south sides and compare sap-flow. Tap other trees with one hole only.

2. Observing sap-flow from natural wounds, from tappings of birds, from gnawings of animals and from broken green boughs and twigs.

3. Observing the animals that take advantage of the sap-flow. Birds and animals may be seen feeding at their own tappings. If there be snow on the ground, the tracks of animals about the places where sap flows down the trunks to the ground will tell of nocturnal visitors that have a "sweet tooth." Insects will be found swarming in the sunshine to every flowing wound: bees and flies and beetles of many sorts. These may be picked up in a cyanide bottle.

The gathering of the sap from the pails during the entire period of flow, and the evaporation of it, are tasks too prolonged for a class exercise, and should be arranged for by the instructor. The making of syrup or sugar from the sap is accomplished by boiling to evaporate the excess water and skimming to remove floating impurities, and may be done indoors or out, and in amounts large or small by anyone. For syrup, the sap should boil until a thermometer immersed in it (not touching the sides or bottom) registers 219 degrees Farenheit; for sugar, until it registers 238 to 240 degrees. After reaching this temperature, the fluid sugar should be removed from the fire, stirred for a time to secure uniformity of granulation, and then poured into small moulds of any sort, paper or tin, to harden. No suggestions as to the disposition of the product will be needed.

The record of this study may consist of:

1. A diagram of the apparatus in place in a tree that is properly tapped, with explanations.

2. Notes on the sap of the various trees tested, as to its quality and abundance.

3. Lists of the animals attracted by the sap-flow; with notes on their abundance, and their times and manner and place of feeding.

"Strong as the sea and silent as the grave it ebbs and flows unseen;
Flooding the earth,—a fragrant tidal wave, with mists of deepening green."—*John B. Tabb.*

XXIII. NATURE'S SOIL-CONSERVING OPERATIONS

"*Behold this compost! behold it well!*
Perhaps every mite has once formed part of a sick person—yet behold!
The grass of spring covers the prairies. . .
The summer growth is innocent and disdainful above all those strata of sour dead. . . .
Now I am terrified at the Earth! it is that calm and patient,
It grows such sweet things out of such corruptions,
It turns harmless and stainless on its axis, with such endless successions of diseased corpses,
It distils such exquisite winds out of such infused fetor,
It renews with such unwitting looks its prodigal annual sumptuous crops,
It gives such divine materials to men, and accepts such leavings from them at the last."

—Walt Whitman (*The Compost*).

Nature's system of cropping is on a permanent basis. Her soils do not "run out." She puts back into them regularly all that she takes out of them, and a little more. All the mineral substances go back to the soil whence they came, and with them, in the humus, goes carbon that was derived from the atmosphere. There is loss of some valuable soil material through leaching and floods, but the gain is greater than the loss, and the longer her crops are grown, the more fertile the soil becomes.

Nature holds the soil together by occupying it fully. She grows mainly permanent crops. They are always mixed crops; and the mixture is so varied that there is always something to grow in every situation. The soil is held with roots, and the dead herbage is held by the tough stems of the living; it is rapidly disintegrated and the mineral residue is fed to the roots again. Thus the food supplies of her vast population are used over and over, and between times of use, are scrupulously hoarded.

Nature practices tillage, and on a vast scale, but it is not our sort of rapid and wasteful tillage. It is slow soil-mixing, that does not extensively destroy the roots nor remove ground-cover. She fines the surface with the heaving of winter frosts. She stirs the deeper parts by the borings of earthworms, by the excavating of burrows for the homes of mammals, and by the overturn of the roots of windfall trees. It is here a little and there a little, but in the long run it is thoroughly done.

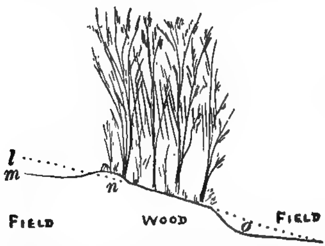

FIG. 68. Diagram of a section of a partly wooded hill. *l*, original contour of the hill slope; *m*, contour assumed after tilling of the fields; *n*, in-wash of soil above; and *o*, out-wash of soil below.

We can see the contrast between nature's soil management and our own on almost any slope where both fields and woods occur. Wherever their boundaries run horizontally, such contours as are indicated in figure 68 result from the rapid slipping away of the topsoil of our tilled fields. A ridge is formed along the edge of the wood when the bare field lies above it: the soil washed from the field is held by the ground cover herbage at the edge of the woodland. When the field lies below, a hollow is formed at the edge of the wood where the tree roots cease to hold the soil together. To be sure, gravity is always operating, and the soil of the woods is slowly shifting to lower levels; but it is only in the fields, where the ground-cover is removed and the root-hold periodically broken, that the process goes on so rapidly that the soil seems to melt and vanish before our eyes; it is only here and with very bad management, that the organic products of one season are all taken from it before the next season comes around.

Let us go into the woods and look at the soil there. The first thing we notice is that there is little soil to be seen—only a few paths kept bare by passing feet. Here and there are little patches of mosses or other low herbage, but nearly all the levels are overspread with leaves, and under the leaves is leaf-mold. Here is humus in the making. Let us examine the bed of leaf mold. On top, the leaves are well preserved, and show clearly by their form on what kinds of trees they

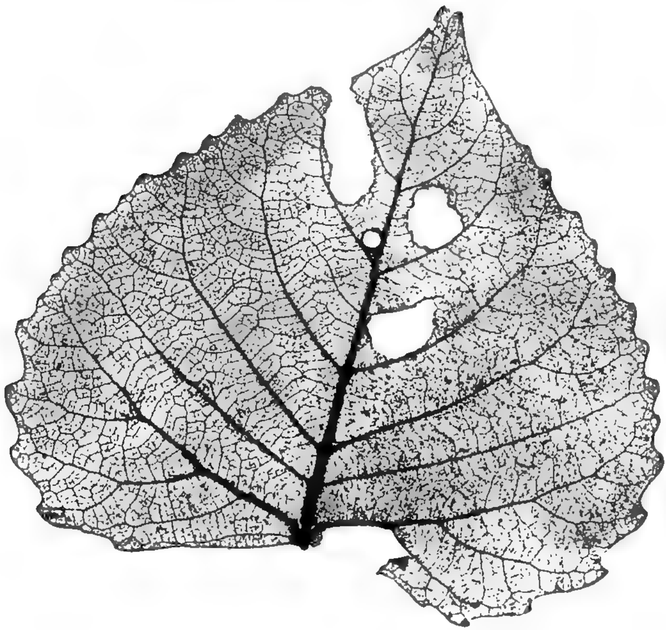

FIG. 69. A skeletonized leaf of cottonwood.

grew. Some leaves, such as those of oaks, that contain much tannin are resistant to decay, and those of two seasons may remain unrotted. But other leaves, such as those of elm, decay so quickly that they will not outlast the first winter. In some, such as those of maple and cottonwood (fig. 69), the veins resist decay so much longer than the blade that the leaves become beautifully skeletonized. In the lower strata such leaves will be found. Commingled with the leaves are pieces of stems and bark and twigs. Strips of birch bark long persist, being rendered well-nigh moisture-proof by their abundant resin.

Under the recognizable leaves and twigs is humus, formed from those that fell earlier. It is black and full of moisture. It is mingled with the top layers of the soil. As we uncover the floor of the leaf-beds, we see some of the agents nature uses in promoting the formation of humus: molds and mildews and other fungi of many sorts. that grow in and disintegrate the plant-stuffs; snails and earthworms and millepedes and pill-bugs and spring-tails and many insect larvæ that eat them. Carnivores are here, also; ground-beetles and centipedes and spiders, among the lesser forms, and salamanders and shrews, among those of larger size. The beds of leaf-mold have a population of their own. All are hastening the restoration of the useful plant materials to the soil. Numberless roots are holding the humus together. They never let go; this is nature's way of keeping the soil productive. It is only after we have dug down through the humus-stained top layers that we come to soil that looks like that in the fields.

Not in the woods alone, but also in the wild meadow and on the prairie, nature practices admirable economy in the use of her soil-riches. Gravity aids in the enrichment of the lowlands, but in spite of gravity the soil of the hills improve as time runs on and wild crops grow upon them.

In holding what is gained the deep-rooting forest-cover is not more useful than is the turf-forming ground-cover herbage. Great and small are colaborers in nature's plan. Her method is conservation with use—the fullest possible use—the use that brings the greatest good to the greatest number, and that insures the continued welfare of a teeming population.

Study 23. Observations on Leaf-mold and Woodland Soil

For this study, digging tools of some sort for individual use should be provided; light brick-layers' hammers will do. Vials or other containers, in which to keep specimens pending identification, will also be useful.

The program of work will consist of:

1. Uncovering the soil in a leaf-bed in the woods, noting the materials of its composition and their condition at different depths; also its population, as evidenced by the presence of some animals and the "signs" of others.

2. Digging two holes down into the subsoil, one in the woods and the other in the open field, carefully noting the color condition and contents of the strata encountered.

3. Observing the agencies concerned in the mixing of the soil in the woods.

The record of this study will consist of:

1. Notes on the leaf-bed as to:
   (a). Its components and their state of preservation.
   (b). Its population and the relative size and abundance of its resident organisms.

2. Comparative diagrams of vertical soil-sections in woods and in field, with notes on such differences as the diagrams do not show.

3. Diagrams of soil disturbance:
   (a). At the mouth of an animal's burrow (section).
   (b). At the root of an overturned tree.

XXIV. THE PASSING OF THE TREES

"My heart is awed within me when I think
Of the great miracle that still goes on,
In silence, round me—the perpetual work
Of the creation, finished, yet renewed
Forever. Written on thy works I read
The lesson of thy own eternity.
Lo! all grow old and die—but see, again,
How on the faltering footsteps of decay
Youth presses—ever gay and beautiful youth
In all its beautiful forms. These lofty trees
Wave not less proudly that their ancestors
Moulder beneath them. Oh, there is not lost
One of earth's charms: upon her bosom yet,
After the flight of untold centuries,
The freshness of her far beginning lies
And yet shall lie."

—Bryant (*Forest Hymn*)

What becomes of the giants of the forest when they fall? A wise man of old said, "In the place where the tree falleth there shall it lie." Yes, if it escape the woodcutter, it lies there; but it does not lie very long. The great oak that crashes to earth, crushing everything in its path, lies but one growing season ere the underlings are green above it: a few years more, and they are crowding into the upper light that it once monopolized. Its building up was long—centuries long; but a decade is ample for its decay. And well it is for the living that the dead do not longer encumber the ground, or hold locked up in their stark bodies the materials needed for the growth of a new generation.

Nature makes of the dissolution of these imponderable trunks a lightsome task. She proceeds, as ever, without haste or noise, making use of frost and sun and rain and a long succession of living agents. From the first souring of the sap to the final mixing of the log-dust with the soil, she uses bacteria, molds and fungi; and of the higher fungi, an interesting succession of forms appears as the dissolution of the wood

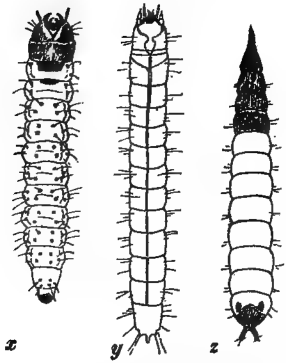

FIG. 70. Three insect larvae that live in logs. *x*, a carpenter-worm; *y*, a wire-worm; *z*, a snipe-fly larva (*Xylophagus*).

proceeds. She uses insects, also, in great variety. Wood-borers and carpenter-worms penetrate to the heart of the solid trunks, in their feeding operations, opening passage ways for the water and for fungus spores. Engraver-beetles, excavating their nests of wonderful .design, loosen and perforate the bark. Wire-worms and firefly larvæ perforate the log heaps when in a crumbling red-rotten condition; and white grubs mix the last recognizable remnants with the soil. So are the largest organic bodies on the earth reduced to earth again, and their masses of food materials put again into circulation; and in the process, generations of lesser organisms have been fed and housed. This is nature's method.

Of course, the population of these logs does not consist of herbivores alone. Wherever fungi and herbivorous animals flourish, their enemies are sure to find them. Stripping off the bark from an old log, we are pretty sure to find fungus-eating animals of several sorts: various beetles, cockroaches, millepedes, sow-bugs and the minute white cylindric legless larvæ of fungus-gnats. Also, we find true carnivores—centipedes, ground beetles, fireflies, etc., searching for animal prey. Even in the burrows of the heartwood borers, occur parasites that have found their well-sequestered victims. Then there are vertebrate enemies, also—salamanders, that

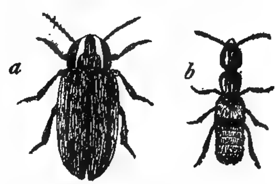

FIG. 71. Adult insects found under bark of logs; *a*, a fire-fly (*Lampyridae*); *b*, a rove-beetle (*Staphylinidae*).

squeeze in under the loose bark; woodpeckers, that cut deep holes to find the borers; and raccoons and bears that tear rotten logs to pieces with their claws, searching for grubs to eat. Each fallen log is a center of considerable resident population, and entertains numerous foreign visitors. A few of the more common and characteristic residents are shown in figures 70 and 71.

The following brief statement of group characters may further aid in their recognition. Most of the resident insects found in logs will be:

I. *Caterpillars*, (Order Lepidoptera) having a long cylindric body, with a brown shield covering the first segment behind the head, and a tuberculate, spinous skin. These are moth larvæ fig. 70*x*.

II. *Beetle larvae*, (Order Coleoptera) having a distinct head, usually small legs also, no brown shield on the first segment after the head, and a great variety of form and size. Beetles are the most important of wood-destroying insects, and a number of the families of beetle larvæ may be recognized by the following characters:

1. The true borers (members of the families Buprestidæ and Cerambycidæ), having the long, straight body greatly widened and flattened toward the front end, the skin naked, pale and wrinkled, and the legs rudimentary. These perforate the hardest woods.
2. The engraver-beetles (Scolytidæ), having short, thick, arcuate bodies that are usually legless, naked, wrinkled, and white.
3. "Wire-worms" (Elateridæ), having very smooth cylindric, elongate bodies, small legs, shining yellowish or brown skin, and a horny disc terminating the abdomen above, the margin of the disc being toothed or sculptured (fig. 70*y*).

4. "Glow-worms" (Lampyridæ), having the body elongate tapering to the ends, flattened on the back, with well-developed legs and usually a pigmented skin.
5. "White grubs" (Scarabæidæ), having the short thick body bent double upon itself, so that the grub lies on its side, the legs well developed; the white skin bristly, and the blunt hinder end of the body smooth and shiny.
6. Pyrochroid beetle larvæ (Pyrochroidæ), having the body very thin and flat, its sides parallel, the legs well developed, the skin brown, and a pair of stout upturned hooks at the end of the abdomen.

III. *Fly larvæ* (Order Diptera), having cylindric legless bodies that taper from rear to front, the head being apparently wanting. Three families commonly are found.

1. Fungus-gnat larvæ (Mycetophilidæ), of minute size, white and soft, usually occurring gregariously under bark.
2. Snipe-fly larvæ (Leptidæ), of similar form but larger and with the pointed front end of the body of a deep brown color, usually found in rotting wood (fig. 70*z*)
3. Crane-fly larvæ (Tipulidæ), less tapering, more cylindric, with the head end more bluntly pointed, and with a respiratory disc upon the rear end in the midst of which may be seen the openings of a pair of breathing tubes. Skin tough and more or less leathery.

IV. *Horn-tail larvae* (Order Hymenoptera), having a long smoothly-cylindric white body with a prominent spine on the posterior end, rudimentary thoracic legs, and a small but distinct head placed low down at the front end; living in large clean-cut holes that are usually disposed in groups in dead or living trees.

One observes in the woods that different kinds of logs have very different behavior in decay. Certain kinds, like poplar and willow, decay rapidly and soon disappear. Others, like chestnut and cypress, long persist. Some, like the oaks, lose the bark and sapwood quickly while the heartwood is still sound: others, like the yellow birch, preserve the hollow cylinders of bark intact, long after the wood has decayed and fallen from them. One finds the segments of the bark of birch kicked about over the forest floor, long after the trunks have vanished. The resinous knots of the pines persist far beyond all other parts of the tree. And with the differences in the character and content of the trunks, go differences in the population. The insects and fungi that work in pine logs are not the same species that work on logs of oak or willow.

In the forest, where every inch of ground is densely filled with roots, the crumbling logs, as they settle into the earth, furnish a new place in which seedlings may get a foothold. Certain shrubs, like wild currant and raspberry, habitually spring up from seeds dropped upon fallen logs by birds; many trees, also, start in the same place from wind-sown seeds, and gradually settle with the disintegrating heap to the level of the ground. How often one finds in the woods a young birch tree or hemlock, standing astride a stump or fallen log with long leg-like roots reaching down either side into the soil.

Gradually the moldering heap is dispersed by winds and the patter of raindrops and the stir of passing feet. The great tree has silently passed and left no sign; but the organic products it gathered in its lifetime have gone to the permanent enrichment of the soil.

Study 24. Observations on the Decay of Fallen Trees

Any natural woods, having a variety of fallen trees, or even of old stumps, will do for this study. The individual equipment needed will be sharp brick hammers or hatchets for stripping bark and digging into logs, and vials of alcohol to hold insects, pending their identification. A few axes will be needed for common use.

The program of work will consist of taking some logs (or tree-stumps) to pieces, observing their condition and rate of decay in various parts, and collecting specimens of their inhabitants.

The record of the work may consist of:

1. Notes on the phenomena of decay in logs of several species: changes in color and hardness; relative rate of progress in bark, sapwood, heartwood, knots, etc.; plants growing in the residual heaps, etc.

2. A table of the wood-inhabiting insects found, prepared with column headings as follows:

Name of insect (ask instructor, if you do not know it).
Stage found (larva, pupa or adult).
Inhabits { Kind of tree (white oak, linden, etc.).
Part of wood (bark, sapwood, heartwood, etc.).
Condition (sound, red-rotten, white-rotten, etc.).
Burrow (depth, form, direction, etc.).
Products (chips, borings, dust, etc.).
Occurrence (rare, common, abundant, etc.).
Remarks.

3. A list of the carnivorous insects found in the logs, with notes on their situation, occurrence, etc.

XXV. THE FENCE-ROW

"I wander to the zigzag-cornered fence
Where sassafras, intrenched in brambles dense,
Contests with stolid vehemence
The march of culture, setting limb and thorn
As pikes against the army of the corn."

—Sidney Lanier (*Corn*).

In any new country, the first sign of civilization is a fence. It signifies control over the animal world. There is something useful shut in, or something harmful shut out. It signifies personal possession of something—an advance beyond the stage when all that nature offers is held in common. It signifies, also, personal insight into the ways of nature and initiative in making better use of her resources.

Fences were first defenses. They were built by man to shut himself in and to keep enemies out. Then they became stockades made of posts fixed in the ground, and were extended to give shelter to a few domesticated beasts, as well as to man. In pioneer times in America our ancestors were still defending themselves and their possessions behind stockades. Then, with the growth of animal husbandry, they were expanded into stock-pens, whose early function was to keep wild beasts out, but whose function has now become that of keeping tame beasts in. Fences have only one agricultural function—the control of animals.

The pioneer built fences for his fields of unmanufactured materials—of brush, of stumps, of stones. These he obtained in clearing the ground. The brush fence could be built quickly, but was a most temporary makeshift. Boughs piled with their tops directed outward formed a good barrier against approach from one side. But they covered much ground (a matter of more importance to us than to the pioneer); they might be destroyed by fire at any time after becoming dry; escaping fire, they soon settled to the earth in decay; and during their time they harbored an abundance of rabbits, mice and other vermin to infest the fields. The stump fence was usually made of white pine, having great horizontal spread of roots. The roots of one side were chopped off, so that when the stump was laid on one side the other side rose erect into the air. By overlapping of roots, an excellent barrier was thus constructed. Tho subject, in a less degree, to the defects of the brush fence, the stump fence had the one great merit of permanence. The resinous roots resist decay, insomuch that there are stump fences all over New York and New England to-day fairly well preserved, that were built by the pioneers. Indeed, after the clearing of the land and the first cutting-over of the woods, there was no material left for building such fences a second time. Stone fences are built with greater expenditure of labor, but they occupy less land, and if properly built in the beginning, are easily maintained. Like the two preceding, they are built of waste material obtained in clearing the land.

But such materials were not available everywhere in quantities adequate even for the first fences built. Furthermore, the trunk of a tree, if split into rails, will build much more and better fence than will the brush of its tops, and the fence will occupy less ground, will be less easily burned, will harbor less vermin, and will last much longer.

When land was being cleared of timber for which there was no market, the best use to which the logs could be put, was to split them into rails and build fences with them. Rails of black walnut and cherry and other valuable woods were used in the fencing of thousands of acres. During that comparatively brief period when men believed the timber supply of the country to be inexhaustible, rail-splitting was one of the most widespread forms of labor; insomuch that when Abraham Lincoln was introduced to the people of the nation as a candidate for president, in order to ally him with the common folks, he was presented to them as a rail-splitter.

Events have moved rapidly since that day. The rail-splitter is well-nigh extinct. The rail fence has become expensive, and wire is taking its place. Another generation will see little of the old form of wooden fence, which in our day still exists side by side with modern wire and ancient stone.

Whatever the form of a fence, if it bound a tilled field, it is bordered by a strip of ground, at least as wide as a whiffle-tree is long, that is a tension zone of wild life. On one side is the fence; on the other, the furrow. Between extends a strip of sod that the plowshare cannot reach, and this sod is full of lusty wild things, all struggling for a place and a living. If the farmer mows it constantly, grass sod develops as in a meadow; if he mows it annually in winter, shrubs and vines possess it; if he neglects to mow it for a few years, trees come in. Whatever plants grow in it, it is a haven of refuge for their wild animal associates; if only grass sod, meadow-mice and shrews will make their runways under its cover; if briers and grass grow together, rabbits will make their forms or dig their burrows in the midst of it. Every post or stake or high point in the fence is a point of outlook and a resting-place for the birds of the fields. Perching, they drop the seeds of berry-bearing shrubs and vines. So, we see dogwoods and elders and sumachs and chokecherries and bram-

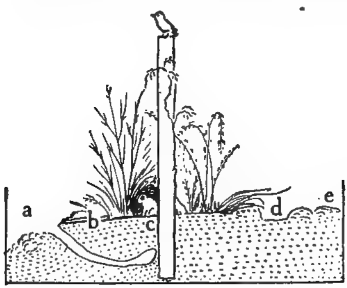

FIG. 72. Diagram of a cross-section of a fence-row. *a*, soil thrown out from a burrow; *b*, the runway of a meadow-mouse under the grass; *c*, the "form" of a rabbit; *d*, the furrow; and *e*, the overturned soil.

bles springing up everywhere, and wild grape, woodbine and poison-ivy climbing up the posts. But, however much grain the farmer may have spilled on the sod, we do not find grain growing there. Our cultivated grains are weaklings, requiring constant coddling.

FIG. 73. May-apple—fine wild herb that lingers in the fence-row.

Just what we do for them when we break the sod, may be seen on the furrow side of the fence-row. If here and there be an overturned sod that has escaped subsequent tillage, we see the wild things have been cut off far below the ground and turned upside down. Thus we kill some of them, and give others a bad set-back, and leave the severed roots of all of them (excepting such as sassafras) to rot in the ground. But as our plowshare cuts, our mold-board breaks the sod while turning it over, leaving it more open to the air, and favoring new growth of roots. The difference made in texture may be proved by probing with a stick, and the effect of subsequent tillage as well, if we probe both the sod, turned and unturned, and the mellow root-free soil of the field.

As time has run, and farms have multiplied and the wild animals, against whose incursions fences were once built, have disappeared, as methods have become more intensive and greater areas have been devoted to raising forage and less to the ranging of the stock, fences have become less important; at least, relatively fewer fences are needed; for many fields may now go unfenced. Yet wherever a fence is built and a little strip of accompanying sod remains unturned, there will still appear the same old denizens of the fence-row that flocked at the heels of the pioneer—berry-bearing bushes and brambles and vines. Amid the vicissitudes of tillage, the fence-row is as a haven of refuge for these wild things.

Study 25. Observations on Fence-rows

The program of work for this study will consist of:

1. A comparison of fence-rows bordering different kinds of fences, in different situations (upland and lowland, adjacent to woods, pasture and fields), and receiving different care (or different degrees of neglect).

2. A detailed study of the population of selected strips of fence-row, as to the larger plants and animals it helps sustain.

The record of this study may consist of:

1. Notes as to conditions obtaining in half a dozen of the different fence-rows observed.

2. Annotated lists of the population of the fence-rows selected for special study:

   (a) Plants, with notes on the kind, size, growth-habit, mode of propagation, abundance, etc.

   (b) Animals, as indicated by "signs" of their occurrence, burrows, runways, nests, borings, tracks, hair, feathers, etc., with notes on haunts, abundance, etc.

XXVI. THE SPRING BROOK

"Oh, for a seat in some poetic nook,
Just hid with trees and sparkling with a brook."
—Leigh Hunt.

The early settlers in our country sought springs of water. Clear-flowing streams were good to dwell by, but springs were better. Their water was cooler in summer, did not freeze in winter and was freer at all times from possible contamination. Springs were the primeval water supply. These, more than any other single thing, determined the home-sites of the pioneers.

Springs were natural coolers for perishable food products—not refrigerators, but coolers; milk or melons they would cool, without overdoing it. A low thick-walled spring-house was often built over the outflowing stream to keep out the sun's warmth and to increase convenience and capacity. The spring-house was the antecedent of the modern household refrigerator, and altho far less convenient, being usually remote from the kitchen, it was an excellent aid to keeping foods fresh and cool. Moreover, its equable temperature insured as well against their freezing in winter.

Springs gave promise of the welfare of the fields, as well as of the household. They signified plenty of ground water; and the levels adjacent to the springs were the areas first cleared and cultivated. In almost any locality, if one would know where the first homes were built, he need only inquire the location of the best permanent springs, and then look for adjacent building-sites.

Springs result from the water percolating through loose soil strata, and flowing out over outcropping impermeable strata. A layer of gravelly soil overlying a sheet of clay was nature's primeval filtration plant. From it the water issues, clear and sparkling, of a low and constant temperature, with a low oxygen content, and, owing to prolonged contact with the soil, with a high mineral content that varies much according to the character of the soil traversed. Deposits of sulphur and of iron are often formed about the mouths of mineral springs. But where the ordinary spring bubbles up, one usually sees only miniature deltas of clean-washed sand at the bottom of a limpid pool, which clears itself quickly after roiling.

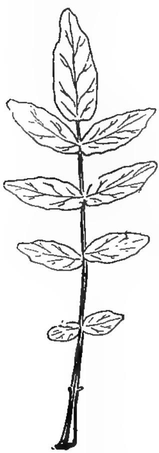
FIG. 74. A leaf of watercress.

Spring water has a population of its own. Man and bird and beast are transient visitors who only quaff its waters; but there are other creatures, that permanently dwell in them. They are things that cannot endure too great heat in summer or freezing in winter: things that like low equable temperature and partial shade. The most characteristic plant that grows in spring water is water cress (fig. 74); it was used by the pioneer to garnish his meat platter, and it is still so used. There are water-mosses, also suited to such a habitat, and many lesser algæ of various kinds, both green and brown.

There are animals, also, that live in spring water; such are the salamander shown in figure 75, and the brook trout, which does its best in water not warmer than 60° F., and many other lesser creatures. Most of the great groups of animals are represented there, if by only a few forms: crustaceans; by the scuds, clambering over and feeding upon the water-cress, and by asellus, wallowing in the soft bottom of the pools (fig. 20); molluscs, by little white clams (half an inch long, more or less), of the genus *Sphærium*, furrowing the

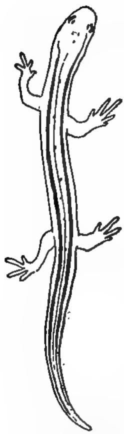

FIG. 75. A common spring-inhabiting salamander (*Spelerpes*).

silt on the pool-beds; worms, by planarians gliding over the stones of the bottom, and by *Tubifex*, in tubes in the bottom mud, waving their long, lithe, filamentous, red bodies in the water; and insects, by a number of inhabitants of the submerged vegetation—caddis-worms (fig. 76), mayfly nymphs (fig. 23), midge larvæ (fig. 24), etc., and by a few burrowers in the bottom. The spring brook does not harbor mosquitoes, but horse-fly larvæ (fig. 77) live in the soft bottom and emerge in midsummer to annoy farm animals.

As compared with the population of warm and stagnant pools, the denizens of the spring brook are few, and many of them are so restricted by conditions that, wherever they are found, they serve as an indication that the water is pure and cool and permanent. The spring brook sustains the life of these, and helps sustain innumerable others that come and go, or that dwell about its borders. Bryant has sensed this in his "Forest Hymn.":

FIG. 76. A caddis-worm (*Phryganea*).

"Yon clear spring, that, midst its herbs,
Wells softly forth and visits the strong roots
Of half the mighty forest, tells no tale
Of all the good it does."

FIG. 77. A horse-fly larva.

Study 26. Observations at a Spring

Any clear-flowing permanent spring will do for this study—whether "improved" with a basin or a spring-house, or not. A time of freshet should be avoided: low water is preferable. The individual equipment needed will be a flat dish (like a white-enameled vegetable-dish) and a hand dip-net, with, possibly, a few vials to hold specimens pending their identification. For common use, a pail, a garden-rake and a thermometer should be provided.

The program of work will consist of:

1. An examination of the spring itself, its water, its bed, its topographic situation.

2. A survey of the inhabitants of its waters, both plants and animals. The plants may be raked out of the water, and certain animals may be picked from them by hand: other animals may be picked from stones in the brook-bed or sifted from the bottom mud with a dip-net.

The record of this study may consist of:

1. A map of the environs of the spring, including a bit of the outflowing brook, showing topography, outcropping strata, riffles and pools.

2. Notes on the spring water, its temperature, color, taste, etc.

3. An annotated list of the population of the water.
   (a) For plants, giving name, kind of plant, growth-habit, relative abundance, etc.
   (b) For animals, giving name, kind of animal, situation in which found, relative abundance, economic importance, etc.

XXVII. NATURE'S OFFERINGS FOR SPRING PLANTING

> "*I should like to live, whether I smile or grieve,*
> *Just to watch the happy life of my green things growing*".
> —Dinah M. Muloch (*Green Things Growing.*)

Planting time! Time to get a spade and tear up the turf somewhere: to clear a space and stir the soil and set in it the roots of some lusty plant-foundlings, in hopes of seeing what they will do when summer comes. This is what one's hands are itching to do (if there be a drop of gardening blood in his veins) when the snowdrops bloom, and the early buds are swelling, and the filmy clouds of the shadbush are whitening all the woodland slopes. Watching things grow, things that his own hands have planted, is one of the chief joys of the householder.

Let us go, not to the garden to-day, but to the wildwood. We know the times and the seasons and ways and uses of radishes and peas and other things that nature lent us long ago, and that we have made the staples of our gardens. Let us seek out some of the little-used things, whose values are chiefly decorative; things that minister to our esthetic pleasure; things that nature has been keeping for us until we should attain to an appreciation of them; and let us begin to learn how to deal with them.

Before there were nurseries, there was plenty of nursery stock grown in the wildwood, seedlings and plants of all sizes. Outside of the nurseries, there is plenty of it still grown. Let us go out and see what nature offers. Let us find her ancient nurseries. We will pass by the seeds: tho there are many of them still hanging on the twigs in the spring, they are for the most part slow to germinate. We will pass by the bulbs, also: tho there are many of them shooting up leaves and flower-stalks, this is not the season for moving them—they are for fall planting. We will consider only young stock, in condition for removal and ready for active growth. We need not look where there has been much mowing or close grazing, or where severe fires have run. These exterminate all the tender green things. But in almost any place where fairly natural conditions remain, we may expect to find young plants of each species commingled with the old. Let us make the old fruiting plants our guide in finding the less conspicuous and less easily recognizable younger generation. Under and near by the old flowering-dogwood tree, for example, we may find a few little dogwoods that have sprung up from seeds. If there appear to be none, let us look closely, for dogwoods come on slowly. The seeds often require several years to germinate, and the seedlings under favorable conditions may grow but a few inches a year. But the puniest of the little shade-dwarfed seedlings that we may find, will respond wonderfully if set out in a nursery row, where they have plenty of room and light. They will soon make fine trees.

Fig. 78. Seedling ninebarks in the lawn. *a*, the old shrub; *b*, the little seedlings in the grass; *c*, an older seedling growing in the shelter of the fence.

Figure 78 is a diagram of a ninebark growing at the edge of a lawn. From its swollen pods hundreds of thousands of seeds are shed every year. They are sown about over the grass, or tossed more widely when the wind sways the bushes. Sooner or later, most of them germinate and a few succeed in striking root in the soil and in lifting their pretty green leaves to the light. The mowing of the lawn clips their tops; but many of these seedlings have leaves that are below the level of the mower, and such live on and renew each season their ill-fated attempts to rise in the world. The grass is full of them— little stubby fellows, each with only two or three small leaves that are put out early as if to take advantage of the leafless condition of the boughs overhead. But even such little unpromising stubs, if replanted in a favorable place, will make long leafy shoots the first season, and tall blossoming shrubs the second season. And if one will look about the borders of the lawn, he may find ready for planting some ninebarks of a larger growth that have escaped the mowing-machine. So one may find wild seedlings of many other sorts, such as june-berry and arrowwood and witch-hazel and of all the forest trees.

Trees whose seeds employ special agencies of transportation may spring up in a new place. Thus seedlings of plants whose fruits are eaten by birds are found about the open places where the birds perch; and those from seeds that are carried by water may congregate along shores and beaches. On sand-bars in stream or lake, one often sees thousands of little cottonwoods, willows, maples or sycamores, lined up along the shore as in a single extended nursery-row.

It is a rough-and-tumble world into which wildwood seedlings enter. When one thinks how small and tender they are at the first, and how both earth and air are filled with competitors and enemies, one wonders that any of them survive. Above them are great trees and lusty, smothering vines and bushes, all struggling to monopolize the light. Round about them are wild animals that trample and browze and burrow, and spread destruction. Drouth and flood and frost are constantly recurring perils while the seedlings are little and have but a tenuous hold upon the soil. Even the overturn of a single dead leaf, if it falls flat upon them and shuts out the light, may extinguish the lives of dozens of them.

Yet some survive. Each wild species holds its own. In the nice balance of nature, enough are produced so that, after all the losses from casualties and enemies, a few will still be living on. A few will have found the chance places of security and of opportunity and will be carrying the race forward. It is nature's method—wasteful of individuals but careful of the species. It necessitates that she should keep her nursery full.

In nature's nursery the number of individuals of any tree diminishes very rapidly as their size increases. It is only

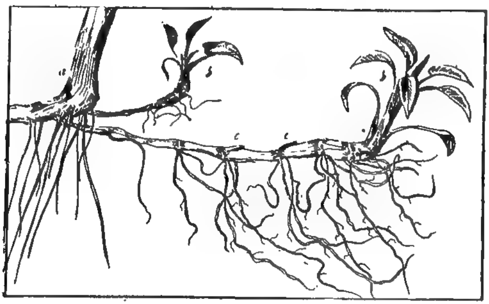

FIG. 79. An uprooted branch of cockle-mint; *a*, the old dead flowering stem; *b*, *b*, two new shoots, ready for the coming season; *c*, *c*, buds that will produce shoots for the year thereafter.

little seedlings that ordinarily are abundant; often, as in the case of the ninebark, just described, they are nearly all too small for landscape use; and those of "planting size" are apt to be deformed by growth in cramped quarters. But if only the severity of the struggle for existence be relieved a bit—as by transplanting these little things into good soil where they may have plenty of room and light—fine symmetrical bushes may be had in a season or two. It requires only a little forethought; it produces the finest plants, and yields, besides, the satisfaction of seeing things develop.

In all nurseries, wild and tame, plants are propagated in a variety of ways. Most trees are grown from seeds; the dominant species of our forests are increased in hardly any other way; but most shrubs and perennial herbs, while they produce seeds abundantly, have other modes of increase. They produce new plants by offsets, suckers, stolons, layers, etc. New plants thus formed are grown and nurtured under the shelter of the old ones.

The cockle-mint of our brook-sides, (*Physostegia virginiana.*) (fig. 79) is a plant well habituated to this mode of increase. It produces annual herbaceous stems that bear four-ranked columns of beautiful bright pink flowers, and that are usually followed by a heavy crop of seeds. But the seeds are minute, and the seedlings are a bit slow about getting started. In the everywhere crowded brook-side thickets, their chance for completing development is indeed a very rare one. Did this plant depend on holding its place by new development from seeds every year, doubtless it would quickly disappear.

But it has other resources. From the base of each flowering stem, a number of offsets are produced as underground branches. Each of these is equipped with an abundance of roots, with a store of reserve food material (thickening it apically), with a big apical stem-bud, and with a few green leaves at the surface of the ground, all ready for growth when spring breaks. As compared with a puny seedling, it is already a strong and well-established plant. The provision it makes for future needs extends yet farther ahead. On the sides of each offset, there are produced a number of long naked buds, that will grow out into new offset branches another season, and rise on stems and bloom and bear and die the summer thereafter.

In contrast with reproduction by means of seeds, the increase by this method is slow but sure. Plants of this sort hold their place in the world by continuous occupancy of it.

They never let go. Slow as is this method of propagation, it still means a steady annual increase and results in mutual crowding. Each offset tends to form a clump, and each clump a thicket. Some plants like—cockle-mint and pearl achille, increase in this way so quickly that, for best results in flower production, they need to be dug up, divided and replanted every second year. Most herbaceous perennials need this treatment every few years. Both the number and the kind of offsets produced give a hint of the future behavior of the plants. If there be only a few little offsets close against the base of the old stem, as in the tall lobelias (*Lobelia cardinalis* and *L. syphilitica*) one knows the plants will spread slowly and stay where placed; but if the underground shoots are both very long and numerous, as in the panicled white aster, one knows the plant is likely to spread. He who digs them should dig observantly, learning thereby how to plant them again in a new place.

Excellent for planting are these offsets of herbaceous perennials. Nature carefully prepares them and fully equips them for rapid and complete development. There are no years of long waiting for results. They will give their full effect the first season. So, while we are waiting for the trees to attain their dignity and for the shrubs to grow to blooming size, we plant herbaceous perennials. Native wild perennials are best suited to informal planting. In using them about our grounds, there are just a few things that need always to be remembered:

1. To plant the best of them in masses, many of a kind together, for too great variety is wearisome.

2. To plant the tallest growing forms at the back and the lowest at the front, so that the lowest foliage masses will drop gently down to the greensward.

3. To plant each kind where its requirements of light and moisture will be met.

4. To plant the tough and thorny things in exposed places where people pass; the weak and brittle things where there is little chance of injury.

5. To plant in such an arrangement that flowers of inharmonious hues will not bloom side by side.

Such plantings will be beautiful and relatively permanent, and will be maintained, year after year, with a minimum of trouble.

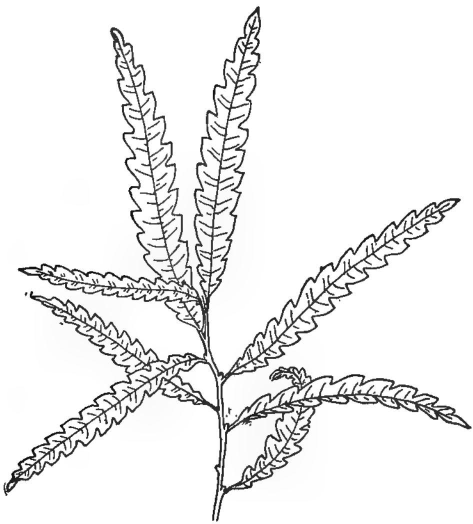

Fig. 80. A spray of sweet-fern (*Comptonia asplenifolia*).

Then, we may plant for fragrance of leaves or flowers, for succession of bloom throughout the growing season, for autumnal colors of leaves or winter colors of bark or berries, or for any other effect that suits our fancy; nature has something for every place and purpose. In the wildwood we may see under what conditions each thing thrives best. And anyone can plant successfully who will observe and imitate nature's ways of using each sort.

If we wish to attract birds, we will plant berry-bearing bushes and vines: such shrubs as buffalo-berry, shadbush, black-berried elder, viburnums, wild black currant, and blueberries: such vines as wild grape, honeysuckles and clematis.

Suggestions as to the natural functions of such materials in the beautifying of our environment will be found in Chapters 16, 32, and 48. In the unmutilated wildwood one may see what elements of grace or of beauty each species may lend to a landscape. Let no one despair of having his place well planted for lack of means: there is little relation between money-cost and real beauty. Many of the most beautiful things require only to be planted in suitable places. Good taste is what is needed, and an appreciation of the requirements of the plants as to food, water and sunlight. Beautiful plantings consist only of plants well placed and well grown; and many wild things, that are to be had for the digging of them, will grow better and fit better than will any costly exotics.

Study 27. Wild Perennials for Spring Planting

Two alternative lines of work are suggested for this exercise. For either, individual digging tools will be needed.

I. **The program** of work may consist of a search in woods and fence-rows for wild things for ornamental plantings—trees and shrubs and herbaceous perennials. These should be dug up and examined, root and branch. Their soil preferences and moisture and light requirements should be carefully noted. Their relations to parent plants and to the conditions under which they have grown should be observed. And then, being things of value, they should be replanted properly in suitable places; if not needed elsewhere, roadside waste places may be beautified with them.

The record of this work may consist of:

1. In the case of seedlings, such data as the following:
   a. Statistics of the number of seedlings of different sizes in a given area.
   b. Map showing the location of seedlings in relation to the parent tree.
   c. Diagrams of the form of seedlings of different ages and grown under different conditions.
   d. Comparative statement concerning all the different kinds of seedlings found and the years required to attain to "planting size" for landscape use.

2. In the case of vegetative offshoots of the various sorts, such data as the following:
   a. Diagram of the principle mode of new plant production.
   b. Records for all the forms studied, of the usual number of new shoots produced in one season from a single crown; also the length of these shoots (as determining the ability of the species to spread).

3. In the case of all the forms studied, a tabular statement under column headings as follows:

Name of plant.

Requirement as to $\left\{\begin{array}{l}\text{moisture.}\\\text{sunlight.}\end{array}\right.$

Fruiting age.
Fruiting size.
Mode of increase.
Time of flowering.
Valued for what decorative quality.
Limitations as to its use.
Remarks.

II. **The program** of work may better consist in the gathering of wild stuff and the setting of it in permanent plantings where such are needed, and where the beautiful wild things, so rapidly disappearing, may be preserved for future generations. Something more educational than the ordinary "ivy day" and "arbor day" performances is here proposed, tho it should have the same patriotic significance. If the school have a ground-plan, let some bit of ground, some bank or border, be assigned to the class for planting. Let the teacher have a planting-plan of the usual sort, but lacking the names of exotic plants, with only the size and character of the plants indicated. Let teacher and class together seek out, gather and plant suitable wild things. For the sake of acquaintance with the plant characters, all should participate in the digging of the stock. The resetting may often better be done by division of labor. Wild plants should be obtained where overcrowded or where in danger of extermination, and those that are flourishing in suitable places should be let alone. Otherwise, ill-considered and unsuccessful efforts at transplanting may only hasten their extermination. The best success with trees and shrubs will lie in taking them when little and setting them first in a nursery and giving them time to grow.

The record of this work may consist in:

1. A diagram of the area planted, with plants named in the diagram.

2. A table of characters of the plants used, such as is indicated under 3 above.

XXVIII. THE CUT-OVER WOODLAND THICKET

> *"For there is hope of a tree, if it be cut down,*
> *that it will sprout again,*
> *And that the tender branch thereof will not cease;*
> *Though the root thereof wax old in the ground*
> *Yet through the scent of water it will bud*
> *And put forth boughs like a plant."*
>
> —The book of Job, 36:14

When the great trees are felled, and the forest cover is removed, if nothing more be done, no plowing or pasturing, then the underlings have their turn. Weakling dogwoods and elders and other shrubs that have been leading a lingering existence under the shadow of the oaks and elms, take a new lease on life. They flourish inordinately. They form great clumps, covered with bloom in summer and heavy with fruit in autumn. Their stems are no longer thin and scattered, but stout and aggressive. They spread and try to cover the whole of the area on which before they had such a slender hold.

But there is hope of a tree—of some trees. The pine tree dies when cut down; but most trees sprout again. They send up a circle of lusty shoots, which, ere the end of the first season, are competing with each other for light and standing-room. Ere the end of the second season, the biggest sprouts are overtopping the competing shrubbery; and thereafter their real competition is with each other. They grow and spread, and gradually bring the underling shrubbery into subjection again.

So, after the cutting of a wood, the first season it looks thin and bare, and the stumps stand out boldly. The second season, it is covered with copses of spreading bushes and clusters of sprouts hiding the stumps. For a few succeeding seasons, it is a mixture, indiscriminate and dense, of small trees and bushes; and thereafter it is a wood again, at first impenetrably dense, but after many years, after time for the formation of a permanent forest cover and for the death and removal of the shaded undergrowth, it becomes open and shadowy again.

The thicket is thickest at the time when the shrubs have reached their maximum and the young trees are beginning to press them back again; and at no time is a wood more interesting. Here one may sense the meaning of the struggle for existence, the peaceful, effective, uncompromising, eternal struggle of the battlefield of nature. Here is a forest society, composed of a mixture of plants, large and small, that have dwelt together for ages. It is temporarily upset by the invasion of the woodman's ax, and is in process of readjustment—of getting its balance again. Here are stumps dead and rotting, and other stumps green and sprouting. Here are poor standing remnants of a former forest growth. Here are shrubs that once struggled along in the shadow, now luxuriating in the light and crowding one another, and trying to smother the small trees ere they get their heads above the general coverlet of green. Outside, when the leaves are on, it all has an aspect of rich verdure, but if one look underneath, the abundance of dead stems there bears testimony of the severity of the struggle.

Woody plants dominate the situation, but they have herbaceous associates, dwelling with them whether the cover be forest or shrubbery. In the leaf-mold are the roots of many little things—bloodroots and trilliums, adder's-tongues, squirrel-corn, and other early blooming-flowers, that make the most of the spring sunshine before the upper leaves come out to shade them. Ferns, also, and thin wood grasses and sedges and slender wood asters and goldenrods keep their places in the intervals between the clumps, persisting through the great struggle for place that goes on over their heads.

Study 28. The Cut-over Woodland Thicket

A patch of woodland that has been cut over rather closely, and left for some years untouched, should be selected for this study. Only the more typical portions will show the phenomena this study is intended to illustrate. The invading population of the roadways and more open places may be passed by.

The program of work will consist of:

1. A brief examination of a bit of natural uncut woodland, especially with a view to noting the condition and size of the plants of the undergrowth when a forest cover is present; this to serve merely as a basis for comparison.

2. A more detailed examination of the cut-over thicket, as to its constituent woody plants, their size and condition as indicating the nature of the struggle for existence between them, and the progress of forest restoration.

The record of this study may consist of:

1. A diagram of a vertical section of a typical portion of the thicket, including tree-remnants, sprouting stumps, and shrubs, large and small, of the commoner sorts, in their proper relations. Possibly the growth may be such that a sprout thicket and a bush thicket may be better shown separately (Bramble thickets, being the special subject of Study No. 44, may be omitted here).

2. An annotated list of the woody components of the thicket. The notes should include, besides name (which instructor will furnish if needed), kind of plant (tree, shrub or vine), growth-habit (erect, spreading, climbing, etc.), reproductive method (sprouts from stumps or from the ground, stolons, etc.), average present size and condition, relative abundance, with special indications of the valuable tree species present, and remarks on the chances of restoration of valuable woodland.

XXIX. THE WILD SPRING FLOWERS OF THE FARM

> *"Take of my violets! I found them where*
> *The liquid south stole o'er them, on a bank*
> *That leaned to running water. There's to me*
> *A daintiness about these early flowers,*
> *That touches me like poetry. They blow*
> *With such a simple loveliness among*
> *The common herbs of pasture, and breathe out*
> *Their lives so unobtrusively, like hearts*
> *Whose beatings are too gentle for the world."*
>
> —Nathaniel Parker Willis (*April*).

Warm sunshine, and the breath of a soft wind from the south, and rills murmuring in every glen, and—surely there must be wild flowers blooming in the woods. Let us go out and find them. Some, like the hepaticas, will be peeping from under the woodland carpet of sodden brown leaves—peeping with eyes of a soft captivating baby-blue. Some, like the anemones, will be lifting their leafy sprays of pearly white blossoms on grassy banks, in tufts of exquisite grace. Some, like the marsh-marigolds, will be spreading their shining leaves and bright golden flowers by the waterside in cheerful array. Each in its own way is brightening some unspoiled spot of earth; and every year, in spring, all are ready to greet and to cheer us again, like old friends. After the barren winter, how welcome they are!

How different they are in their behavior! The fugitive flower of bloodroot shoots upward encased in a single huge leaf, which then spreads out its broadly scalloped border, making a fine background for a fine blossom. The adder's-tongue shoots out on its long slender stalk from between two spotted leaves. The trillium flower unfolds from between a whorl of three green leaves, held at the top of an erect stem. These flowers come singly. But the flowers of the hepatica come all in a troop and unattended; the leaves of the past season, still green, lie prone about them; those of the coming season will shortly rise and expand—indeed, ere the flowers have faded, a new crop of leaves may be seen lifting their fuzzy tips all together. For hepatica has the curious habit of producing its entire crop of leaves, as by a single mighty effort, all at once, and holding them until the next annual crop is matured.

Most spring flowers tend to form clumps or great masses in the woods, and to this habit many charming effects in wild-wood landscapes are due. Think of the banks you have seen of moss-pink, or trillium, or columbine; the levels covered with violets or bloodroot or spring beauty! Mandrakes are gregarious and flock together like sheep. They hang their big white flowers coyly under huge umbrella-shaped leaves, and make a beautiful ground-cover of shining green domes. Wild ginger also, hides its curious brown-purple flowers under a beautiful leaf-mosaic at the very surface of the ground. The big white trillium lets its flowers lop over on one side and holds them until they turn rose-purple in fading.

It is not flowers alone for which these plants are desirable. Their foliage is often of beautiful design. Where can there be found stronger simple outlines than those of the leaves of the hepatica, bloodroot or bird's-foot violet? Where, more airy, lacy effects than in the foliage of squirrel-corn, anemonella, and early meadow-rue? Where, softer leaf colorings than in adder's-tongue, hepatica or the spathe of Jack-in-the-pulpit? The flower of the wild columbine is splendid—and worthy of having been advocated for adoption as the flower of the nation—but it is hardly more pleasing than the finely cut, gracefully poised, silvery tinted foliage, which lasts all summer long. Some bulbous-rooted spring flowers, to be sure, lose their foliage before midsummer, and disappear utterly above ground until spring comes around again; such are adder's tongue and Dutchman's breeches, and others that grow in the deepest shades of the woods. But, on the other hand, the foliage of hepaticas and moss-pink is evergreen.

Fig. 81. Hepatica.

Fine as are these wild flowers, they are rapidly being exterminated. Their value is esthetic, not commercial. The land they occupy is all being taken from them for fields and stock-pens. Long since, they were driven from our doors. Of late, with the pressure of men for room, with the extension of fields, and especially with the pasturing of every bit of woodland, they are being exterminated in their last retreats. The time is coming when, if we would save them for our posterity, we must get them back about our doors again, where we can propagate them and protect them from utter annihilation. They will grow there as well as in the woods, if planted in suitable places. Of course, they will not grow on a smoothly mown lawn; but possibly the present zeal for leveling everything and having only mown lawns about one's place may yet develop into something better. Far more beautiful than grass as a ground-cover for the moist bank or for the shady place where there is no trampling, is a growth of common blue violets or of bloodroot or of wild ginger. Finer than any grass, for covering a dry sunny bank, is a close gray-green carpet of moss-pink. Why should one drain the low wet spot on his grounds, when he may, by properly planting it, have there, through the season, a succession of such beautiful flowers as the marsh-marigolds, lady's-slippers, cardinal-flowers, and hibiseus, maintained with a minimum of care. Why reduce everything to this dead level of artificial mediocrity?

One should not "rob the woods," where wild flowers remain, and selfishly deprive others of the pleasure of seeing them there. It is better to raise them from seeds, or to buy from a dealer who raises them from seeds (and not from one who is making a business of robbing the woods). But often when a wood is being cleared for plowing, or a new road is building, the wild flowers about to be destroyed may be taken up and given a place of refuge in private grounds.

Success with growing wild flowers depends on one's ability to take a hint from nature. Every plant has its requirements of light and moisture, and one may learn what these are by observing under what conditions it thrives best when wild. It is a waste of time and labor, and an advertisement of stupidity, to set out wild plants where they cannot possibly live. They are far better suited to informal plantings than are expensive exotics, and once established in suitable places they are practically self-sustaining.

Fortunately the wood-crop and the wild flowers grow well together, and flourish on rough land not suitable for tillage. Fortunately for the wild flowers, also, farmers are learning that the woodlot is more productive when not closely pastured. Often it has seemed to be the policy of the farmer to include every bit of rough woodland, however little forage it might afford, inside his pasture fence, on the general theory that every green thing his cattle might eat was clear gain to him. But of how much value in the diet of an ox is a handful of lilies? Yet if they be eaten or trampled out of existence, how much beauty is lost! On many farms a better spirit of enlightenment prevails. The woodlot is outside the pasture fence; and, protected from grazing and trampling and fires, the wild things again take possession of the banks and dells and ledges. It is at once a better woodlot and a wild flower reservation, and serves both use and beauty. Happily, the day is passing, when to help fill the paunch of some cattle-beast will be considered the chief end of every green thing growing wild on the farm.

Study 29. Wild Spring Flowers of the Farm

The program of the work for this study will consist of a visit to some native bit of woodland where the wild life has not been exterminated, and of an examination of the wild flowers, one by one, observing where they grow and what manner of life they lead.

The record of this study may consist of:

1. A map of a small woodland glade, with indications thereon of the distribution of the common kinds of wild flowers in relation to slope, moisture, shade and forest cover.

2. A table of all the wild flowers found, prepared with some such column headings as the following:

Name (ask instructor if you do not know it).
Stem (erect, trailing, creeping, underground, simple, branched, leafy, naked, etc.).
Flower (color, odor, form, size, etc.).
Flower-cluster (diagram).
Foliage (leaf-form, color, texture, etc.).
Situation (wet or dry, in sun or in shade).
Social habit (Solitary, commingling, cover-forming, etc.).
Remarks.

" 'That little patch,' said a successful flower-grower to me the other day, pointing to a bed of some rare daffodils about four feet by five, 'is worth fifty pounds.' I tried to look duly impressed: but I bethought me of a certain streamlet thickly, but not too thickly, edged with king-cups, which, if human delight were the measure of value, must have been worth fully fifty millions."—*Hubert P. Bland.*

XXX. WHAT GOES ON IN THE APPLE BLOSSOMS

"Around old homesteads clustering thick they shed
Their sweets to murm'ring bees;
And o'er hushed lanes and wayside fountains spread
Their pictured canopies."

—Horatio H. Powers (*Apple Blossoms*)

Sweet is the scent of the orchard in May. When the apple trees array themselves in pink and white it is the time of a great annual festival. The apple tree is host. In every one of its florets a place is spread for a little winged guest. The food is nectar and pollen, provided in lavish abundance. A brilliant company of bees and flies and butterflies are guests. The merry activity runs for days together, heightening when the sun shines brightly. It is held at the opening of the summer season, and the serious work of producing an apple crop is dependent on the good will and patronage of these visiting insects.

For, not all the pollen is eaten by them. Some of it is carried on their bodies and implanted on the stigmas of the flowers, where its growth results in the fertilization of the ovules; this conditions the development of fruit. To secure this service which the insects render unwittingly while satisfying their own appetites, the apple tree advertises its feast by fringing each flower with a circlet of pink and white petals, hung out gaily like banners, and sets a green dish in the center filled with drops of fragrant nectar, which perfumes the passing breeze. It also provides pollen greatly in excess of its own needs and offers great bursting anthers full of it. Then the bees come.

A honey-bee alights on the edge of a flower with her hind feet clutching the petals and her head thrust in among the stamens. She would like nectar; so she unslings her long proboscis and thrusts its tip downward between the bases of the stamens into the nectar dish, lapping up what she can reach. Then she raises her head and pushes her body through and over the central clump of stamens and style tips, and makes another downward thrust on the other side. In doing this, she brushes roughly against bursting anthers, filling the hairy coat of her body and legs with pollen; and she rubs stigmas, also, depositing pollen upon their moist tips.

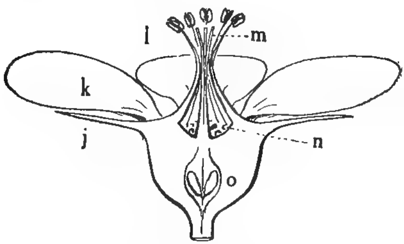

FIG. 83. Diagram of a section of an apple blossom. *j*, sepal; *k*, petal; *l* , anthers; *m*, stigmas; *n*, nectar.

Figure 83 shows where the nectar is, and explains these movements of the bees. The nectar is in a basin, out of the center of which arise the five stout styles, and it is fenced round about by a close-set palisade of stamens. It can be reached only from above. It cannot all be reached from any one position (hence the successive thrusts of the bee into the flower). Owing to the close crowding of the stamens and pistils, it can only be reached by a slender proboscis. This feast is not to be wasted on any wandering insect that may come along; it is reserved for those that are endowed with suitable nectar-gathering apparatus.

A little burrowing bee, *Halictus* by name, descends upon the flower and goes tip-toeing upon the top of the stamen cluster. She has a short proboscis that is quite unequal to reaching down to the nectar-cup: so she gathers pollen and in trampling about over the anthers tramples the stigmas as well and deposits pollen on them. A little green-and-gold bee, *Augochlora* by name, of size intermediate between the little halictus and the honey-bee, settling upon the stamens, spreads them with her feet and pushes head downward between until her not very long proboscis reaches the nectar in the cup below. Bees are the most important pollen distributors for apple blossoms: the larger ones seek both nectar and pollen; the lesser ones, pollen only. Bees go about the work in a brisk business-like way, passing rapidly and directly from flower to flower, visiting many in rapid succession and gleaning their food products thoroly. They are little disturbed by a person quietly watching them. Perhaps the possession of a sting may have something to do with this assurance of manner.

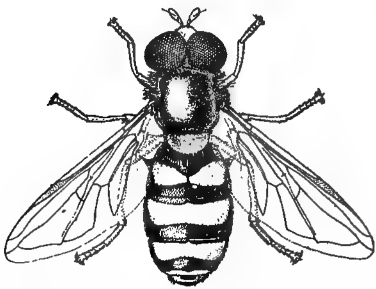

FIG. 84. A syrphus fly (*Syrphus americanus*, after Metcalf).

At any rate, the stingless visitors of the apple blossoms, true flies and butterflies, behave very differently. They flit about nervously, making circuitous flights between visits, and manifesting great wariness. A handsome banded syrphus-fly (fig. 84) settles lightly upon the stamens and laps up a little pollen with his proboscis and is away again, being gone before one has discovered that he is taking flight. A pretty nimble bee-fly darts up to a flower, makes a thrust or two at the nectar-cup with its exceedingly slender proboscis, and is away again. A fine butterfly soars overhead, and finally settles upon a flower cluster as if by accident, and sits there languidly dipping the tip of his uncoiled proboscis into such nectar cups as are in reach. Having greater length of proboscis than the apple flower demands, he swings it around like a dipping-crane. But he also darts away at the passing of a shadow.

The pollen of the apple is freely exposed, and there are many chance visitors that nibble at it, such as house-flies and beetles. But the insects that can reach the nectar are rather few. Bumblebees and honeybees are the most persistent and efficient distributors of pollen. All the bees are equipped for carrying pollen abundantly by reason of the bristly plumose hairs that clothe their bodies, and that make veritable pollen brushes (see figs. 105 and 106).

When rain falls constantly in blossoming time, the apple trees set little fruit because the bees are kept away from them: but when the sun shines, the busy hum of their prodigious activity is the sure forerunner of an apple crop.

Study 30. Observations on Apple Blossoms and Their Visitors

This study should be begun at home, where one may sit at a table and work carefully. With a bunch of fresh apple blossoms in hand, notice first the difference in condition of the flowers, from fresh unopened buds to spent flowers with falling petals. Observe especially the condition of the tips in the central cluster of stamens and pistils—the yellowish anthers capping the numerous stamens, and the naked stigmatic surfaces terminating the five pistils. Note carefully the changes of position and of condition during flowering. Then split several flowers of different age in halves, lengthwise, and look with a lens in the shallow green cup surrounding the pistils and encircled by the bases of the stamens for shining droplets of nectar. Then make a diagram of such a section, showing carefully the relative position of anthers, stigmas and nectar at time of full bloom.

The field work of this study will require fit weather. A calm bright day will be best. Rain will drive the flower visitors away, and too much wind will interfere with observations on them. The tools needed will be individual insect nets, cyanide bottles* and lenses.

The **program** of field work will consist of a visit to apple trees in full bloom and observations on the doings of the flower visitors. Trees with low-hanging boughs, having abundant blossoms within reach from the ground, will be best. If wild crab-apple trees or even haw-apples are more convenient, they will serve equally well. The visitors will be seen, coming and going, or flitting from flower to flower, each kind after its own habit. The bees may be captured in a cyanide bottle directly, but the more wary flies and butterflies will require the use of the net. A quick deft stroke will land them in the net, and a quick turn of the handle will make a fold in it and keep them in the bottom until they can be removed in a cyanide bottle, inserted unstoppered for the purpose. Effort should be concentrated on watching the insects, not on catching them. Their comings and goings and how they obtain the nectar, should be observed carefully. Then a specimen of each kind of visitor should be captured for identification.

The **record** of this study should consist of:

1. A diagram of a longitudinal section of the flower as mentioned above.

2. A similar diagram with a bee added in the position taken when obtaining nectar. Show position of proboscis and feet carefully.

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*A cyanide bottle for killing insects may be made by placing half an ounce, more or less, of cyanide of potassium (a deadly poison) in the bottom of any wide-mouthed bottle, covering it with dry sawdust or other good absorbent, pressing down on top of it a few discs of stiff blotting paper, and affixing a POISON label. The discs should fit the inside of the bottle tightly and will stay in place better if lightly gummed at their edges when inserted. Most insects are very quickly killed when shut inside. The nets also may be made at home but not so easily. Those offered by the Simplex Net Company of Ithaca, New York, are recommended as being light, strong and inexpensive.

3. A list of all the apple blossom visitors observed, with data as far as obtainable incorporated in a table prepared with the following column headings:

Name (of the insect; ask the instructor if you do not know it).

Seeking (pollen or nectar. Do not guess at this; better leave the space blank).

Alights where (touching what parts of the flower).

Carries pollen on (what parts of the body).

Touches stigmas with (what parts of the body).

Reaches nectar with (what proportion of proboscis, or of whole body, inserted into the flower)

Number of flowers visited { per minute.
between flights (i. e. between the longer flights).

Activity (relatively quick or slow, wary or approachable, direct or circuitous, etc.).

Fitness (well or ill-adapted for pollinating apple blossoms).

If there be any difficulty arising out of the crowd, concluding observations may, with advantage, be made individually, at one's own convenience.

XXXI. THE SONG-BIRDS OF THE FARM

> *"The woods were filled so full of song*
> *There seemed no room for sense of wrong."*
>
> —Tennyson.

Nothing is more natural than that we should be interested in birds. Their appeal to us is manifold. Their colors are beautiful, and the texture and design of their garb are elegant beyond comparison. Their sprightliness is wonderful. They flit from morning till night unceasingly, and traverse the air with a freedom that often moves us to say, enviously, with Darius Green, "Birds can fly, and why can't I?" When we shall have "conquered the air", our flying bids fair to be serious work rather than play, such as theirs is. Their songs are the finest vocal expressions of the animal world—expressions apparently of contentment, of tender sentiments and of exuberant joy. Their nests show fine discrimination in the selection and use of materials, artistic sense of decorative values, and in their construction they disclose the elements of basketry and carpentry, and of both plastic and textile art. Their family life is nearly ideal; the fidelity of mates to each other and the devotion of parents to their brood being such as human society aspires to, but has not yet fully attained.

And if all these things were not enough, there would still remain the practical consideration that birds aid us in our agriculture. They feed on insect pests of field and orchard: and if any one were so devoid of sentiment as not to like a robin singing from the housetop, he might still appreciate the bird when found devouring cutworms in the garden. It is not economic, but esthetic values, however, that are to be the subject of this study. Let us get acquainted with the birds dwelling near us for the sake of the pleasure to be had from personally knowing creatures so beautiful, so tuneful and so artful.

This is the age of birds. They outnumber, in species, all other air-breathing vertebrates put together. Doubtless, their ability to fly and thereby to find food and to escape enemies has had much to do with this preponderence. Hardly any other living things have acquired such power of flight, and no others have established regular seasonal migrations between summer and winter homes. A hundred or more species may be found in any good locality in the course of a year—more than half of them, song-birds. A few are permanent residents; a few are winter visitors from the far north; many are transient visitors that winter south of us and summer north of us, and a substantial number, including all the song-birds that we value most highly, are summer residents. These return to us every spring and settle and build nests and sing and rear their broods. Who does not feel a thrill of pleasure at the return of the bluebird, that soft-voiced harbinger of spring?

FIG. 85. Simple types of home-made nesting boxes for birds.

Wild birds they are, yet they do not mind our presence if we treat them well. And a number of the most charming little birds will settle near us and remain with us year after year if we provide them suitable places for nest building, located in safe and congenial surroundings.

It is a pleasant aspect of evolution to contemplate that the birds we like best—the birds that sing and that fashion beautiful nests and rear their young with most parental care—are the ones that have been and are most successful in the race of life.

While a number of the smaller birds look much alike on first approach, each species has its distinguishing peculiarities that a little careful observation will reveal—peculiarities of color and attitude, of flight and of notes, of haunts and of manners toward man and toward each other. A few, like the crow and the jay, are so well marked as not to be mistaken. The habit of running head downward along the bark of a tree at once marks a bird as either a nuthatch or a creeper. The songs are perfectly specific, and will often lead the careful observer to the bird he is wishing to see. There is no need of attempting to describe differences here; for a morning in the field with the birds is worth more than all the descriptions.

Study 31. Song-birds of the Farm

This study is intended primarily for those who do not know the local song-birds at sight.* An instructor who knows them is assumed; yet the student working alone may easily do what is here outlined and identify his birds with the aid of some of the excellent bird books now generally available. Field glasses (or opera glasses) while not absolutely necessary will be a great aid in field work on birds. Dry weather will be desirable, and a shift of meeting time to an early morning hour (when birds are most in evidence) may be advantageous. Prepared bird-skins may be used by the instructor in pointing out recognition characters.

The program of work will consist of a short trip made quietly along some woodsy lane where birds congregate, and across upland and lowland meadows and by a willow-bordered stream, observing the different species of song-birds, one by one, as opportunity offers. Careful observations will be needed to obtain the data called for by the table outlined below.

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*For such members of the class as know the birds well, the instructor may assign other work, such as intensive specific observations on some one species of bird temporarily abundant and not too well known; observations on such matters as its haunts and nesting habits, food and feeding habits, voice and social habits, enemies and warning habits and mode of escape, etc. Or, better, such extended individual work as is outlined in Optional Study 6 on page 229.

The record of this study may consist of a table of recognition characters of local song-birds, prepared with column headings as follows:

Name of bird.

Haunts (be as specific as the facts will warrant in indicating the kind of cover sought, and the habitual elevation, whether in the treetops or on the trunks, in the undergrowth or on the ground, whether near or far from water, etc.)

Recognition colors:
- At rest (give general color and chief markings with their location on the body—only such as can be seen at a short distance on the living bird).
- In flight ("flash colors"; i. e., additional markings that appear in outspread wings and tail).

Perching attitude.

Social habit (number seen together, resting or flying. State sex, also, when distinguishable).

Voice (briefly characterize notes of monologue, of social converse and of song).

Flight (undulating, straight or soaring: wing-strokes, continuous or intermittent, etc.).

Familiarity (how close can you approach: estimate in yards).

Remarks.

XXXII. TREES IN THE EARLY SUMMER LANDSCAPE

"The birch tree throws a scarf of green
Around her silver white,
Woven of little polished leaves
All delicate and bright,
It sways with every passing air
And shimmers in the light.

Oh, like a Dryad nymph she stands,
The birch tree, silver white!
And all day long that flowing veil
Trembles for my delight.
She stirs it as she moves in it
As a young maiden might."

—Ethel Barstow Howard (*The Fairy Tree*).

Out in the country, wherever we go, trees rise about us and bound our view. They make vistas along the roadways; they fringe the streams; and they gracefully mass themselves about the shores of lakes and bays. In a new country, they cover the valley-side with a rich robe of green, and in an old country, they rise like oases about the homes that nestle among the cleared fields. In their shelter our race has always dwelt. When men settle upon a treeless prairie, they take trees with them and plant them cosily about for shelter, and use them to make a pleasing outlook by bordering the view from the windows of their homes.

Trees furnish the chief elements of beauty in most landscapes, and usually those views are the most pleasing that include the most trees. Near at hand, they rise about us like the giants that they are, and show their individual characters—their mighty trunks clad in bark, each with its own coloring and sculpturing; their great arms and crowns; and the elegant outlines of their leafy sprays outspread against the sky. At a little distance they appear, not as individuals, but as masses, with their architecture hidden, and their foliage piled in shocks of green, full of lights and shadows. And on the far horizon they are still in our view, spread out in innumerable companies in a long thin line where overspread with pale haze.

The well-grown clump of trees shows us, from the outside, only its leaves, with just enough of glimpses of supporting framework to suggest stability. The leaves are all on the outside, spread out broadly to the sun. We put our head through the leafy cover to the inside and look up—and it is like looking into an attic, seeing beams and rafters instead of familiar roofs. Inside all is gray bare boughs forking, and forking again, and stretching up to and supporting the overshadowing leaf-cover. We examine the outside carefully, and we see that all the leaves are mutually adjusted to get the maximum benefit from the light. The removal of a single leaf alters and mars the adjustment; the overturn of a single spray sets it grotesquely awry.

How the outside of a tree appears in the foreground of the landscape, depends on the size and form and number of its leaves, and on the way they are held up into the light. Foliage masses are endlessly varied. They are cumulous masses in the sugar-maple—masses of broad, shade-resistant leaves heaped up and compound-heaped like the front of a thundercloud. They are cancellate masses in the white birch. with its small thin leaves in open order like latticework. They are frondose masses in ailanthus and sumac and other trees having compound leaves. They are soft and furry cylinders, rather symmetrically arranged, in the spruces and tamarack; and other trees show all grades between these types. Hickories are given to be a bit irregular, and to hold their sprays rather stiffly, while the beech lets the fringe of its leaf-cover run down in long ornate sprays, that are poised in the hollows of the woods with exquisite grace. The softest effects of all are produced by the small pale leaves of the willow, which form fluffy cloudlike masses of green reposing by the stream-side. There are other, stricter-growing species of willow, whose shining leaves sparkle brightly in the sunlight. Wind changes the color of certain foliage masses, such as those of the white oak tribe, by overturning the leaves and exposing to view their paler under surfaces. It takes a hard wind to overturn the leaves of the speckled alder, but when overturned, they entirely change the aspect of the alder thicket.

Endless are the tints of green, also, in the trees of the landscape, ranging from the light silvery green of the white willow to the heavy somber green of the white pine. Nature uses other colors sparingly, only here and there lighting up the edge with a show of flowers, as with masses of Judas-trees, or flowering dogwood, or hawthorn.

Nature adorns every species of tree with its own graces of form and color. None is like any other. Each looks best where it grows best; for the handsome tree is, indeed, the tree that is well grown.

When we walk beneath the trees of a forest cover, the beauty of their foliage is lost on us, we are such pygmies, walking beneath it: we must climb to some point of outlook to see it. But when the wood is cleft, as by a stream, the leafage comes down softly to the ground in all its beauty. Viewing a steeply-rising wooded slope from the vantage of the opposite bank, we may see how nature uses trees. She plants them in masses, using a few of the best kinds in vast numbers, and scattering the others thickly, but not too thickly, about the edges. Always there is enough variety to maintain our interest, and enough repetition of like combinations to avoid weariness. Always there are vines about the edges for drapery; and in the openings, shrubs and herbage mask all the angles and cluster about well-grown full-leaved single trees. So, nature makes of every open woodland glade, a charming sylvan picture.

Study 32. Observations on the Decorative Features of Tree Growth in Early Summer

The weather, when this study is undertaken, must be such as will permit one to sit down out-of-doors and study for a time, with comfort, the details of the landscape outspread before him. If the student has no familiarity with the decorative values of foliage masses, let him read the preceding pages while sitting where illustrations of the foliage phenomena cited may be drawn from nature. One may often see many foliage types by looking out of his window over well-planted grounds, if native woods be absent.

Photographic prints, (preferably blue-prints), of the scenes selected for special study, or maps showing outlines of tree masses, may be prepared in advance and supplied by the instructor.

The program of work for this study may consist of:

1. An examination of the scaffolding by means of which some broad-leaved tree holds its leaf masses up to the light, and a comparison of method in solitary and clustered trees. Also a comparison of inner and outer aspects of some small clump of trees.

2. An examination of leaf sprays as to leaf arrangement and its relation to light exposure, and to the formation of the larger foliage masses that adorn the landscape.

3. A detailed study of several landscapes, selected for the beauty and variety of tree growth within the view. Study the foliage masses formed by the different kinds of trees, comparing them as to color, form and texture, setting down as worthy of consideration whatever appeals to you as being good to look upon, and indicating the features of it

that are to you pleasing. Also name the kinds of trees responsible for such effects.

4. Comparison of well and ill-grown, unhealthy trees of any species as to the decorative values of their leafage.

The record of the work may consist of:

1. Comparative diagrams showing framework and outline of:

(a) A single specimen tree, growing alone, unpruned.

(b) A clump of several close-growing trees of the same kind, also unpruned, forming a unit mass of leafage.

2. Comparative diagrams of leaf arrangement on a small undergrowth spray of such trees as elm, maple and larch.

3. Indications (as footnotes to a photograph, or as explanations to a map, or otherwise, as preferred) of the character of foliage masses in the scenes studied, covering:

(a) The kind of trees involved in each type.

(b) Their height.

(c) Relation of leafage to trunks, such, for example, as the contrast in the white birch.

(d) Color of crowns (light or dark green, dull or shining, reactions to wind, etc.).

(e) Texture (open or close, light or heavy and somber, etc.).

(f) Form (mass outlines and spray relations, etc.),

(g) Suited to a place in the foreground or in the background; in the exposed or in the sheltered places; with reasons therefor.

Individual Exercises for the Spring Term

Five studies follow, which, like those for the Fall Term (pages 126 *et seq.*), are intended to be made by the student working alone. The first three may be entered upon early in the term (in our latitude); the other two are for the latter half of the term.

Optional Study 6. A Calendar of Bird Return

This study is available only to those who know the birds at sight, or who are willing to take the necessary trouble outside of this course to really make their acquaintance. Doubtful identifications will render the record quite worthless. Permission to offer this record will therefore have to be obtained in advance of undertaking the work.

The object of this study is to give opportunity for extending personal acquaintance with our local migratory birds on the part of students who already know them by sight. Field observations, made at least once a week, may conveniently be entered in a cross-ruled table having the left-hand column reserved for bird names, and each of the other columns devoted to one day's observations, the date, time of day, and relevant weather conditions being written at the top. Following each bird's name, there should be written in the proper date columns, the observations made upon it: number and sex seen at first appearance; arrival of sexes, and of young birds, separately; arrival of "waves" of migrants; etc.

Optional Study 7. A Calendar of Spring Growth

This study is for one's own dooryard. It is intended to foster acquaintance with the plants one lives with all the while. These are apt to be choice things that have been sought out and planted, and other things that have come in uninvited, and that we call weeds. Nature makes no difference in her treatment of them; the rain falls and the sun shines on them all alike. The following study should be made with like impartiality. It should continue through the entire term, observations of every actively growing species being made at least once a week. All kinds of dooryard or roadside plants are available, whether giant trees or puny herbs.

For record, the observations may be entered in a cross-ruled table having the left-hand column reserved for plant names, and each of the other columns devoted to one day's observations, the date being written at the top. Following the name of each plant, there should be written under proper date the first obvious swelling of the bud, the first leaf open (as determined by the exposure of its upper surface), the first flower open, the first fruit ripe, etc., and any other little idiosyncrasies of the plant that appear from time to time. Footnotes may be made to include observations for which there is not room in the table.

Optional Study 8. A Calendar of Spring Flowers

Observations on the blossoming of the early spring flowers is less work than pleasing pastime. It is worth while from every point of view; and this study is offered in the hope that more of it will be done voluntarily.

If one would keep track of the flowers of his own locality, he should first know where the near-by places are in which the wild flowers abound, and then he should so lay out his walks as to cover the greatest variety of situations; for thus he will see the largest variety of flowers.

For record, the field observations may be entered in a table prepared with the following column headings:

Name (ask instructor if you do not know it, presenting, always, a specimen for identification).

Date of blossoms { first appearance. / maximum. / last appearance.

Relation to leaf-unfolding (before, with, or after the leaves).

Duration of a single flower (from first opening to withering).

Movements of flower-parts { with day and night. / with progress of flowering.

Changes of color.

Date of first fruit ripening.

Remarks.

Optional Study 9. Noteworthy Wild Flower Beds of the Farm

Optional Study 10. Noteworthy Wild Shrubbery of the Farm

These two studies are intended to encourage personal observations on the ornamental things growing wild on the farm; on their character, their requirements, and their availability for making the farm more beautiful and more interesting. The data called for may easily be obtained in the course of walks afield for air and exercise. For record, blank tables, like those on pages 231 and 232 may be used. The flowers and shrubs therein named are such as are most available at Ithaca.

9. NOTEWORTHY WILD FLOWER BEDS OF THE FARM

Best specimens I have seen of	Location	Area covered	Character of haunts	Date of flowering	Character of foliage
1. Hepatica					
2. Rue Anemone					
3. Adder's Tongue					
4. Moss-pink					
5. Trillium					
6. Columbine					
7. Bishop's Cap					
8. Cranesbill					
9. May Apple					
10. Iris					
11. Others of your own selection					
12.					

BEST WILD FLOWER-GARDENS OF MIXED SORTS

	Location	Components	Seasonal range of flowers
1. On level woodland			
2. On dry hillsides			
3. In wet swale, marsh or bog			

10. NOTEWORTHY FLOWERING SHRUBBERY OF THE FARM

Best Natural Plantings I have seen of	Location	Area covered	Conditions‡	Date of flowering	Character of foliage
1. Azalea					
2. Maple-leaved arrowwood					
3. Elder*					
4. Flowering Dogwood					
5. Other Dogwood*					
6. Viburnum*					
7. Sumach*					
8. Witch Hazel					
9. Spicebush					
10. Buttonwood					
11. Willow*					
12. Mountain Ash					
13. Juneberry					
14. Any other					
Pleasing Shrub Combinations					
1. Border plantings					
2. Cover plantings					
3. Mixed-specimen plantings					

*Any species, but specify which species.

‡ Of moisture and sunlight.

PART III

Studies for Summer Term

XXXIII. THE PROGRESS OF THE SEASON

"Now is the high tide of the year. . .
We sit in the warm shade and feel right well
How the sap creeps up and the blossoms swell;
We may shut our eyes, but we cannot help knowing
That skies are clear and grass is growing;
The breeze comes whispering in our ear
That dandelions are blossoming near,
That maize has sprouted, that streams are flowing."
—Lowell (*A Day in June*).

Summer is here!

The fields that were brown when overturned in the spring are now all green again. The desolation wrought by the plow was but to prepare them for a better growth. The cattle stand knee-deep in the grass. The butter is yellow. There is no bare ground in the garden of the thrifty householder. Splendid flowers are blooming; nestlings are trying their wings. The earliest of the wild fruits are ripening; and living is easier for every creature.

The spring rush is over and the great work of the heated season is on—the work of crop production. We speak figuratively of raising crops—that is nature's work, not ours. All we can do is to arrange some of the conditions favoring their growth. We can remove their competitors and destroy their enemies and stir the soil about them, but nature makes them grow.

Most plants consume their food reserves in getting started in spring; then they settle down to the steady work of gathering new sustenance from the soil and from the air. Under natural conditions, they must act quickly when the season gets warm enough, in order to hold a place among aggressive competitors. To be outrun in the race for light is fatal. So, they put forth tender shoots with all the leaves they can carry, leaves being their working capital. So, in early summer, all the world is full of soft green tints. New growth is everywhere. In dark-hued evergreens, like hemlock and spruce, the contrast between the pale new shoots and the mature old ones is very striking. In the heat of summer the new growth will harden and new reserves of food will be accumulated.

This is the ordinary routine for the larger perennial plants that are best suited to our temperate climate. But there are some little plants that avoid the strife of summer by making haste to finish all their work in the spring. Such is the narcissus, now withering on our lawns; and like it are the adder's-tongue and the squirrel-corn, and many other early spring flowers that dwell under the heavy shade of the woods. Doubtless the onion grew originally where it was subject to late-season shading, and there acquired the habits which it still retains when grown in the open fields.

Our field crops are mostly annuals, brought from various climes. Some, like oats, are natives of cold countries, and are sown early and mature early. Some, like corn, are semi-tropical, and are sown late and grow well only in hot weather. Our hottest spells are proverbial "corn weather". Some, like wheat, spend a part of the season thickening up their "stand" by producing offsets from the bases before rising to full height and flowering. We plant one grain of corn for each stalk wanted in the field, but not so with wheat or timothy: seedlings of these, early in the season, produce at the surface of the ground a clump of buds, which later shoot up tall flowering stalks simultaneously. The wheat, after fruiting, dies, but the timothy goes on producing other offsets at the base, holding its ground after the manner of perennials, and getting ready for another season.

In nature, annual plants occupy the spaces left temporarily unoccupied by perennials. They fill the niches, both spatial and seasonal. So, when we move them into our open fields, they enjoy unaccustomed abundance of room and light. We change conditions and increase their yield, but we do not greatly change the nature of any of the plants. Out in the clover-field, we see a few stalks of rye that have sprung up where a seed fell and germinated. The swaying stems rise to thrice the height of the clover. Why this unnecessary length of stem, and undue exposure to the rude winds? We need only look at the wild rye growing among the forest undergrowth, to see in what conditions this growth-habit was acquired. There, all that length of stem in needed to reach effective light.

We plant such spindling things closely for mutual support, while to potatoes we allow plenty of "elbow-room." We till one crop and not another, according to their need of help in competition with weeds. We adjust our farming operations to the seasonal behavior of our very varied crops: for no adjustment the other way about is possible. According to the temperature and time requirements of our crops, we make a series of plantings in spring and a succession of harvests in the summer. So, our ways conform to theirs.

One who raises plants, gets pleasure out of his craft in proportion as he follows their idiosyncrasies, and knows what they are doing in root and branch or in flower and fruit, at every turn of the season.

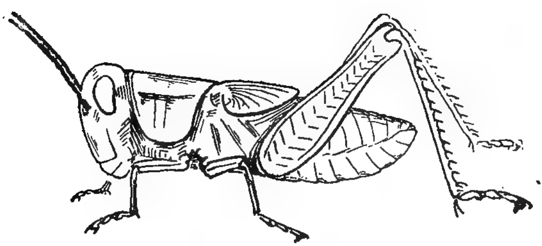
Study 33. The Progress of the Season

The program of this study includes a trip over the fields and gardens of the farm, map in hand, noting, inspecting and recording the more striking seasonal activities of the growing things. To determine whether vegetative increase of field-crop plants is going on, specimens will have to be dug up and examined root and branch.

The record.

1. On the map of the field, the principal crops may be recorded directly, and their stage of advancement briefly indicated.

2. An annotated list may be made of all the crops observed, giving location (as by name or number of the field), area, stage of advancement (as germination, height, blossoming, etc.), condition (good, poor, weedy, infested with plant-lice, etc.). Include, besides field-crops, fruit and truck-crops and pastures.



XXXIV. THE CLOVERS

"Now, Cousin Clover, tell me in mine ear;
Go'st thou to market with thy pink and green?
Of what avail, this color and this grace?
Wert thou but squat of stem and brindle-brown,
Still careless herds would feed."

Sidney Lanier (*Clover*).

"Knee-deep in clover" is a purely agricultural figure of speech. No one who has seen the pigs or the heifers turned out into a clover-field of a summer morning, will need to be told that it signifies complete and unalloyed satisfaction. Nor does it mean merely pleasures of the palate, even for the beasts; for they gaze on the clover, sniff at it and take deep breaths, and lie down and roll in it. Doubtless there was clover in Eden.

There are many kinds of clover, and they are of varying utility to us. Of all groups of cultivated plants, there is hardly another that is intimately bound up with so many agricultural interests. Clovers furnish green forage, both for pasture and for soiling. They furnish hay—hay that sets a standard of quality for all other hay; hay so rich in proteins, it needs to be diluted with other forage for ordinary feeding; and that, alone, is ground and used like meal.

The clovers also supply fertilizers to the soil, especially nitrogenous fertilizers: directly, when plowed under and decomposed; and indirectly, through the action of the nitrogen-gathering bacteria that live in the nodules on their roots. The practice of rotation of crops depends for its success largely on the work of the clovers in replenishing the supply of available nitrogen in the soil. Both by the deep penetration of their roots, opening up the hard subsoil to the ingress of air and water, and by the materials they contribute in their decay, they leave the soil in better condi-

FIG. 86. White clover. (This and other drawings bearing the same monogram prepared by Miss Olive N. Tuttle for this book.

tion for subsequent crops. Most other crops deplete the soil, but the clovers enrich it, and restore its fertility.

The clovers also furnish the finest of the honey crop—especially white clover, which fills the land with the fragrance of its nectar in June. Among them are excellent soil-binders for holding together the surface layers of eroding hill slopes; excellent cover-crops for the orchard in the dry season; and excellent plants for the lawn and the fence-row.

And besides all these very practical matters, there is their beauty! Crimson clover, red clover, white clover—what neatness and elegance of design in the single sprays; what beauty of leaf form; what freshness of flowers! And in mass, also, they give fine landscape effects—the red outspread over the plain like a carpet of roses; the white sprinkled over the green hills like flakes of fugitive snow.

FIG. 87. Red clover.

All the clovers are deep-rooting herbs that grow in spreading tufts and bear trifoliate leaves, having stipules at the base of the leaf-stalk. They have small flowers in clusters, and short, few-seeded pods. The true clovers (members of the genus *Trifolium*) produce their flowers in heads: the others (sweet clovers of the genus *Melilotus* and the medics of the genus *Medicago*) bear them in more open spike-like racemes. Red and crimson clovers are the most striking species of the fields, but in northern latitudes our native white clover is the hardiest and the most widespread of all. It grows in fields and pastures and copses everywhere, often from self-sown seed. Its creeping stems,

FIG. 88. White sweet-clover.

FIG. 89. Alsike clover.

striking root wherever they touch the ground, fit it for life in pastures and in lawns. From its sweet flowers, the whitest of all honey is gathered by the bees. Alsike clover is a similar but more robust, imported species, with lax stems, not rooting at the nodes, and with rose-tinted flowers. Buffalo-clover is another rather obscure native species, with piebald, red and white flowers. Then there are two other kinds of

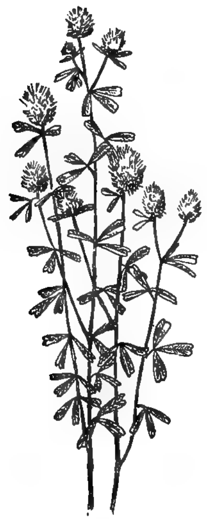


FIG. 90. Rabbitt's-foot clover (after Britton and Brown).

imported true clovers of very different appearance: the tall, branching, rabbit's foot clover, with its whitish corollas hidden among long and silky calyx lobes, which, combined together in the soft heads, suggest the name it bears; and two delicate little yellow-flowered hop-clovers.

The sweet clovers are two species of tall fragrant roadside weeds, similar in appearance except that one bears white, and the other yellow flowers. The white sweet clover (fig. 88) is able to follow the road grader and take possession of and thrive in the hardest and most unpromising of soils.

FIG. 91. Yellow-hop clover.

The medics differ from the sweet clovers in having bent or spirally twisted pods, instead of straight ones. They also have shorter flower clusters. One of them, alfalfa, is of vast importance as a forage crop. It has purple flowers. The others are unimportant, yellow-flowered species that we find in waste places.

Of all the array of clovers, only the white clover and a few of its nearest allies in the genus *Trifolium* are native American plants. But all of them are interesting and worthy of a little careful study.

Study 34. The Clovers of the Farm

The program of work for this study will consist of finding the clovers, wild and cultivated, growing on the farm, and digging them up and examining them, root and branch, flowers and fruit, and of making field observations on their habits, conditions of life, enemies and associates.

The record of this study may consist of two tables of the clovers, one relating to the green plants, and the other to their flowers and fruits, prepared with column headings as indicated below:

1. The Green Plants.

Name (red clover, sweet clover, alfalfa, etc.).

Duration (annual, biennial, short-lived or long-lived perennial).

Height (average height in inches).

Growth-habit (erect, trailing, creeping, etc.).

Stem (stout or weak, cylindric or furrowed, straight or zigzag, etc).

Leaves
- form (diagram of the compound leaf as a whole, including the basal stipules).
- color (light or dark green, markings, etc.).
- margin (diagram of edge of leaflet).

Root
- form (diagram).
- nodules (relative size, form, abundance, etc.).

Grows wild where (in what kind of soil and situation).

Is grown with (what other cultivated plants, sown or associated).

Is fed upon by (what animals: what insects).

Farm uses (green forage hay, cover-crop, honey-crop, green manuring, lawn-cover, fence-row cover, etc.).

Remarks.

2. The Flower and Fruit

Name (red clover, sweet clover, alfalfa, etc.).

Flower-clusters
- form (diagram a longitudinal section of it).
- No. of flowers (in an average entire cluster).
- No. of clusters (on a plant of average size).

Flowers
- corolla (color, form, etc.).
- calyx (length in relation to corolla, hairiness, etc.).
- fragrance
- visitors (insects seeking nectar).

Seed-pod form (diagram).

Size seeds (length by width in fractions of a millimeter: to measure, lay ten seeds, touching, on a metric rule (see p. 12); read, and divide by ten.)

Remarks.

XXXV. THE AROMATIC HERBS OF THE FARM

"Excellent herbs had our fathers of old,
Excellent herbs to ease their pain,
Alexanders and Marigold,
Eyebright, Orris and Elcampane,
Basil, Rocket, Valerian, Rue
(Almost singing themselves they run),
Vervain, Dittany, Call-me-to-you,
Cowslip, Melilot, Rose-of-the-Sun.
Anything green that grew out of the mould
Was an excellent herb to our fathers of old."

—Kipling (*Our Fathers of Old*).

Our great demands upon the plant world are for food, clothing, and shelter. Given these essential things, we then demand other things for pleasure or adornment. To necessary plain food, we add flavorings; to textiles, we add dyes; to walls and roof, we add decorations; and then we enrich our social intercourse with garlands and wreaths and incense. We use these things because nature has placed them near at hand, and has made us to appreciate them.

Nature has singularly commingled the bare necessities of our existence with the pleasant gifts of her bounty and with the things we may not use. They grow together out of the same soil, foods and sweets and poisons. Fortunately, our instincts guide us in a considerable measure in the choice of foods, for what nature has made most pleasing to our palate is, in general, most wholesome. There are, however, many wholesome plant products that are not at first pleasant to the taste, and there are poisonous fruits that are attractive in appearance. Nature has put into her plant products an endless variety of substances, nutritive, stimulating or poisonous, from which we may pick and choose. Moreover, she has so mingled these qualities in her products that their effect upon us depends upon our use of them. Foods are stimulating if rightly used, and yet may act as poisons if used in excess. Many poisons are used medicinally to stimulate the latent powers of the body: and most stimulants are poisons if too freely used. Between foods and medicines and poisons, no hard and fast lines can be drawn. Strawberries and may-apples and other raw fruits act as poisons in the case of individuals. Many foods act like medicines on the system. Blackberries are mildly astringent: prunes are laxative: asparagus is diuretic: lettuce is soporific—these effects varying with personal idiosyncrasy. An editor of one of our leading agricultural journals, in an excess of enthusiasm, once wrote: "The virtues of the onion [in diet] render it a whole pharmacopeia in itself". Truly, "what is one man's meat may be another's poison".

It was one of the earliest tasks of mankind to explore the plant world and find out the source of foods and medicines and poisons. Primitive folk, by tasting and trying, discovered nearly all these plant resources that we know today. The cultivation of all our important food-plants antedates written history. There is hardly an American vegetable drug whose use was not known to the Indians before the coming of Columbus.

In that day when every one garnered his living with his own hands, plant lore was knowledge of first importance. Experience was handed down by oral tradition. To what men knew about plants, was added much that they imagined. Before the days of botany, the best of this lore was published in herbals. These were great compilations of what was known or believed about the names, habits, and uses of plants. They included practically all known plants, and in the list of their "vertues" nourishing and stimulating and curative properties are all set down together, side by side. The herbalists were very optimistic about plant virtues. Most plants were good for many of the ills of human flesh.

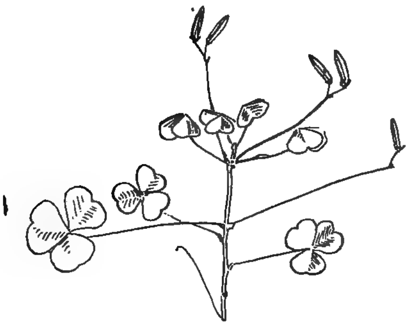


FIG. 92. Yellow sorrel.

Everything was good for something, tho in some cases the good was undiscovered. Thus, Gerard says concerning "divers other wild campions" (Herbal, 2d ed. 1633, page 474): "The natures and vertues of these, as of many others, lie hid as yet, and so may continue, if chance, or a more curious generation than yet is in being do not finde them out."

There is more than nourishment to be had from foods. The pleasures of the palate are inseparable from a good digestion and good assimilation. There are wholesome foods that cloy, and others that quicken. There are things, not in themselves nourishing at all, that, added in moderation to our diet, help to keep our nutritive machinery working efficiently, and so contribute to our welfare.

FIG. 93. Round-leaved mallow; the fruit (shown at the side) is known as "Cheese."

Only foods proper are of sustaining value, but many harmless food adjuncts, especially the milder flavorings of vegetable products, add to the zest of our eating and to the value of our diet. Of vegetable flavorings there is no end. There are acid flavors, like those of the leaves of the sorrels, long since supplanted in our diet by artificially prepared vinegars (yet what child of the field does not still nibble at sorrel leaves?). There are pungent flavors in the peppers and in many crucifers—in the leaves of the cresses, in the roots of radish and horse-radish, and in the seeds of pepper-grass and of mustard. It is flavor and not food that children get from chewing mallow "cheeses" (fig. 93), or slippery-elm bark, or linden buds. There are pleasant oleraceous flavors in kale and cabbage and cauliflower; and then there are the flavors of the savory herbs, the subject of this study.

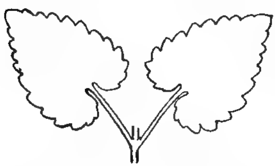


FIG 94. A pair of leaves of catnip.

The beasts also desire these pleasant adjuncts to their diet. Cats like catnip and valerian. Dogs like certain of the goose foots. Cattle love to crop the twigs of apple and hawthorn and even the shoots of the poison-ivy and other plants that are to us harmful. Wild deer are fond of nettles. Horses like their hay best when it is fragrant with the natural aromatic oils of certain of the grasses, well preserved by proper curing. It is noticeable that in these animals, as in ourselves, taste and smell are intimately associated. The cat not only bites the leaves of the catnip to taste them, but he sniffs of them and rolls himself upon them, so as to carry the aroma with him. Then he licks his fur in complete satisfaction.

Savory herbs, possessing fine aromatic scents and flavors, have been sought out and used by all the races of men. They have figured in the ceremonials of all religions, serving for perfume, for incense, or for purification. They have served in public gatherings in hall, chancel and theater to make pleasing unobtrusive appeal to the senses. "English literature is redolent of all the sweetest leaves and flowers of English gardens" (Barbidge).

Herbage-scents are not transient and effusive, like the odors of the flowers. They last through the life of the plant itself, and are often sweetest in the dried herb. They are faint and ethereal, like the delicate scent of sweetbrier leaves distilling into the motionless air of a summer evening after rain. Or they may not be noticeable at all unless the foliage producing them be rubbed or bruised.

It was for this reason that our grandmothers planted lavender and rosemary and balm close beside the garden paths, where their leaves would be brushed by the clothes of a person passing, liberating the fragrance. They prized these for the garden in summer, and such sweet things as lemon-verbena and rose-geraniums for the window-garden in winter. It is because herbs yield their fragrance most abundantly when crushed or bruised, that they were used of old as "strewing herbs." They were scattered in the path of a bridal or other procession, to raise a pleasing perfume when crushed by passing feet.

Aromatic herbs are mainly such as secrete essential oils in leaves or seeds or roots. They belong mainly to two families of plants: the mints and the umbelworts. Well-known, often cultivated members of the mint family are sage, thyme, spearmint, peppermint, sweet majoram, summer savory, balm, basil, catnip, pennyroyal, bergamot and horehound. The garden umbelworts include anise, coriander, caraway, parsley, etc. Single representatives of other plant families are ginger, orris-root, sweet-flag, sweet-fern, musk-mallow, dill and wintergreen.

Such names as those just mentioned at once suggest many uses these have served. The flavoring of foods may well have been the earliest of these. Gerard reports Pliny as having said that "The smell of mint doth stir up the minde and the taste to a greedy desire of meat"; and for himself he adds, "Mint is marvellous wholesome for the stomacke". (Herbal, p. 681). To the modern cook or confectioner, the herbs themselves are hardly known, tho their essences are used to excess. But our great grandmothers knew them, grew them, cut them, cured them and then seasoned with them. The plants were gathered about the time when their first flowers were opening, dried rapidly to preserve their essential oils, and put away for winter use. Then they were used with discrimination. It was experience, not chemical analysis, that settled upon sage and summer savory as proper seasoning for sausage and roasts; upon parsley and thyme as suitable for stews and soups.

Fig. 95. Pennyroyal.

Our grandmothers made tea from sage, mint, horehound, balm, catnip, pennyroyal, etc. It was a common practice to steep a quarter of an ounce of the dried leaves in a half pint of boiling water, and then strain and sweeten to taste. Such teas were at once beverages and "simple home remedies." Pennyroyal tea was used to promote perspiration. Horehound was good for colds. Each herb had its virtues, and all of them had the great merit of being rather harmless when so prepared and administered. If one had a cold, a pleasant cup of horehound tea (happily supplemented by good hygienic measures) gave him the pleasant feeling that he had "done something for it."

Our forefathers were making use of the antiseptic properties of the aromatic oils, when they burned as incense the herbs containing them to make the air of public halls more wholesome. Sprigs of lavender were laid in clothes-presses, both to repel moths and to impart a delicate odor to the garments that were stored therein. Pulverized leaves of many aromatic herbs were put in scent-bags, and pillows, and extracts from them were used for perfuming baths and lotions, and pomades and ointments. All these were ministrations to the human sense of smell—the most subtle of all our senses.

Fig. 96. Watermint.

A garden of scented herbs was a household necessity in that day, before the advent of superabundant bottled scents, when discriminating use of herbs was intimately bound up with all the little refinements of life. It is still a mark of household culture. But only a few of the many fine herbs available are much planted, and of these, few are indigenous. Every fertile country has its own fragrant herbs, and it were well if every householder who plants a scented garden should seek out the wild fragrant things native to his own locality—things that the gardener's catalog knows not—and use them also in situations appropriate to them. By the waterside are marsh-mint (*Blephila ciliata*) and watermint (*Mentha canadensis*), as sweet as any mints of the gardens. On the hilltops are fine wild bergamots and basils, sweet-fern (fig. 80), fragrant everlasting (fig. 130), odorous goldenrod, and other sweet things, having scents in pleasing and endless variety. These are among the wild things that every one should know.

Study 35. Aromatic Herbs of the Farm

The program of work for this study will consist of a **trip** along fence-row, brookside, waste places, and woods, devoted to finding the wild aromatic herbs. Test all kinds of foliage by drawing it through the hands and smelling of it. Test barks and woods also. Certain odorous roots such as sweet Cicely and sarsaparilla, should be dug up and crushed and tested; also the seeds of any umbelworts found ripe. A few rank-smelling aromatics, like richweed, should be included, by way of contrast. A look-in upon the aromatics of an herb garden may conclude the work.

The record of this study may well consist of a table of aromatic herbs, prepared with column headings as follows:

Name (of plant).

Grows where (in what sort of place, wet or dry, sun or shade, etc.).

Growth-habit (erect, trailing, creeping, climbing, twining, etc.).

Part aromatic (leaves, stem, root, seed, etc.).

Character of aroma.

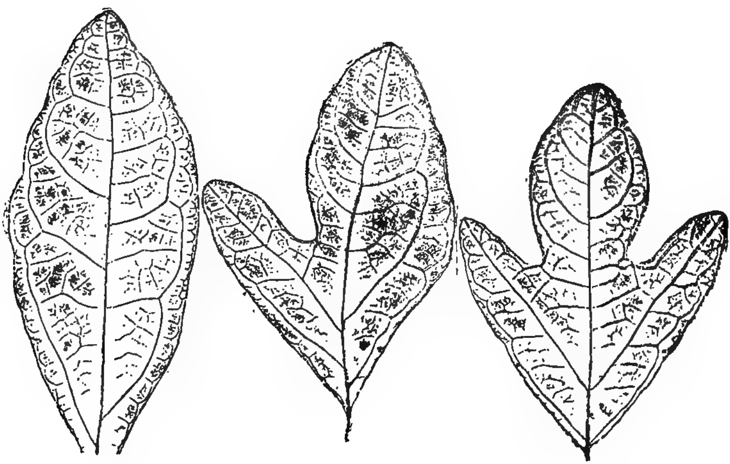
Suited to what use.

Remarks.

An additional study on

The Fragrant Trees and Shrubs of the Farm

may be made if desired, following the same plan, and using for record a table with the same column headings, adding one for height. More attention should then be paid to fragrant woods, like those of sassafras, spicebush and cedar, and to their products of gums, resins, and oils, like those of cherry, balsam and pine. Food-flavors will, of course, be less in evidence; flavors for manufactured products, more common; things for medicinal use, about as with herbs.



XXXVI. THE TREES IN SUMMER

"*Under the greenwood tree*
Who loves to lie with me,
And tune his merry note
Unto the sweet bird's throat,
Come hither, come hither, come hither."
—Shakespeare (*As You Like It*).

In summer we live nearest the trees. We exchange our solid roofs for their latticed crowns, and sit beneath them in the open air. They spread green canopies above us, all fringed with beautifully sculptured leaves. Broad-leaved trees with the densest crowns, like hard maples, we like best for shade: these best exclude the sun.

In summer, the characters of boughs and buds, which have served us best for winter studies of deciduous trees (see Study 9 on page 76), are somewhat obscured by the foliage; but the leaves in themselves offer ample recognition marks instead. The species of tree is usually to be told from a single leaf; for each kind, though variable in lesser details, has a form and a structure and a texture of its own. The differences are sometimes extraordinary, as in the leaf types shown in figure 97: but even when the leaves of two species look very much alike, there are apt to be minor differences of outline, of venation, of margin, of hairiness, of length of leaf-stalk, etc., by which the two may be distinguished.

In summer, the trees are busy. Each one is increasing, as much as it can, its hold upon the earth and its spread into the sunlight. To every living twig it is adding new growth. Until full stature is attained, it adds long leafy shoots at each sunlit tip; and afterwards, and underneath in the shadow, it adds enough new growth to hold a few green leaves every year so long as the tip remains alive. Wherever there is an opening in the crown, adjacent twigs tend to crowd into it and fill it up.

In summer, the trees are flowering and fruiting. A few of them, like the tulip tree and the magnolias, have very large flowers. A few, like the maples and the linden or basswood, have smaller nectar-bearing flowers that are thronged by bees and other insects. Basswood, indeed, stands next to

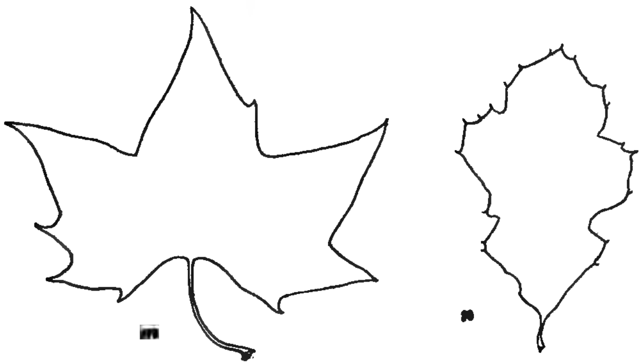


FIG. 97. Leaf outlines; *m*, sycamore; *n*, red oak.

white clover in the quality of the honey it yields. Most of the larger trees have small and inconspicuous flowers, that shed their pollen lavishly and depend on the wind for its distribution. Some trees, like the soft maples, flower early, and ripen and shed their fruit before the summer is well under way; and others, like the black oaks, hasten slowly, taking two years for maturing a crop of acorns. So, at any time, we shall find some trees bare of flower and fruit, and others with one or both in various stages of development. There is nothing more interesting about the trees than this wonderful variety of habit. How interesting they are, you may never know by merely reading about them: it can only be learned at first hand.

Study 36. Observations on the trees in summer

The program of work for this study will consist of an examination of the crowns of a dozen or more of the commoner deciduous native trees, principally as to their habits of growth and the characters of their leaves, flowers and fruit. A few flowering and fruiting boughs of each tall-growing species should be previously pruned and brought down to earth for common use.

The record of this study may consist of one or the other or both of the following tables, according to the needs of the student. Table 1, on recognition characters of the green tree, is intended for those who have not already a good acquaintance with these characters, such as is prerequisite to the work on reproductive habits that is outlined in the second table. The tables (to contain only original observations) may be prepared with column headings as indicated below.

1. Table of Growth-Characters of Trees

Name.

Height (estimated height of a mature tree, in feet or meters).

Growth-habit (see page 72 and figure 40).

Leaves
- type (simple or compound).
- arrangement (opposite, alternate, whorled, etc.).
- form (diagram a single leaflet, if compound).
- size (length by width in inches).
- surface (rough or smooth, dull or shiny, hairy or spiny, etc.).
- margin (diagram a bit of it).

- Shoots
  - maximum length (length of one season's growth in young trees, not crowded).
  - minimum length (length of one season's growth of over-shadowed twigs).
  - number of leaves developed
    - to date (on average new shoots).
    - last season (as indicated by old leaf-scars).
  - growth season (early, medium, or late, or all-season).

2. Table of Characters of Flowers and Fruits

Name.
Date.

- Flowers
  - as to size
    - Fruiting height (flower and fruit borne at what distance from the ground, measured along bole and branch).
    - of single flower (diameter in millimeters).
    - of cluster (length and breadth in millimeters).
  - as to sex (perfect—*i.e.*, stamens and pistils in the same flower; monœcious—*i.e.*, stamens and pistils in different flowers on same plant; or diœcious—*i.e.*, stamens and pistils borne on different plants).
  - as to form
    - of clusters (diagram; twice, if of two sorts).
    - of flower (diagram in longitudinal section, showing parts).
  - color.

Fruit
- arrangement (diagram in position on stem; in cluster, if it grows in one).
- stage (proportion of growth attained to date).
- structure (diagram single fruit in section, or in whatever way will best convey an idea of it).

This table should include only such facts as may be observed on the date when the study is made. Blank spaces in it will then be significant as indicating different seasonal habits on the part of different trees.

XXXVII. WEEDS OF THE FIELD

"In the garden more grows
Than the gardener sows."

—Spanish Proverb.

Weeds were not invented by the Devil to plague the farmer. Oh, no. Weeds were here before there were farmers. They were here holding their own on the bits of fallow ground nature allowed them—on the new-made bar left by a receding flood; on the denuded slope laid bare by a landslide; in the ashes of a devastating fire: wherever there was a bit of soil left open, weeds were ready to enter in and possess it.

Weeds were fewer before the days of agriculture than now; for nature kept most of the land occupied with more permanent crops. It is due to the farmer himself that weeds have become so abundant. The farmer turns the soil and makes it ready for new occupants. He could not prepare it more to the liking of the weeds if he were doing it expressly for their benefit. They like the tilth of soil his plow and harrow yield; they like his tillage and his fertilizers; they like his dust-mulch; and, if they do not chance to be uprooted, they show their appreciation by lusty growth. What magnificent specimens of weeds they do become in a rich field. The wild ones of the same species that we find in the woods are puny things in comparison.

Weeds have a wonderful way—it takes a figure from the language of business to express it—a wonderful way of "getting in on the ground floor". The field is no sooner prepared than they are found occupying it. They nearly all spring from seeds, and their seeds have great facility at getting about. Seeds of dandelion, thistle, hawkweed, etc., travel by air and settle in every field. Seeds of cocklebur, burdock, pitchforks (fig. 39), etc., travel by pack animals, and go wherever the animals carry them. These are less ubiquitous. Other seeds of weeds are distributed with the mud that adheres to the feet of men and animals, and to the wheels of vehicles. This is the chief mode of distribution for our commonest weeds. The seeds become embedded in a thin layer of mud, and when dropped, find themselves well situated for growing. This method properly plants them. They travel, also, with the farmer's cargoes; with his hay and straw and feed and with his imperfectly winnowed grain; and they are distributed along with these commodities to remote regions. So, in any place, we find the new and unusual weeds, like our western oxybaphus, and the Russian thistle, first appearing along the railroad track, where dropped from passing cars.

Weeds are such opportunists; they make the most of small favors. If they can not get more, they will take less. One well-fed cocklebur plant in a rich cornfield may attain an almost treelike stature, and another, whose lot is cast on a barren sand-bar, may not attain a finger-height. But the latter does not give up because soil is barren and water scarce. It may develop only a few leaves and bear only one bur, but it ripens good seed in that bur, and is ready for the next season's opportunity. Dandelions, in rich meadows, grow often knee-high to a man; but on the lawn, after repeated clipping, they will bloom so close to the ground that the mower passes harmlessly over their heads. Morning-glories, finding no trellis at hand, will cheerfully accept a cornstalk in its stead, or in the absence of all support, will spread over the bare ground.

Nature sows many kinds of seeds in every field. Some of her sowings are welcome, like that of blue-grass in the fields that we are turning into pasture. Most of them come to nought because the seedlings cannot withstand tillage. They fall before the first onslaught of the cultivator. Fortunately for the farmer, this is the fate of nearly all plants that spring from seeds that travel by air. There are others, however, that have staying qualities, and they are the troublesome weeds.

Obviously, there is no hard and fast line to be drawn between weeds and other plants. Buckwheat, when sown as a field crop one season, may spring up as a weed in the midst of the corn crop next season. Some very bad weeds, like mustard and wormseed, are raised as crops for their seed. Some, like dandelion, are eaten as salads. Many, indeed, of the weeds of the field are eaten by live stock, and, like pig-weed and purslane, at once disappear when fields are turned into pastures. Some weeds, like mallow, mullein, and yarrow, have beautiful foliage, and others, like morning-glory, daisy and thistle, have splendid flowers.

FIG. 98. Beautiful weeds: a, yarrow; b, sheep sorrel.

Weeds, like other plants, have their preferences as to situations. Pitch-forks and the larger docks like abundant moisture, and cluster in low ground. Abutilon and jimson-weed do well only in rich soil, while rag-weed and foxtail flourish on poor soil. Pigweed and lamb's-quarters and crab-grass love the garden and the edge of the manure heap. In dooryards and along paths where much trampling keeps down the tall weeds, low-growing things, like dandelion and plantain, or prostrate tough-stemmed things, like mallow (fig. 93) and doorweed, thrive. Obviously, prostrate plants, that cast so thin a shadow as do doorweed and spurge (fig. 100), are not a match for taller weeds and can flourish only on bare ground.

Successful weeds must be able to thrive on the treatment accorded to the crop with which they grow. In our study of pasture plants (Study 6, p. 56), we found that the weeds of pasture, like the forage plants there, are chiefly perennials that are able to withstand browsing and trampling. So, in the fields, they must be able to mature a crop within the lifetime of the cultivated species with which they are associated. Since good plowing puts an end to both alike, a new start must be made from seed. Between plowing and plowing, therefore, a new crop of seed must be matured. Hence, the important weeds of the cornfield are annuals. Perennials are of little consequence in tilled fields. The weeds that in season and habits and requirements are most like the crops with which they grow, are the ones that give the farmer the most trouble. They are natural competitors.

FIG. 99. Sun prints of camomile and carrot.

The farmer gives them as bad a handicap as possible at planting time. He buries their seed deeply by plowing the soil, and at once he plants seed of his own crop at the depth most favorable for quick and early growth. Certain plants, like buckwheat, that grow up quickly, smothering the weeds, are often used to clean a weedy field. Potatoes, on the contrary, being slow to appear above ground, are certain to be beaten in the occupation of the soil by many weeds. So they are often tilled just before they appear above the ground. The weed seedlings are easily killed when little. Tillage breaks their mooring in the soil. The weeds are thus

FIG. 100. Sun prints of weeds, showing the extent to which they shade the ground. *1*, paint-brush; *2*, moth-mullein; *3*, evening primrose; *4*, creeping spurge; *5*, door-weed or goose-grass.

given a second setback, while the stout potato shoots come along uninjured. The farmer ought to be something of a naturalist, for his success in handling plants must needs be based on observations of their habits, their powers, and their requirements.

The farmer might save himself much labor of exterminating weeds in his fields, if he was more careful not to encourage their growth outside the fields. He provides too many reserves for them in roadside and barnyard and fence-row. Enormous crops of weed seeds are matured in such places. It is not enough to keep the fields clean. The fence-row may be a source of reinfestation. A clean field may

FIG. 101. Leaves of rag-weed at all ages; *a* seed-leaves; *b, c, d, e,* successively older leaves; *m, n, o, p, q, r, s,* leaves successively formed on a fruiting spray; *z*, a fruiting tip.

be infested with seeds in manure from a weedy barnyard; or with seeds carried in by the stock turned on to feed; or with seeds gathered from a weedy roadside and carried in on wagon wheels.

The farmer, above all persons, should know that nature will be raising something on every bit of ground; and that if he destroy her more permanent crops, that something will be weeds. Weeds follow the ax and the scythe and the plow as summer follows spring. The scythe, especially, is used with too little judgment. The altogether harmless and altogether beautiful goldenrods and asters fringing many a roadside are mown to extermination to make a place for ragweeds and mulleins to grow. The native shrubbery under the trees is cut away to make a place for burdocks. Such sort of self-inflicted vandalism destroys the beauty of the farm and increases its drudgery. If the farmer is so ignorant that every green thing, that is not a crop-plant, is to him a weed and to be treated accordingly, then in increased labor and in the sweat of his brow he must pay the cost of his stupidity.

FIG. 102. Better than weeds in the fence-row—the maple-leaved viburnum.

Study 37. Weeds of the Field

The program of work for this study will consist of a trip about the fields containing both tilled and untilled crops, examining all the common weeds occurring in each, and comparing them and writing their characters in a table prepared with the following headings:

1. Name (ask the instructor if you do not know it).
2. Height (or length of stem, if horizontal, in inches).
3. Growth-habit (erect, spreading, trailing, creeping, climbing, twining, etc.).
4. Root (form, depth and strength of attachment to soil).
5. Leaf (diagram, and state size, length and width in mm.; of a leaflet, if compound).
6. Flower or flower-cluster (diagram).
7. Seeds.
   - Size.
   - Form (diagram).
   - Mode of dispersal.
8. Preferred situation.
9. Crop.
   - Name (of crop in which weed is found).
   - Stage (time elapsed since seeding).
   - Spacing (average interval between plants each way as expressed in inches).

The record of this study will consist of:

1. The above table complete for at least a dozen weeds.
2. Lists of all weeds found in corn field, wheat field, etc., arranged in what appears to be the order of their abundance and harmfulness there. Note that not numerical abundance, but bulk and aggressiveness are here intended.
3. Comparative diagrams for half a dozen weeds, illustrating peculiarities of growth-habit, or mode of increase, or mode of seed distribution, that make them factors in the competition of the fields.
4. A map of the farm, with the centers of possible dispersal of seeds of noxious weeds marked in red upon it.

XXXVIII. SUMMER WILD FLOWERS

"He is happiest who hath power
To gather wisdom from a flower,
And wake his heart in every hour
To pleasant gratitude."
—Wordsworth.

The splendor of summer would not be complete without its splendid flowers. They punctuate the slopes. They adorn the roadsides. They mellow the air with fragrance. They fill the fields with the humming of bees, and with the flashing wings of brilliant butterflies.

The summer flowers are not like those of spring. They grow more openly, and fling out their colors like banners by the roadsides. Spring flowers flash up on fragile evanescent stems, solitary or in little clusters of unstudied grace; but the summer flowers take their time, developing first strong stems and abundant leafage, and then producing great compound clusters in fine mechanical adjustment. Saint John's worts and campions and sunflowers and daisies—how lustily they crowd to fill the wayside with their banked-up foliage masses, and then how gloriously they bloom!

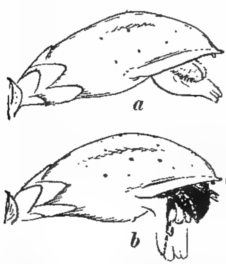


FIG. 103. Turtle-heads (*Chelone glabra:*) *a*, the flower from the side; *b*, the same with a bumble-bee entering.

Summer flowers are, mostly, rather small, and produce their brilliant effects by the massing of great numbers together. A few large ones, like wild roses, are solitary. Others of moderate size like gerardias and other figworts are hung out in open panicles; those of the common mullein are in long stiff erect spikes. Many of the mint flowers are in shorter and denser spikes, but most of the lesser flowers are

FIG. 104. Meadow-sweet with its feast outspread.

arranged in flat-topped clusters, either heads or umbels.

The clustering of the flowers is directly related to visitation by insects, the distributors of their pollen. Close grouping greatly economizes labor on the part of their visitors. A bee must pass from one pea flower to others by separate flights, but a score of flowers massed together into a clover head may be visited without intervening flight, and with only a slight turning of the body about while standing on the top of the cluster. While insects are most abundant in the summer season, flowers most abound then, also; and there is competition for the services of the bees.

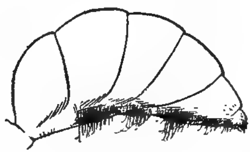


FIG. 105. Side view of the abdomen of a bee, showing pollen brushes.

Their patronage is desired. So the flowers in their natural evolution have perfected ways of drawing visitors, that singularly parallel the methods of the corner grocery in drawing trade. First, they get in a stock of desirable goods—nectar and pollen. Then they advertise that they have got it and are ready for business. They advertise with bright colors and attractive odors. Their signs are showy corollas that often bear special "guide marks" about the entrance. Then they array their wares to suit their visitors' convenience. They set their open corollas all out in line on a narrow spike as at a common counter; or, they spread them out flatwise in a head or corymb or umbel, as on a common table. This last

FIG. 106. Pollen-gathering hairs from the honey bee.

arrangement is doubtless most convenient for the visitors; it is the one most commonly adopted, and most successful. And as there are groceries that cater to a select and limited patronage, so there are flowers that put their nectar out of reach of common visitors, and reserve it for those that are epecially endowed—not with long pocketbooks, but with lcng proboscides. They secrete their nectar at the bottom of deep and narrow corolla tubes or spurs, or behind barriers of sharp offensive spines, or glandular hairs. The nectar of certain trumpet-like convolvulus flowers can be sucked only by long-tongued humming-bird moths. That in the tightly-closed bilabiate corollas on the monkey-flowers can be had only by bumblebees, having strength to open the mouth of the corolla and enter.

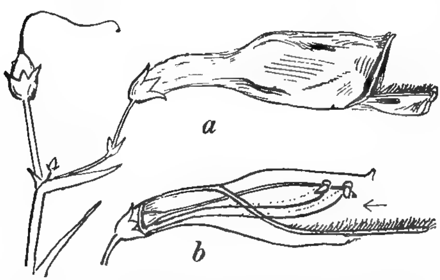


Fig. 107. Beard-tongue (*Pentstemon pubescens*) *a*, the flower; *b*, section of the same, showing the trigger-like bearded upper stamen, which is declined so that it overlies the stalks of the pollen-bearing stamens. The insect, entering where indicated by the arrow, in clutching this stamen shakes pollen from the others down upon its own back. (From the author's "*General Biology*.")

So, when we watch the flower-clumps in the fields, we shall see but few visitors about such specialized flowers as turtle-heads (fig. 103), and butter-and-eggs, while the outspread tables of open corollas of such as meadowsweet (fig. 104) and wild carrot are thronged with visitors of many sorts.

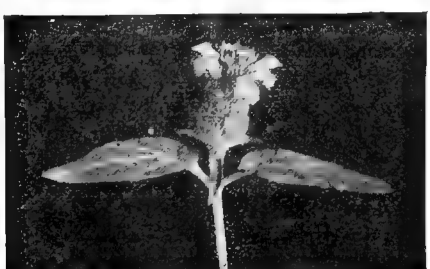
The colors of summer flowers are in themselves very beautiful and satisfying. Their forms are wonderfully varied and interesting. But colors and forms are alike increasingly instructive when we learn what roll they fill in the drama of life. And we shall enjoy our contact with nature better when we have grasped the fact that in the world of flowers or elsewhere, "there is no beauty apart from use."

Study 38. Summer Wild Flowers

The program of work for this study should include a trip to the field for collecting wild flowers and studying their characters and habits. All the showier sorts of wild flowers of one small locality should be observed, gathered and compared. They will be found in uncultivated places by the roadside and streamside and in the woods. They will show great differences in color and form and attractions to insect visitors. Many of their characters will appear curious and inexplicable if studied only indoors and apart from their environment; but in the field, when the day is bright and calm and insects are abundant, one may see exactly what the most puzzling of floral structures are good for, by seeing their mechanism in action.

The record of this study may consist of an annotated list of the flowers studied, illustrated with a few simple diagrams of flowers or clusters, etc., where possible.

The notes should cover: kind of plant, manner and place of growth, sort of flower-clusters, of flower, its color, odor, and general attractiveness to visitors and means of attracting them.



XXXIX. SOME INSECTS AT WORK ON FARM CROPS

"That which the palmerworm hath left hath the locust eaten; and that which the locust hath left hath the cankerworm eaten; and that which the cankerworm hath left hath the caterpillar eaten.

Awake, ye drunkard, and weep; and howl, all ye drinkers of wine, because of the new wine; for it is cut off from your mouth.

For a nation is come up upon my land, strong, and without number, whose teeth are the teeth of a lion, and he hath the cheek-teeth of a great lion.

He hath laid my vine waste, and barked my fig-tree: he hath made it clean bare, and cast it away; the branches thereof are made white."

—The Book of Joel, 1:4–7.

Before there were farms, the plants we cultivate all had their insect enemies. They developed together in the wildwood. The primitive farmer sought out the valuable crop-plants and brought them into his fields. The insects came along with them, uninvited.

The making of fields disturbed the nice balance of nature. The massing together of plants that grew sparingly in the wildwood, made it possible for their insect enemies to find unusual food supplies, and to develop in extraordinary numbers. Potato beetles, hatched in the garden, find food plants waiting for them in abundance; they do not have to search the mountain-side for a few straggling wild plants on which to lay their eggs. Thus the farmer has made easier conditions for them, and is himself responsible for their unusual increase. It is because he has aided their increase that he now must take measures for their destruction.

Each kind of plant has its own insect enemies. Different ones work in its leaf, its stem, its root or its fruit. No part is exempt from attack. Some insects feed openly upon the plant; others are concealed, as stem-borers and leaf-miners. Some, like the aphids, feed in great companies; others are solitary. A few scale insects attach themselves to the bark

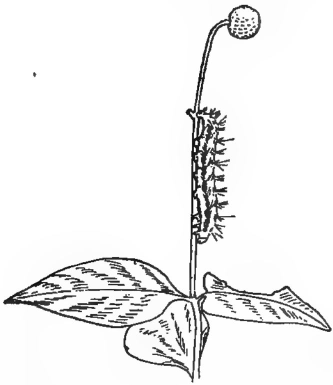


FIG. 108. A leaf-devouring caterpillar (*Acronycta*) on button-bush.

and remain in one position. Most insects appear during only a portion of the season, and often several different insects follow one another in a regular succession of depredations.

Of insects that feed openly upon the crops of our fields, there are two classes that affect the plant tissues differently, and that we have to deal with differently. These are biting insects and sucking insects. The former are armed with jaws, and consume the tissues of the plant: the latter are armed with sharp puncturing beaks, and they merely perforate the tissues and suck up the fluid contents. Biting insects are beetles and grasshoppers and cutworms and many large caterpillars that consume parts of plants bodily, and many lesser leaf-skeletonizers of various groups that eat the soft superficial tissues, leaving the more solid framework of the leaves intact. All these are controlled by spraying or dusting suitable poisons (arsenate of lead, Paris green, etc.) upon the surface of the plant, to be eaten along with the plant tissues. The puncturing insects are bugs of various sorts and aphids and scale insects. These penetrate the epidermis with their beaks and suck out the plant juices

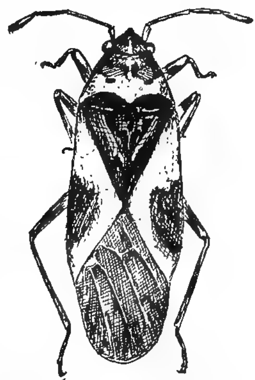


FIG. 109. A sucking insect: the red milk weed bug (*Oncopeltus fasciatus*).

from within. These thus escape poisons deposited upon the surface of the plant, and are killed by spraying only when some contact insecticide (like kerosene emulsion, or various preparations of nicotine, etc.) is thrown upon their bodies.

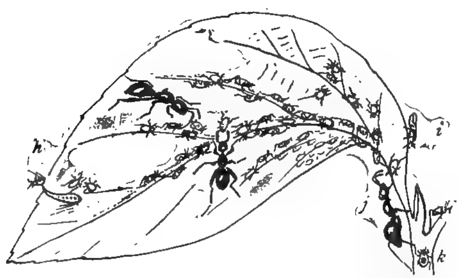


FIG. 110. A colony of aphids on a leaf of *Ceanothus*; *h*, a syrphus-fly larva, feeding; *i*, a winged aphid; *j*, an ant attending the colony; *k*, an aphid parasitized (see fig. 113).

Both types of feeders we often find side by side. We go into a cabbage-field, where little white butterflies flutter above the rows, and we find their green larvae, "cabbage-worms," stretched at length upon the surfaces of the leaves, placidly eating out scallops in the margins. On loose cabbage leaves we find whole colonies of minute gray-green aphids, "cabbage-lice", sucking the sap out of the leaves and making them buckle and curl.

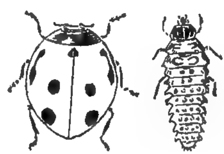


FIG. 111. The nine-spotted ladybird beetle and its larva.

Most herbivorous insects are very limited in the range of their diet. They will feed upon the plants of but a few species—usually closely related species. The common potato-beetle eats other things besides potato, but only a few other species of the same genus—other solanums. This is, for the husbandman, a very fortunate limitation.

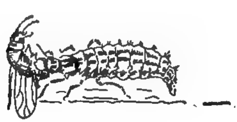


FIG. 112. The larva of the lacewing fly (after Marlatt).

The worst of our field and garden pests are species of insects from other lands. They have been brought to our shores along with imports of plant materials of various sorts. They have become established in our fields; but fortunately they attack only a few of our plants that are closely related to their own native food-plants. Pests like the brown-tail moth, having an unusually wide range of diet (including in this example the leaves of most of our deciduous trees), are unusually difficult to control.

FIG. 113. An aphid skin with a hole in its back, whence has emerged a parasite.

Under natural conditions, there is an occasional excessive increase of foraging insects. Hordes of them suddenly appear, and destroy the foliage of one or two species of plants. For this evil, nature has her own methods of control. She uses carnivores and parasites to keep each species in check. In the midst of the aphid colony on a cabbage leaf, or on the curled tip of an aphid-infested apple spray, one may often see both predatory and parasitic foes of the aphids working side by side to keep down the colony. Ladybird beetles and their larvae (fig. 111) consume the aphids bodily. Lacewing fly larvae (fig. 112) and

FIG. 114. A parasitized moth larva on a blue-grass top: some of its parasites have spun their cocoons beside it, others, on the grass-blade above. *b*, shows an easy method of hatching out the adult parasites from the cocoons. (From the author's "General Biology").

syrphus-fly larvae impale them and suck their blood. This destruction is wrought openly. But greater destruction is often wrought by minute parasites that feed unobserved on the internal tissues of the aphids. Their work is evident mainly in the dead and empty aphid skins, each with a round hole in its back from which a little winged parasite has emerged when fully grown.

Study 39. Insects at Work on Farm Crops

This study may be made at any time excepting when the vegetation is wet. The equipment needed will be lenses, insect nets, and cyanide bottles or vials of alcohol to hold the specimens of insects found, pending their identification.

The program of work will consist of a trip into the field for collecting and observing the insects that are at work upon the crops. Many pests may be located by the discolorations and deformations of plant tissues they produce: curling of the tops, ragged outline of leaves, yellowing, etc. A few, like the potato-beetle larvae, are so conspicuous in color and position as not to be easily missed. Some, notably aphids, chinch-bugs, etc., are in dense colonies; but most are solitary and protectively colored, and difficult to see. The grass and herbage is full of plant-bugs and caterpillars, that one would not notice ordinarily, but that are readily found by "sweeping" the leaves with a net. Then having found out what to look for and where to look, specimens may be observed at work upon the plant. Species working where less easily discovered, as in the stems or fruits, or underground on the roots, may be pointed out by the instructor. The treating of biting insects with food-poisons, and of the sucking insects with contact-insecticides, may be demonstrated

The work may cover either the commoner insects of a number of crops, or a more careful collation and comparison of all the pests present on some one crop.

The record, in either case, may be an annotated and illustrated list of the insects found feeding.

The notes should cover name and kind and size and stage of insect; its habits, the nature and extent of the injury it causes, etc. Simple diagrams may be made to illustrate its location on the plant and the character of its injury.

XL. INSECTS MOLESTING FARM ANIMALS

"Thou'rt welcome to the town; but why come here
To bleed a brother poet, gaunt like thee?
Alas! the little blood I have is dear,
And thin will be the banquet drawn from me."
—Bryant (*To a Mosquito*).

In the season of black-flies, no one goes into the North Woods except on business; though it is late spring and the flowers are blooming everywhere and all the world is fresh and inviting, the flies are in the woods by day, and the mosquitos and punkies are there by night, and there is no peace of life for man or beast. The lumber-jacks, who must labor there to earn a living, smear themselves with tar-oil and other fly-repellants. The wild deer leave the streams and adjacent woods and go far out among the rushes in the open marsh, and stand half immersed in the water. The hogs in their pens root up the bottom of the pools and trample and roll it into a soft paste, and coat themselves thickly with mud. This is fly-proof. The bison, also, in days gone by, wallowed in the mud about spring-holes, attaining by like inadmirable procedure the same desirable end—immunity.

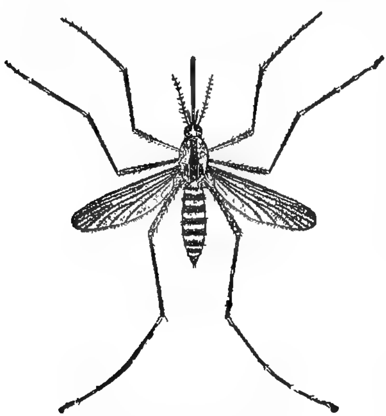


Fig. 115. A mosquito.

Fly-time, fortunately, is fleeting. Early spring and late summer and autumn are more or less free from blood-sucking flies. The black-flies are the daylight pests of early summer, and ere they are gone, the horse-flies and deer-flies are at hand to remain through midsummer; also the bot-flies; which, though they do not bother us, are aggravating to live stock beyond all proportion to their number and size.

All these transient pests are two-winged flies (members of the order Diptera), belonging to a very few families. In all of them, the larvae live in situations very different from those of the adults. The larvae of the blood-sucking flies—black-flies and mosquitos and horse-flies—are mostly aquatic. The young of the bot-flies are parasitic in the bodies of animals. In all of them, it is the females that pester the live stock, the blood-sucking flies by biting, and the bot-flies by the operations attendant upon laying their eggs.

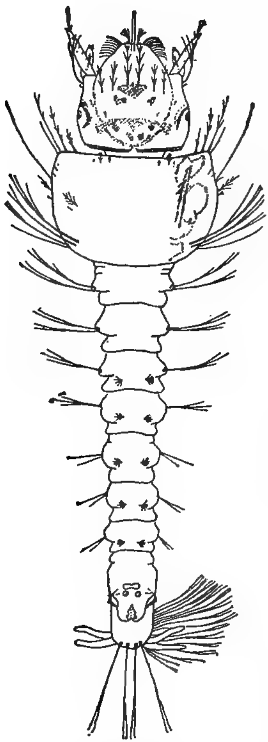


Fig. 116. Larva of the mosquito *Anophles punctipennis*. (Drawn by Miss Cora A. Smith).

The mosquitos represent the best-known of these families (Culicidae). These do most to make the night interesting. They have a soft little hum that probably would be counted among the sweet sounds of nature, were it not accompanied by so strong an appetite for blood. They come earliest in the spring and stay latest in the fall. They breed in standing water—especially in shallow and temporary pools. Rain-water barrels, and even tin cans cast upon a rubbish-heap

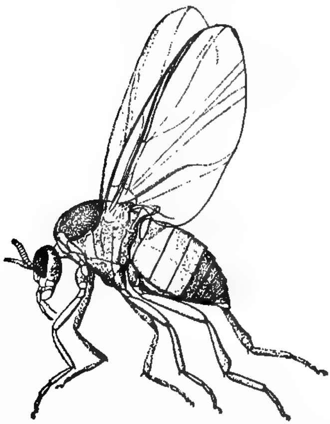


FIG. 117. The buffalo-gnat (*Simulium pecuarum*, after Garman).

and filled with water by the rains, often furnish the chief supplies of mosquitos to a whole neighborhood. Few are reared in open water inhabited by fishes; for the fishes eat them. The smaller the pool, the more likely it is to contain mosquito larvae. The larvae take air at the surface of the water, but swim down below to find forage or to escape danger. Many species are adapted to the drying up of their native pools, and live on (usually in the egg stage) in absence of water, and come on again and fly and sing and bite at their proper seasons. Some are short-lived, and run through quite a number of generations in a single summer; these develop in vast numbers when a rainy season maintains an abundance of little pools.

Black-flies (Family Simuliidae) develop in running water, and are most troublesome about woodland streams. The habits of the larvae, which live upon stones, have been discussed on pages 36 and 37. When there are no stones in the streams, larvae may be found hanging to sticks and to grass blades that trail in the edge of the current. The eggs are laid on logs and stones at the water's edge. The adults (fig. 117) love the sunshine, and their biting is troublesome only by day.

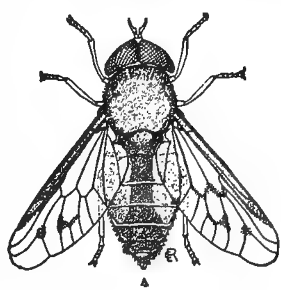


FIG. 118. A horse-fly (from the U. S. Bureau of Entomology).

Horse-flies (Family Tabanidae) develop in moist soil or mud, usually in the beds of reedy brooks and ponds. One finds the larvae (fig. 77) among the roots of aquatic weeds and grasses by lifting these from the water. The annual crop of flies matures in midsummer. The males sip nectar and plant juices, and are short-lived; the females bite fiercely and suck the blood of all the larger hoofed mammals. They are troublesome only by day. When fully mature they lay their eggs on the vertical stems and leaves of aquatic plants, just above the surface of the water. Many handsome flies (see fig. 118) are found in this group.

Fig. 119. The bot-fly of the horse. (Wood engraving by Mrs. J.H. Comstock, from *Comstock's Manual for the Study of Insects*).

The bot-flies (Family Oestridae) are parasitic as larvae. Three are notable and dangerous: one in the alimentary tract of the horse, causing various derangements; one in the frontal sinus of the sheep, causing vertigo to the animal and often killing it; one under the skin on the backs of cattle, causing great lumps that may be readily felt by running one's hands over an animal's back. These larvae (known as "ox-warbles") are the easiest of the bots to observe. Over each of them is a hole in the skin, out of which the larva will emerge when grown. When approaching the time of emergence (best in the spring) it may be brought to light prematurely. By placing one's thumbs at either side of the lump and pressing hard, the warble may be made to pop out through the hole into the daylight.

The horse bot-fly is most easily observed of the adult insects. It often follows teams along the highways or about the fields, and its presence may be suspected from the frenzied action of the horses, flinging their heads upward. The bot-fly does not bite; it merely seeks to attach its eggs to the hairs about the front legs and shoulders of the horse, within reach of his mouth. But the horse instinctively shuns it, strikes at it, and seeks to drive it away. One may often see the eggs attached singly to the hairs—little oblong whitish specks, glued fast, to remain during incubation. If licked off and swallowed in ten to fifteen days after they are laid, they may develop into parasitic larvae in the horse's stomach. They then remain attached to the walls of the stomach or intestine during their larval life. The swiftly-flying, loudly-buzzing, terror-inspiring bot-fly darts about the horse's forelegs like a golden bee.

These are the worst of the fly pests: but there are many others; horse-flies and stable-flies and house-flies and minute punkies, some of which bite, and some of which lap up exudations from the skin, and some of which merely perch and tickle, causing but slight annoyance to the beasts.

Cattle and horses are specially equipped for dealing with such pests. They have an abundant development of small subcutaneous muscles for shaking them off from the skin, and thus temporarily disposing of them with a minimum expenditure of energy; and their tails are equipped with heavy brushes of long coarse hair, indestructible fly-brushes, which they swing with considerable force and precision. One often learns this while engaged in milking the family cow. One of the most inane "improvements" that ever became fashionable is the docking of the tails of horses. It is a mild form of cruelty to animals; for it deprives them of their natural means of defense against the flies. In any pasture on a summer day, one may see the horses standing in the shade in pairs, side by side, head to tail, each one's tail switching the front of the other, each one's front being switched by the tail of the other; it is a mutual-benefit association, the efficiency of which lies in the possession of natural full-length fly-brushes.

Small as these pests are, they are capable of causing very great annoyance. Cows give less milk in fly-time, and horses grow thin, so much of their energy is spent in fighting flies. The loss of blood, also, is very considerable.

There is no finer illustration of the nature of animal instincts than is furnished by the behavior of horses and cattle toward these pests. By stamping of hoofs and twitching of skin and switching of tail, they drive off what they can of the bloodsucking flies, and the remainder they patiently endure; but they flee before a few bot-flies, leaving good pastures to bury themselves in the brush of the thickets. Yet the bot-flies do not bite; they only seek to gently deposit a few eggs on the tips of the hairs. The larvæ are dangerous enemies, and nature has taught the beasts to shun the flies that lay the eggs. The sharp bites of the bloodsucking species are merely annoying, but the mere buzzing of the bot-flies, that are themselves quite incapable of causing pain, is terrifying.

Study 40. Insects Molesting Farm Animals

A dry, calm day in hot weather should be chosen for this study, and if animals can be found resting in sheltered places near woods and water, pestiferous insects will be numerous about them. If the animals are gentle enough, the insects may be captured by hand. Teams in the harness may be examined for horse-flies and bot-flies, etc. Insect-nets may hardly be used without frightening the animals. Captured insects may be kept in cyanide bottles or in vials of alcohol pending identification.

The program of work for this study may consist of observations on the behavior of horse-flies, horn-flies, bot-flies, warble-flies, black-flies and other day-flying pests of animals, made in whatever time, place and manner local circumstances will permit. Mosquitos may be observed at night without effort. They attack animals as they do ourselves, being satisfied with any situation where they can suck blood. The life history of mosquitos may be demonstrated by leaving a vessel of rain-water exposed on a shaded window-sill, outside, where the adult mosquitos may fly to it, for a fortnight before it is needed. Eggs will be laid on the surface and all stages of development will quickly follow. Living larvæ of black-flies ("turkey-gnats," "sand-flies," etc.), horse-flies and punkies and alcoholic specimens of bot-fly and horn-fly larvæ may be shown in demonstration.

The record of this study may consist of a fully annotated list of the pestiferous insects observed. The notes should cover such points as the following:

Time and place of observation and relevant weather conditions.

Kind of animal molested, and sort of molestation (buzzing, tickling, biting, egg-laying, etc.).

Means employed by the animals for evading or in combating the pests (standing in water, in wind, in brush, switching or biting them, coating their hair with mud, etc.).

Breeding, places of pests.

XLI. OUT IN THE RAIN

"Rain! Rain!
Oh, sweet Spring rain!
The world has been calling for thee in vain
Till now, and at last thou art with us again.
Oh, how shall we welcome the gentle showers,
The baby-drink of the first-born flowers,
That falls out of heaven as falleth the dew,
And touches the world to beauty anew?
Oh, rain! rain! dost thou feel and see
How the hungering world has been waiting for thee?
. . . .
How streamlets whisper and leaves are shaken,
And winter-sleeping things awaken,
And look around, and rub their eyes,
And laugh into life at the glad surprise;
How the tongues are loosened that late were dumb,
For 'the time of the singing of birds has come';
How every tender flower holds up,
In trembling balance, its tiny cup,
To catch the food that in sultry weather
Must hold its little life together?
Oh, blessings on thee, thou sweet Spring rain,
That callest dead things to life again!"

—James Brown Selkirk (*Rain*).

From the point of view of thirsty things, the best weather is the day of rain. The earth grows brown and sere, waiting for it. Growth ceases. The cattle languish. The farmer scans the sky anxiously, looking for clouds that promise refreshment; for water is life's prime necessity.

The rain comes with phenomena of great impressiveness. Were such things to be seen at only one place in the world, men would travel the world over to see them. Bold thunder-clouds rise, with crests as white as snow, resting on banks as black as ink. The lightning flashes and the thunder rolls. The landscape darkens and the rain descends. Zig-zag flashes cleave the blackness only to intensify it. There is a scent of ozone from overhead, and the scent of the ground comes up from below. It rains. And then the clouds lift a little, and a flood of light flows in on the freshened atmosphere. The rain ceases and the verdure of the earth appears, slaked and washed clean.

We do not, naturally, seek to keep out of the rain. As children, we sought to be out in it. The warm summer rain was as refreshing as sunshine. It is due to our clothes that we avoid getting wet. Our modern attire is set up with starch and glue, and the rain wilts it. For the sake of such artificial toggery, we sacrifice some pleasures that are part of our natural birthright.

Other creatures enjoy the rain. At its approach, many of them enter upon unusual activities. Insects swarm. The rabbits by the roadside become more familiar. They approach nearer to our doors, and sit longer amid the clover when we come near them. Snakes run more in the open; indeed, a snake in the open roadway is a venerable "sign" of rain. Chickens oil their feathers, alternately pressing the oil-gland and preening with their beaks; and if they get well waterproofed before the storm breaks, and if the downpour be not too heavy, they will then stay out in it, and enjoy it. Many birds sing more persistently—notably the cuckoo, which doubtless, from this habit got the name "rain-crow." Frogs croak vociferously, as if in pleasant anticipation. Flowers bend their heads.

When it rains, the moisture-loving things come forth. Slime-molds creep out over the logs. Mushrooms spring up. Slugs and millepedes and pill-bugs wander forth into the open, and earthworms, as well, at night. And everywhere running water is performing its great functions of burden-bearing, cutting, filling, leveling, and slowly changing the topography of the land, and distributing all manner of seeds over its surface. There is plenty to see and plenty to hear when it rains.

Study 41. Out in the Rain

This is a study for the day when raincoats and rubbers and umbrellas have to be taken afield, and when the coming on of a heavy shower puts an end to other work. Then, instead of fleeing indoors, it will be well to stay out and see some of the interesting things that go on in the rain.

The program of work for the day of rain will vary with time and circumstances. Therefore, we shall have to be content with a very few general suggestions.

First, before the storm breaks, during the lull when the "thunderheads" are mounting the sky, it will be a good time to observe the increased activity of certain animals, the preparatory movements of certain flowers, the interesting behavior of the barnyard fowls, and, above all, to listen to the anticipatory chorus of frogs and tree-toads, and birds and crickets and other animals that can not keep still.

Then, when the rains comes, the water-shedding power of different kinds of foliage may readily be tested, if members of the class will step under trees of different kinds and wait, with raised umbrellas, and note how long it takes for the rain-drops filtering through the foliage to come through in sufficient numbers to make a continuous patter, with no individual drops distinguishable. One may test the way in which any tree standing in the open disposes of the water that falls upon it, by walking under it over all the area it covers and listening to the sounds of the drops falling about his head, on the stretched umbrella.

When things are soaked with rain and the water is gathering in rills, there are many things that may then be observed with unusual advantage. The clouding of the streams with inflowing silt will be very obvious. The burden the streams are carrying may be easily demonstrated. It may be tested by dipping a glass of running water and letting the water settle to see the sediment; by placing one's fingers across the current so as to feel the pelting of the pebbles that are carried by the rill; or, by listening to the pounding of the rocks in their descent of the larger gullies. Part of what the stream carries is floating stuff stems and leaves, that will fall and decay, and seeds that will spring up in new situations. The washing of different kinds and conditions of soil may be seen. Indeed, it is only out in the rain that erosion by the rills, and the building of miniature deltas and flood-plains, may be seen at their height.

When the rain has ceased, the rate of drying of the surface of different kinds and conditions of soil may be observed. One should compare newly plowed and fallow land, bare fields, meadows and woods. Certain moisture-loving animals will be seen abroad abundantly when the shower is ended—snails, slugs, pill-bugs, worms, frogs, etc. Indeed, the wood thrush is likely to be heard singing again almost as soon as the downpour is ended; for, as Alexander Wilson observed of it, "The darker the day, the sweeter is its song."

The record of this study may properly consist of notes on things heard and seen, that are connected in any way with the coming of the rain.

XLII. THE VINES OF THE FARM

"*They shall sit every man under his vine and under his figtree, and none shall make them afraid.*"—Micah, 4:4.

The cultivated crops of the world have in the past grown mainly in fields, gardens and vineyards. Many crops have been raised in the fields, and still more in the gardens, but the vineyards have been given over mainly to one crop—the fruit of the vine. There is but one vine that fills any very large place economically: the word vine means grapevine in much of our ancient literature.

Before the dawn of history, the ancient cultivator found the grape suited to his sunny hills. It was long-lived and strong-rooted, and served to bind the soil of the terraced slopes. It was resistant to drought and adaptable to situation. It was responsive to care and amenable to training. It was beautiful in leafage and fragrant in flower and luscious in fruit, and in every way desirable about his home. So he made a vineyard for it, equipped with a watchtower and a wine-press, and he fenced it in. He planted and fertilized it and pruned it and trained it over arbors, and sat beneath its shadow. He ate its fruit and drank its vintage—and, sometimes, used its wine to make him drunken, even before the dawn of history. It is a large and varied role that the products of the vine have played in human affairs.

Other vines besides the grape are cultivated in fields and gardens, but they are mostly short-lived herbaceous things like hops, pole-beans, and gourds. One wild vine with excellent edible tuberous roots, the apios, we have had before us in Study 7 (fig. 37). Aside from the grape, the best known of our vines are those that are raised for the singular beauty of their flowers and foliage. Splendid flowers, indeed, are those of

Fig. 120. A spray of wild grape.

the climbing roses and honeysuckles, of the scarlet trumpet-vine, of the virgin's-bower, of the morning-glory and the sweet pea. Most of these are fragrant as well as beautiful. Fragrant also are the less conspicuous flowers of the wild grape, the climbing hemp (*Mikania scandens*) of the marshes, and the apios.

Vines are plants that cannot stand alone. They must have some support to hang or lean upon. They vary in size from the wild grape that revels in the tops of the great trees of the forest, to the little cranberry that trails over the surface of the bog. They vary in strength from the wiry rattans to the succulent cucurbits. Some of them are possessed of special climbing apparatus; more of them sustain themselves by twining about their supports; some of the lesser herbaceous sorts maintain their position merely by leaning—resting their elbows, so to speak—upon their neighbors. All of them are long of reach and rapid of

Fig. 121. Virginia creeper or "woodbine".

growth, and all show a marked capacity for keeping their heads out to the light.

Our wild vines vary in habit according to the form and habits of the plants that furnish them support. As there are trees and tall shrubs and low shrubs in every woodland, so there are high-climbing and intermediate and low-growing vines. The vines that are able to ascend to the crowns of the forest are all woody climbers, having perennial stems. They have two sorts of climbing apparatus. Wild grape and Virginia creeper climb by means of tendrils; poison ivy and trumpet-vine, by means of root-like holdfasts which penetrate the bark of supporting trees. These are the vines that furnish the principal draperies of our forests; that garland with inimitable grace the old bare trunks; that spread incomparably beautiful leaf mosaics over walls and fences and over the crowns of small trees; and that fling out banners of brilliant hues in autumn. They often smother the lesser spreading trees under their dense leafage, and in killing them, destroy their own support.

Of these tall vines, the wild grape has the longest reach. Its annual shoots often attain a length of twenty feet. These are equipped with long and strong tendrils that coil tightly about any suitable small support. Once firmly attached, they seem able to withstand the driving of a hurricane. Failing to find support, the shoots hang pendant, like streamers, in the air. The Virginia creeper likewise wraps its tendrils about twigs, but it also inserts their tips into crevices, and then expands them into attachment discs. By means of these, it is able to ascend bare trunks, as do the vines with holdfasts, or to cling to the vertical face of a stone wall, holding on with delicate but unyielding grasp.

The vines that reach the level of the tops of the largest shrubs are mainly twiners. They ascend the shrubs by twining their slender stems about them. The bittersweet

(*Celastrus scandens*) is perhaps the tallest of these, and has the best development of woody stems. It grows on dry wooded hills. The moonseed (*Menispermum canadense*) is a half-woody twiner that overruns the bushes in moist lowland thickets. It is one of the best of vines for shady

Fig. 122. Bittersweet, with fruit unopened.

places, and it has beautiful foliage. The large scalloped leaves overlap one another from the top to the ground like the slates on a roof. There are herbaceous twiners on the taller bushes also, like the bindweeds and the hops. And the balsam-apple (*Echinocystis lobata*) climbs by neat tendrils of singular efficiency. And virgin's-bower (*Clematis virginiana*) and other species of Clematis, climb by twisting the stalks of leaf and leaflet about stems for support.

FIG. 123. An herbaceous climber—climbing buckwheat.

Of low-growing vines there is endless variety. They twine, they climb, they sprawl. A few of the finer flowering sorts, such as climbing roses and honeysuckles and apios, have already been mentioned. Many of the lesser ones have charming foliage. No gems glisten more brightly than do the pendent fruits of the nightshade-bittersweet (fig. 124). Nothing in the world is more beautiful than the delicate tracery of these low-climbing things, commingling with and garlanding the bushes.

Precious to the gardener are the vines, most slender and fragile of nature's "lace-workers of the woods and brake". With them he may quickly cover the unsightly shed or fence with roods of blossoming verdure. He may overspread the bare walls left by the builder with a mantle of varied green and brown wrought in exquisite design. He may throw a filmy mantle of life over the top of mutilated shrubbery. Nature sets him splendid models in every thicket and by every brookside.

FIG. 124. The climbing nightshade-bittersweet.

Study 42. The Larger Wild Vines of the Farm

The program of work in this study will consist of a trip about the borders of a wood, along a fence-row, and through a bottom-land thicket, examining, one by one, the different wild vines of various sorts, and writing their characters in a table prepared with the following column headings:

Name (of plant).

Duration of stem (annual, biennial, perennial).

Grows where (in sun or shade, wet or dry places, etc.).

On what (name support).

By what means (climbing or twining, when climbing by tendrils or holdfasts, diagram the same).

Character of { Stem (tell it in English). Leaves (diagram). Flower-cluster or fruit (diagram).

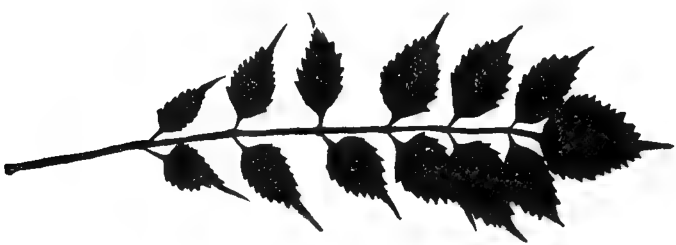
Foliage (character of).

Season's growth, (maximum length of).

Best suited to what situation and use.

The record of this study will consist of:

1. The complete table, outlined above.
2. A little special report concerning some one very common vine, stating in what variety of situations it is founp growing, and with what different kinds of supports.



XLIII. THE SWALE

"Bubble, bubble, flows the stream,
Here a glow and there a gleam;
Coolness all about me creeping,
Fragrance all my senses steeping,—
Spice wood, sweet-gum, sassafras,
Calamus and water-grass,
Giving up their pungent smells.
Drawn from Nature's secret wells."

—Maurice Thompson.

Waste land is land we have not learned how to use. Much of it is too dry, and lacking water—the prime requisite for plant growth—it produces little, even of wild crops. Much of it is too wet and, therefore, unsuited to our agricultural methods, though nature produces on it her most abundant crops. Much of it is too rocky, and unsuited to the use of our implements of tillage. Deserts and rocks and swamps overspread vast areas of the earth's surface. But miniature waste places of like character appear in sand-ridge and stony slope and swale on many an inland farm.

Let us study the swale a bit—that most interesting and most productive of waste areas. We will find it among the tilled fields, where their gentle slopes run together, forming a depression that is poorly drained. We will find it over-spreading the level surface of some miniature valley between upland hills, or by the stream-side or at the head of a bay or pond. In such places the crops that we know how to raise on farms will not thrive. There is too much water. The soil is soft under foot. Though black with humus, and enriched with the washings from surrounding slopes, it is sour, and unavailable to our field crops.

It has its own crops, and they are never-failing. Always it is a flowery meadow, densely crowded with plants of many kinds in interesting association. It is a place of rushes and sedges, rather than of grasses. It is a place of abundant flowers the whole season through, from the cowslips and cresses of spring to the asters and gentians of autumn. It is a place where crawfish sink their wells, unmolested by the plow, piling little circular mounds of excavated earth about the entrance; a place where rabbits hide, and where song-birds build their nests; a place where the meadow mice and shrews spread a network of runways over the ground: in short, a place where rich soil and abundant light and moisture support a dense population, among which the struggle for existence is keen.

If a fence-row extend down from the field into the swale, let us follow that, and see how the wild plants change with increasing soil moisture. The grasses of the fence-row begin to be crowded out by sedges as the water-level comes nearer the surface of the soil. Dry-ground asters and goldenrods and lobelias disappear, and wet ground species of the same groups appear instead. Bracken fern is replaced by marsh-fern and sensitive fern; hazel by willow. Under foot, the soil is growing softer, blacker and more spongy.

If the swale has been cleared of woody plants, still alders and willows are prone to linger about the wetter places, and black-berried elder, osier-dogwood and meadowsweet about the edges. Cat-tails and bulrushes (fig. 16, p. 36) will fringe any open wet spot, and tussock-sedges and clumps of juncus will rise on mounds of gathered humus, like stumbling-blocks before our feet, where diffused springs abound.

No two swales are alike in the character of their plant population. But all agree in their meadowlike appearance, in being made up of patches of rather uniform character, where uniform conditions prevail, and in having each of these areas dominated by one or two species of plants, with a number of lesser plants as "fillers" in its midst, and a greater variety of miscellaneous plants growing about its edges.

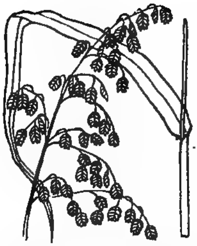


FIG. 125. A heavy cluster of manna-grass (*Panicularia laxa*) after Britton and Brown.

The dominant plants that cover considerable areas of the swale, almost to the exclusion of other plants. are mainly grass-like plants, capable of close growth above ground and nearly complete occupation of the soil. They are such marsh grasses as the panicularias (from which marsh hay is made) and reed, on wetter soil; such bulrushes as *Scirpus fluviatilis*; such other plants, as cat-tails and bur-reeds (fig. 16); and, over smaller areas, sweet flag (*Acorus calamus*) and blue flag (*Iris versicolor*). Where these grow most compactly, there are a few lesser plants intermixed, filling the niches, reaching into light above and spreading roots in the superficial layers of the soil.

With permanent conditions, the mixture of plants will remain much the same year after year. They are nearly all perennials, holding their place by continuous occupancy of it. Each is striving to extend its domain, but there is little opportunity. In the permanent association of certain species together there are some fine mutual adjustments. The taller broad-leaved perennials, like swamp-milkweed and joe-pye-weed and boneset, root rather deeply, and stand stiffly erect. The top layers of the soil are left by them to such lesser things as marsh skullcap, bedstraws, and tear-thumbs, whose straggling sprays reach out and find the light. The annual herbs of the swale are few; they are such as jewel-weed and Spanish needles, that depend for their opportunity

FIG. 126. Flower and fruit of the jewel-weed.

to find a place on some disturbance of existing conditions. A muskrat or a mole upheaves a mound of earth, and the seeds of these annual weeds, falling into this unoccupied soil, flourish there for a season ere the rootstocks of more permanent perennials again invade it. The annuals of the swale are quick-growing things, that depend for their success in the world upon their ability to shift from place to place, to find new openings, and to get in and mature a crop of seeds before the perennials crowd them out again.

There are many beautiful and interesting flowers in the swale: yellow flowers, such as Saint John's wort, buttercups, goldenrods and loosestrife; blue flowers, such as monkey-flowers, lobelias and gentians; white flowers, such as meadow-rue, turtleheads, avens and cresses; pink flowers, such as cockle-mint, willow-herb, fleabane and marshmallows; red swamp-lilies and flaming scarlet cardinal-flowers; and others in great variety and in continual succession. Forms like those that grow on shoals (mentioned on page 35) will appear if there be permanent open water. Indeed, a careful study of even a small swale might discover the presence of a hundred or more plant species. Ten or a dozen of these are likely to be found to comprise the greater bulk of the plant population. The dominant species are mainly those having comparatively simple and inconspicuous flowers, whose pollen is distributed by winds. The dominant species extend their domain chiefly by strong vegetative offshoots, occupy the soil with strong roots, and never let go.

Study 43. Observations on the Plant Life of a Swale

Some small open area of wet ground, well grown up in wild meadow, undrained, and not pastured, should be selected for this study. An outline map should be provided, unless the form be simple. Digging tools will be needed, and also facilities for washing roots.

The program of work may consist of:

1. A general survey of the swale as to:

(a) The mixing of dry-ground and wet-ground forms at its margin.

(b) The areas into which it is naturally marked out by the uniformity of the plant growth covering them ("plant associations").

(c) The relation between topography, soils and water and these plant associations.

2. An examination of the plants in several associations as to the relations they bear to one another both above and below ground. Some should be cut so that the leafage may be viewed from the side as well as from above; and some should be dug up, so that the depth and distribution of the roots may be noted.

The record of this study may consist of:

1. A map of the swale, with topographic features and the principal plant associations (including bordering shrubbery) marked out upon it. Explanations to the map should name at least the dominant species present in each association.

2. Diagrams, illustrating vertical sections of the swale herbage, showing the relations of the principal components of several associations, both above and below ground. These should show how the branches of each species are placed to reach the light, and how the roots are distributed in the soil.

[NOTE: The above program is laid out in the belief that the study of the swale will be most instructive if we seek to learn how the various members of nature's dense wet-ground population get on together; but if an acquaintance with the entire plant population be desired, the record may take the form of an annotated and illustrated list of species.]

XLIV. THE BRAMBLES OF THE FARM

> *"Erratic wanderings through deadening-lands*
> *Where sly old brambles plucking me by stealth*
> *Put berries in my hands."*
>
> —Riley (*A Country Pathway*).

Brambles are intimate associates of the farmer. Wherever man has tilled a field, thorny things of some sort have settled peaceably along its borders. Ever ready to invade the "garden of the slothful," they have had a share in promoting regular tillage. Just beyond the domain of the plow, they stop and hold the fort. They are wild intractable things, no respecters of clothes, nor of feelings, nor of any of the ways of civilization. Under their cover other wild things dwell.

Before there were farms, the brambles doubtless occupied the openings in the woods where giant trees had recently fallen, and other spots left temporarily unoccupied; for, after the annual weeds, they are among the first plants to appear in such places. Their seeds are planted by birds, which eat their berries. Hence the dead tree, the fence, the stone pile or the stump pile in the field, or any other thing in the open ground that offers an alighting place for birds, is sure to have a lot of brambles about it.

They spring first from seeds, but later they spread lustily from offshoots of various kinds, and form thickets. The more typical brambles (thorny members of the genus *Rubus*) have short-lived stems, which early crowd out the weeds, and after a few years are themselves outstripped and overtopped and shaded and killed by taller-growing shrubs and trees. In the woods, therefore, their occupancy of any given place where trees may grow is but temporary: but in the fence-row where the farmer keeps the trees cut down, they may hold on indefinitely. If mowed or burned, they spring up again from uninjured roots.

Our most typical bramble is the wild blackberry. Its stout, thorny biennial canes shoot up to full height one year, and bloom and fruit and die the next. Year by year, the dead canes, commingled with the living, accummulate in the bramble patch, making it more and more impenetrable. They gather to themselves as they settle to the earth, an abundance of falling leaves, and fill up the center of the thicket with a rich mulch that keeps the ground moist, and favors the growth of the tallest canes and the finest berries. There is no chance for grass to grow in the midst of such a thicket, but only about its borders.

FIG. 127. Wild blackberry: A young shoot of the season, a fruiting shoot, and a dead cane.

The wild red raspberry makes thickets that are less thorny and less dense, but that are hard to penetrate because the long overarching canes, fastened to the earth at both ends, trip one up badly. The red canes, covered with whitish bloom and bearing handsome and gracefully poised leaves, are very beautiful. This bramble loves the shelter of a brush pile or fallen tree. Its extremely long reach and its habit of striking root wherever a tip meets the ground, enable it to shift its location, moving one stride each season. It often springs from seed on the top of some rotting log or stump.

The dewberry forms low, trailing, nearly thornless thickets at the level of one's shoetops in dry fields. There are other blackberries and raspberries also, in both wetter and drier situations, and many other thorny things, such as wild rose, wild gooseberry (fig. 3 on p. 18) and greenbrier, in the thorny thickets of the farm. But such as those above described are the ones that have most affected human interests. Fit only to be burned—except when (as not infrequently), without care or thought from us, they happen to be found bearing a load of luscious fruit. Their fruiting in the wild we may, indeed, with profit observe, if we would manage wisely their cultivated relatives; for in the wild we may easily see what sort of soil and amount of shading and kind of mulch produce the finest crop of fruit. Their love for partially shaded situations renders raspberries especially adapted to be used as "fillers" in young orchards.

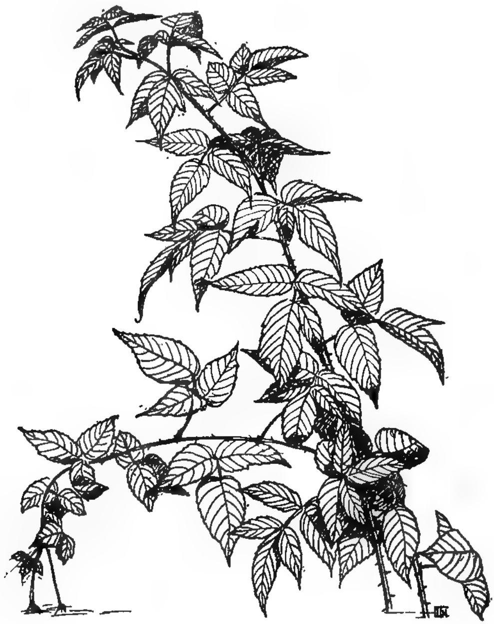


FIG. 128. Wild red raspberry.

Any good blackberry patch, clustering about an old stone heap or rail pile in a pasture, will give an excellent opportunity

FIG. 129. Wild rose.

for observing the mutual helpfulness of many of the wild things in nature. At the edges of the clump, the adventurous new bramble sprouts, venturing out too far, are cropped with the grass by the cattle: but, wherever a stem has lived to harden its thorns, close by it new sprouts may raise their heads in safety. So may other herbage also, some common associates of the brambles, being cudweed and goldenrod and bracken fern and elder. The seeds of the last named are doubtless planted also by the birds. The grass grows tall in a peripheral zone among the canes, and under its matted tufts numerous runways of meadow mice are to be found. And it is a poor brier patch, even tho it be a small one, that does not shelter the door of a deep burrow of some family of woodchucks, skunks or rabbits. Lovers of Uncle Remus will remember that Brer Rabbit proclaimed the brier-patch to be the place of his nativity.*

FIG. 130. Cudweed.

*"Co'se Brer Fox wanter hurt Brer Rabbit bad ez he kin, so he cotch 'im by de behime legs, en slung 'im right in de middle er de brier-patch. Dar wuz a considerbul flutter whar Brer Rabbit struck de bushes, en Brer Fox sorter hang 'roun' fer ter see w'at wuz gwineter happen. Bimeby he hear some body call 'im, en way up de hill he see Brer Rabbit settin' cross-legged on a chinkapin log koamin' de pitch outen his har wid a chip. . . . Brer Rabbit . . . holler out: "Bred en bawn in a brier-patch, Brer Fox—bred en bawn in a brier-patch!"—Harris (*Uncle Remus*, p. 18.)

Brambles follow in the wake of the ax. In deadenings of standing timber they flourish apace—a transient population, soon submerged if trees be allowed to grow again, and easily eradicated with the plow. Yet feeble and transient as they are, they are ever with us in those nooks and angles of the farm that are neither plowed nor tree-covered, and all manner of wild things love them.

Study 44. The Brambles of the Farm

The object of this study is to learn something of the interesting habits of this little-esteemed class of wild plants, something of the conditions of their existence, of their relations to other plants and animals, and of their relations to ordinary farming operations.

The program of work will consist of:

1. Digging up in the patches specimens of all kinds of brambles, examining them, root and branch, and making brief notes and sketches for the list mentioned below.

2. Examining in some pasture the make-up of a typical blackberry patch that is spreading from an old fence or brush pile or stone heap.

3. Comparing the growth of specimens of some one common kind of bramble, as the blackberry, in different situations, in relation to conditions in each place.

The record of this study will consist of:

1. An illustrated list of all the brambles studied, with diagrams showing, for each species, manner of growth, mode of increase, succession of stems (canes), flowering or fruiting, etc.

2. A diagram of a vertical section of a brier patch, showing the briers in their relative height and abundance from center to margin, showing dead mulch and green ground-cover herbage, showing the common plants intermixed,

including at least one small tree, and showing the location of nests, runways, or burrows of such resident animals as are noted. Both the preceding diagrams call for clear and detailed labels and explanations.

3. A brief statement of the best and worst natural conditions found for good growth and fruit production in the bramble selected for special study.

XLV. THE POPULATION OF AN OLD APPLE TREE

"My host was a bountiful apple tree;
He gave me shelter and nourished me
With the best of fare, all fresh and free.

And light-winged guests came not a few,
To his leafy inn, and sipped the dew,
And sang their best songs ere they flew.

I slept at night on a downy bed
Of moss, and my host benignly spread
His own cool shadow over my head."

—Thomas Westwood (*Mine Host*).

There are few trees about the farm home so well beloved in childhood as the old apple trees. The grass grows like a carpet under their spreading crowns. Their smooth horizontal boughs seem to have been made to climb in. Their fruit was certainly made to eat. Food and shade and pleasant pastime—all these for us, and not for us alone, but for many other creatures as well.

The robin loves to build her plastered nest in the stout crotch of the apple bough where well concealed by the leaves on a few thin "water-sprouts." The dove selects a horizontal spray, and lays her thin platform of twigs across the level branches. Catbird and thrush and many other song-birds search the thickest of the unpruned crowns for home-sites. The apple tree covers them with its leaves and embowers them with its flowers in the time of nest building, and supports, all summer long, a multitude of insects that serve them well for food. In an old "stag-headed" tree, the dead and hollow snag may be perforated and occupied by woodpeckers, or later by wrens and sparrows. But whether woodpeckers find a nesting place in the apple tree or not, they find food in it, in the insects that burrow in its bark and wood. One may hear their tapping in the orchard at almost any time; and by carefully watching, may see them chiseling holes with their stout beaks, and extracting borers from the wood, or caterpillars hidden under the heavy flakes of bark. Their perforations may be found on any old tree, especially in bark and dead bough. Often there are sap-pits to be seen, also, in the fresh green bark of the larger boughs. These are placed in regular transverse rows, close together. They are made by sapsuckers, at the time of sap-flow in the early spring (see Chapter 22, page 169). These are made to "bleed" the tree and not to rid it of pests. They are not very harmful, however, for they are made in such a way that they quickly heal in the growing season. The pits are small, and living bark from which new growth may spread is left between the pits. Nature has taught the sapsuckers how to take the sap and soft fiber of the inner bark from the trees without seriously injuring them. The sapsuckers pay for this by eating injurious insects that hide beneath the old and flaky bark of the trunks.

A few birds are residents in the trees, but many others come and go. Some, like crows and jays, slip in unawares, merely to peck holes in the reddest of the apples on the upper boughs. Others, like cuckoos, come to feed on caterpillars. There are many mammals that like apples as well as we do; and some small wild ones make nocturnal visits to the orchard. There are many insects that visit it, in blossoming time, for nectar or for pollen, as we have seen in Study 30. But the most important part of the population of the apple tree is the resident population, composed of insects that are wholly dependent on the apple tree for their livelihood.

These are both beneficial and injurious insects; and the latter will usually appear to be in excess. There is no part of the tree exempt from the attacks of some of them. On the roots, there are wooly aphids clustering and causing rounded galls to grow where they make punctures with their beaks. On the new bark and on the leafy shoots, there are other aphids feeding together in great colonies, gregariously. These, though minute and inconspicuous in themselves, are readily located on new shoots because of the crinkling they cause the leaves to undergo. On an old neglected apple tree, there are apt to be many minute scale-insects scattered about, adherent to the bark of the green twigs. These are very minute and inconspicuous creatures, that appear lifeless, indeed, but they are, by reason of the persistence of their attack and their very rapid rate of increase, among the worst enemies of the trees.

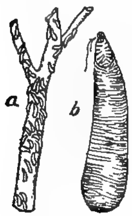


FIG. 131. Oyster-shell scales on an apple twig, and one enlarged.

Of caterpillars, there is a long succession and a great variety to be found on the apple tree. In spring, the tent-caterpillar spins its huge webs conspicuously in the crotches of the apple boughs. Though the tent-caterpillars will all be gone before midsummer and a new growth will be replacing the leaves eaten by them, their empty webs will still be seen upon neglected trees. In their stead, two other moth larvae, popularly known as the yellow-necked and the red-humped caterpillars, may be found devastating the foliage. Other lesser caterpillars that injure the leaves are the bud-moth caterpillar, that works in opening buds, the pistil-case-bearer that gnaws out little patches from the surfaces of the leaf, and the apple-leaf-miner, that lives within the leaf substance, making a trumpet-shaped blotch of a mine between upper and lower epidermis. The last two will be found by looking for spotted leaves that have their margins uninjured.

The fruit of the apple is the place of residence for three insects of the sort shown in figure 6 on page 22. The larva of the codling-moth is a caterpillar that works in the core of the apple. The larva of the apple-curculio is a weevil that works in the flesh of the apple, its location being marked by a conspicuous surface scar. The apple-maggot works also in the flesh, burrowing through it in all directions, and leaving discolored streaks from which rotting proceeds. Then there are beetles, whose larvae are borers, the most injurious of which work beneath the bark of young trees at the surface of the ground, more or less completely girdling the trees. Two or three of these burrows may kill a large tree. These illustrate the appalling harm that may come from a small wound in a critical place; these cut off the tree-crown from its base of supplies.

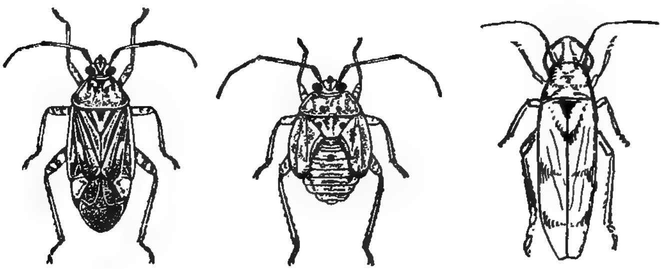


FIG. 132. A plant bug, its nymph, and a leaf-hopper.

These are the worst of the apple pests. Others there are in plenty, that feed here and there, now and then. Plant bugs and leaf-hoppers are always present in some numbers among the foliage, feeding. And in an old tree, having much dead wood present, there are sure to be found wood-destroying beetles of most of the sorts mentioned in Study 24. And each and every one of these species has its enemies and its train of parasites.

The apple tree is useful to us, but it is necessary to many lesser creatures, for it furnishes all their living. It is the center of a considerable population, the inter-relations of which are of infinite complexity. There is no living thing that either lives or dies unto itself alone.

Study 45. The Population of an Old Apple Tree

An orchard of old neglected apple trees should be selected for this study. A few tools will be needed for common use: saws for bringing down branches; hammers for stripping bark; nets for "sweeping" the foliage to capture flying insects; and cyanide bottles to hold specimens pending their identification.

The program of work will consist of:

1. A preliminary survey of the trees (to be made while walking among them, by the members of the class observing things together) to discover the location of birds' nests; the work of woodpeckers, of mice, etc.; the old nests of tent-caterpillars; fresh defoliation by caterpilalrs; colonies of aphids and scale-insects; the presence of wormy fruit, etc.
2. A detailed examination (to be made by members of the class individually) of the life to be found on or in the leaves, bark, twigs and fruit of a single tree. Old bark should be stripped off and its crevices examined; new bark should be searched carefully. Every discoloration or deformation of the leaves should be looked into, and fruits should be cut open and searched carefully. Those examining different trees may, with profit, compare results in the end.

The record of this study may consist of:

1. A large diagram of a single apple tree with the location of the members of its population, that affect the green and living tree, indicated (by symbols and explanatory footnotes) upon it.
2. An annotated list of the entire population in three parts:
   (a) Transient visitors.
   (b) Resident enemies.
   (c) Parasites and predaceous insects.

The notes should cover the relations that each species bears to the apple tree.

XLVI. THE LITTLE BROOK GONE DRY

"In heat the quivering landscape lies;
The cattle pant beneath the tree;
Through parching air and purple skies
The earth looks up in vain for thee;
For thee, for thee, it looks in vain,
O gentle, gentle summer rain."
—William C. Bennett (*Invocation to Rain*).

When summer comes, many brooks cease their singing. When the leafage of the season is developed, the surplus water of the soil ceases to feed the brooks; for it is gathered by the plant roots and distilled silently through the pores of innumerable leaves into the thirsty atmosphere. The silvery streams become broken into segregated pools, which dwindle and dwindle as the drouth increases. Where the floods of springtime made their deepest plunges, there lie basins of bare mud. Truly the brook's inhabitants are subject to sore vicissitudes; to the ice of winter and the floods of spring is now added the severest test of all—the withdrawal of the water.

Let us take our way up the bed of some small stream that has lingered well through a long dry season, but has finally gone dry. How great are the changes in the conditions of life! Here, where shining water played among the pebbles, toying with their dainty drapery of green and brown algae, there is nothing left on stones and brook-bed but a gray powder that crumbles to dust at a touch. There, where was a pool, where tadpoles basked and water-skaters raced over the surface, now lies a sheet of baked mud, caked and cracked in deep fissures. The life of the brook itself is gone: at least, it is gone from the places in which we usually find it. And yet, we know it will reappear, for where there is drouth now, there has been drouth before, and failure of

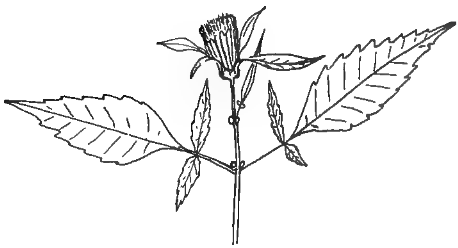


FIG. 133. "Pitchforks" or "Spanish Needles" in flower: see fig, 39 on page 69 for fruit.

water, times innumerable, thru past centuries: and we know that nature maintains in the brook only such plants and animals as are capable, in one way or another, of meeting the exigencies of such times as this.

If the aquatic plants have disappeared, and the aquatic animals also, save for a few that may be discovered hiding under trash in the moister places, there will be found plenty of semi-aquatic brookside things still remaining. There will be weeds of many sorts, overhanging and brushing against us as we pass up the channel; willow-herbs and pitch-forks (fig. 133) in the sun, and rich weed (fig. 134) in the shady places. Then there will be coarse and straggling

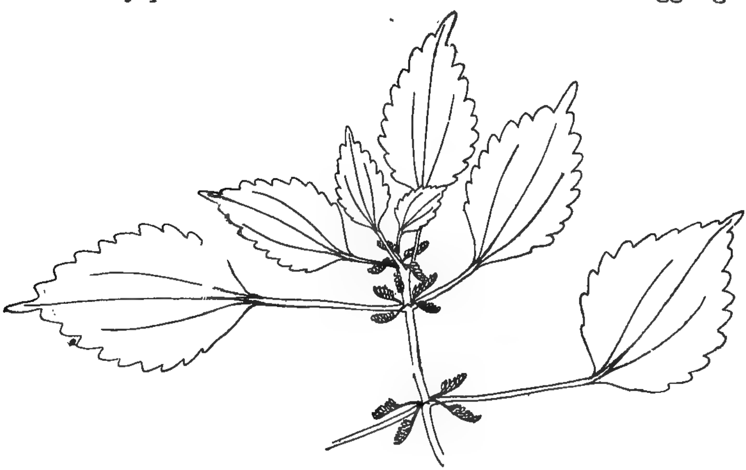


FIG. 134. Richweed (*Pilea pumila*).

sedges; also, some fine close-growing tussock-sedges, that build hillocks of green at the edges of the channel. There will be grasses, also; especially the pale cut-grass (*Leersia*), fringing the edges of former pools. There will be a few fine mints, such as peppermint, spearmint, watermint, and the less attractive bugle-weed. There will be a few fine wild flowers, such as turtleheads, skullcaps and lobelias. There will be evidences of animal life in the tracks of the muskrat and of birds in the dried mud-bed of the pools.

FIG. 135. A late-season spray of the fowl meadow-grass (*Panicularia nervata*), showing vegetative aerial offsets with roots: a small lateral offset is shown enlarged at the right.

Robins, that sit, while we pass by, on the lower branches of the trees, with gaping beaks, panting in the shade—these have been exploring the brook-bed before us. They have been seeking for things to replace earthworms in their diet, since the drying of the topsoil in the fields has driven the worms down below. Other things there are to take advantage of the hapless brook-dwellers. The concentration of the pools leaves their inhabitants exposed to merciless enemies.

Where burrowing crawfishes abound, their holes will be found—some of them capped over with mud chimneys since the drought began. We can test the depth to which the water-level in the soil has descended by probing the crawfish holes with a stick.

FIG. 136. Fruiting panicle of the fowl-meadow-grass.

Where we lose the channel of the brook, as we pass out into a small grassy flood-plain, we find that though there is no water in sight, there is moisture in the soil. Such soil-gathering things as the fowl-meadow-grass (fig. 135) are making the most of the situation; they are covering the plain with a tangle of stems that will strain out of subsequent floods their burden of silt and trash. Thus will the plain be built a little higher; another layer will be added to form rich moisture-holding soil.

By the side of the brook gone dry, nature sets us examples in the conservation of moisture. There we may find plants burned to death with the drouth; others of the same species wilted sadly, but still alive; and others, green and flourishing. The differences are mainly due to the disposition of the soil about their roots; soil hard and bare in the first case, and well adapted to facilitate loss of water; and loose soil well covered from the sun in the last case, and full of reserve moisture.

Somewhere, along our brook, we may come upon a reedy swale now dry enough to walk across, but never dry enough for field-crops, and therefore left unmolested by the plow. It is apt to be filled with sedges and marsh ferns, with a few cat-tails in the wettest spots, and to have round about, a fringe of moisture-loving composites such as boneset, joe-pye weed, swamp-milkweed, goldenrod and New England aster. Such a meadow glade is sure to be the home of many little rodents, such as meadowmice and shrews. If we look among the grass about the flower-clumps, we will find their shallow runways at the surface of the ground.

Study 46. A Brook Gone Dry

This is a study for a dry season in midsummer. The brook chosen for it should be flowing through water-holding soils, and it should be one that is ordinarily a "living" brook, but that has succumbed to the drouth.

The program of work will consist of a survey of a portion of the brook-bed and its borders, of sufficient extent to include typical portions, such as riffles and pools and miniature flood-plains. Brookside plants are to be observed, as well as all signs of animal life; also the more obvious relations of the water supply and the brook to different levels of adjacent fields. Observe what kinds of plants have succumbed to the drouth and where situated.

The record of this study may consist of:

1. A sketch-map of the portion of the brookside studied, showing location of pools, riffles, rock ledges, flood-plains, leaf-drifts, etc., and showing also the principal natural plant formations by the brookside.

2. Lists of plants and animals found in the more typical situations, with notes on their condition as affected by the drouth. List all plants found in the brook-bed, whether they belong there or whether they be chance seedlings of land plants springing up in unsuitable places.

XLVII. SWIMMING HOLES

*"We twa hae paidl't i' the burn
From mornin' sun till dine."*
—Burns (*Auld Lang Syne*).

Of all elemental tastes, the liking for dabbling in water is, perhaps, the most widespread. Man and beast and bird, with few exceptions, love the waterside. They drink, they bathe, they play there. The water is cooling and refreshing. It yields cleanliness, and comfort, and pleasant recreation.

Swimming is one of the most widespread accomplishments in the animal world, even among terrestrial mammals. Most of them swim instinctively, just as they eat or breathe. Man is the only one that acquires the art by practice. For nearly all others, swimming is an inherited ancestral habit, that probably harks back to a remote age; for life began in the water, and the more primitive members of all the great groups of animals are aquatic still.

Certain of our wild semi-aquatic mammals, like the otter and the mink, swim and dive and play in the water with an ease and a grace and an abandon that are delightful. Their agility almost equals that of fishes. Young otters are reported to chase each other down slides in the banks, like boys in a swimming hole. But our domesticated beasts rarely swim voluntarily. They prefer merely to dabble in the edge of the water, enjoying its coolness and a certain protection it affords from flies. Hogs wallow and smear themselves with mud. The American bison did likewise. Cows stand in the water in fly-time, with their thin-skinned under parts immersed, and their tails flinging spray over their backs. This sort of installment shower-bath does good in two ways. When it wets the wings of flies, it puts them temporarily out of commission; and when the water evaporates, its effect is cooling on the cow's skin.

The song-birds, also, have their bathing places. We walk up a small rivulet on a hot day, and cautiously approach its pools, and there we find the robins and the sparrows and other birds at their aquatic sports. Standing singly or by twos and threes in the shoal water, they create a great shower with the flutter of their wings. And this they do at great personal risk; for cats and other enemies may be lurking in the shrubbery that grows beside the pools. One of the ways to conserve the birds is to provide them with safe water fountains.

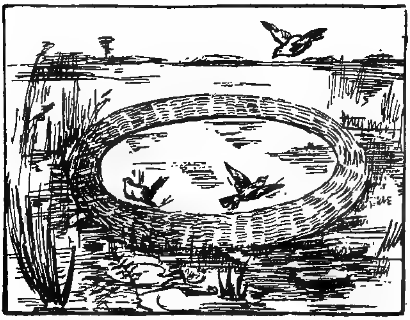


FIG. 137. A floating birds' bath on a pond: out of the way of cats.

Man is imitative far beyond every other creature, and especially so in youth. It is natural, therefore, that he should enter the water and try to do there, even though clumsily, what he sees other creatures doing. Once in the new medium, and used to its coolness and its buoyancy, the boy begins to try the tricks of the swimming-things about him. The dog swims in one way, and he imitates that. The frog swims in another way, and he imitates that. And then he begins to invent new ways of his own.

The greatest social center in Boyville is the swimming hole. Its popularity is undoubted. Its resources are inexhaustible. It is democratic beyond most of our institutions. It isn't much of a place to look at, as a rule—just a bit of open water, a pond, or a pool in the creek, with broad shoals where beginners may learn, and a deep hole for the skillful to plunge in, and a clean bank on which to come out and dress. The only necessary artificial equipment is a spring board, to aid in making spectacular plunges. And if it have, sloping into the water, a soft clay bank down which bare feet may slide, or a black sticky mud, suitable for bodily decorations, it is especially well endowed by nature. Where else on earth is there so simple an equipment capable of fostering so much unalloyed pleasure, or of so effectively putting "every care beyond recall?"

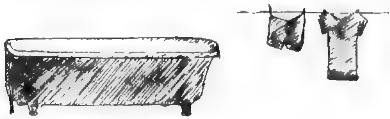


FIG. 138. Poor modern alternatives.

There is so much to learn at the swimming hole! Floating, and diving, and ducking, and staying under, and springbroad plunges, and swimming in all positions and with all the strokes; and every new feat mastered and well and publicly performed, adds so to one's standing and respectability and influence in the swimming-hole community—it must be real education!

FIG. 139. "Every care beyond recall"

Study 47. Swimming Holes

This is a study of the common propensity of land animals toward water sports and pastimes. A hot day should be selected, and places chosen where animals naturally gather by the waterside. The creatures most available for observation will probably be small boys, dogs, pigs, cows, and birds. If any one does not know where the swimming holes are, let him ask the first small boy of the neighborhood encountered. To locate the watering-places of farm animals, let him ask the stockman. To locate the best bird baths, let him ask some local ornithologist; or, better, let him put up his own basin for the benefit of the birds in some place convenient for observation and away from danger and alarms and keep it supplied with fresh water; the birds will come and use it, without resenting observation. Times for making observations of the various sorts suggested should be so chosen as to avoid school-time and mealtime of the boys, milking time for the cows, and feeding time and sleeping time for all the others.

The program of work for this study will have to be shaped in accordance with the local opportunities offered; it is left wholly to the instructor. Better than a single session's observations on the aquatic habits of a variety of animals, may be a record for a week of brief daily observations at one bathing place (as for example, at a bird-fountain), notes being kept on the numbers and kinds of participants and the nature of their aquatic sports.

The record of this study will vary with the subjects selected and the opportunities for observation. It should narrate the full procedure of the animals studied when they are taking a bath, whether in mud or water. It should include an account of all the aquatic activities of the animals observed, evidences of benefit or of pleasure derived therefrom, and the location and character of the aquatic situations chosen by each species for its pastime.

XLVIII. WINDING ROADS

"O, down the valley do they go, where all is sweet and still,
To gently wind and turn about and hide behind the hill.
They are not as the city's streets; they have no clash and roar
But high and wide above them do the songbirds wheel and soar;
And bordering their sides are vines, that spill their wealth of bloom
Through which the sunshine spatters like jewels in the gloom.
Where do they go? the little roads that find the hidden ways,
As memories that ramble down through misty yesterdays."

—Wilbur D. Nesbit (*The Winding Roads*).

This is our last field trip together. Let us betake ourselves to some little winding roadway that has escaped the "march of progress." No fine highway for us today; no boulevard, graded like a speedway, raw in its newness, full of dust and din, or stinking with oil. No, let it be a little unimproved roadway winding among the hills; a roadway with a past, and with no concern about the future, settled, peaceful, redolent with the fragrance of bordering woods and fields; a roadway circling the hills and not demanding their removal; a roadway with the scars of its ancient struggle for existence all healed; its embankments hidden by graceful drapery of verdure let down over them from the bordering woods. And, if it be a dusty roadway, may the dust be clean and cool, dappled with the shadows of pleasant trees or pitted with the fall of the great drops of the summer rain, or printed with the feet of men or animals, or with the wheels of lazy vehicles.

If such it be, we shall see few people passing, but we may see other inhabitants: for the bushes by such a roadside are full of birds, and rabbits and gophers sit nibbling at the wayside clovers. The signs of other passers-by will not be lacking. A sinuous trail through the dust may show where a garter snake crossed the road; the streaks radiating from a "chuck-hole" in a rut may show where a grouse took a dust-bath. Tracks of crows and squirrels on the dust or on the mud after a rain may tell of their coming and going.

But if there be neither man nor beast nor bird in evidence, there are many other things that make the roadside interesting, and not the least of these is the succession of pictures that every turn discloses.

Here we pass a few panels of old fence draped with Virginia creeper, and backed up by spreading hawthorns and sprightly chokecherries. The clay bank at its foot is overspread with a mixed carpet of grasses and mosses and cinquefoil and mouse-ear. A long purple raspberry cane reaches through the panel, and near it are a coarse pink-topped teasel and a blue aster. Nobody planted these so: nobody figured out their times and seasons, their harmonies of color and form, their requirements of light and moisture. They slipped in unawares, each finding its own place, and proceeded to cover a clay bank and a bare fence with loveliness. Yonder, where a carelessly set fire has laid bare a little strip, one may see by the contrasting ugliness what beauty they have wrought.

On the other side are trees. Their boughs are thick and bushy, and heavy with leafage. Long years have passed since the road was cut through, giving full exposure to the sun, and the trees have robed themselves with heavy foliage masses coming down to the ground. They are full-fledged. Ahead, we see their gracefully rounded outlines and their colors, and near at hand the dainty sculpturings and textures of their leaves come into view. Yonder is a dark, shadowy glade with a canopy of overarching birch tops above, and with slender horizontal sprays of leaves of maple extended beneath as though they were floating in the air. Below we catch a gleam from the surface of a dark pool.

Now we come to a steeply rising bank, which doubtless was once bare—long since, when graders had finished their work. But nature had some wild roses and asters growing on the summit, and these grew and spilled over and poured down the slope to the very roadside, where they remain to this day in charming confusion. And year after year the bank is flecked with the pink of the roses in summer and dappled with the blue of the asters in autumn.

We pass under a great oak that stretches its long horizontal boughs across our way, holding out flat canopies of leaves, whose shadows run waveringly over the dust of the road. We round the top of the little hill, where the view opens out across a valley with a strip of sparkling water. We descend a gentle slope and come upon a low-lying meadow, bordered with great masses of golden-rod and elder. We cross a bridge, almost without seeing it; for it is the sort of bridge our fathers builded, a bridge of gray stone taken from the hill-side ledge: a broad and solid bridge built to stand while the rill runs beneath it. The rill is hidden by herbage, but we hear its gurgling. What was once a rubbish-heap below, is now a blossomy mass of verdure, with virgin's-bower and morning-glories running riot over it. Across the meadow lie the shadows of tree-forms cast from the hill behind us, and beyond the meadow rises a steep tree-clad slope, with the tessellated sprays of beech and the rounded crowns of the maple mingled and rising like billows to the ridge. There, a few white pines stand out like sentinels. While we are looking at the spreading herbs beneath the trees, our road turns again to pass around the hill.

So, it leads us on, with its promises of ever-new and charming pictures. Its vistas, disclosed at every turn, are not more satisfying than are its sweet miniatures, seen near at hand. These are the ripe results of many years of nature's handiwork. Every nook and corner is planted with verdure of incomparable design.

This is not a road to race over, seeing nothing. No; it must be travelled slowly, and a bit reverently, if one would see and know. Nature never rewards impatience. So may we go serenely, expectantly, around the next bend. So may we ever go when seeking the true pleasures of life.

And when a little winding road shall, some day, bring us to the town where we must dwell, happy shall we be if the simple elements of the wild roadside loveliness are cherished there; if the plants by the way grow lush and fine; if the roadside greenery drops down gently to the borders of the street; if the little side-paths lead into pleasant places, and the shadows that lie across the grass seem to invite one to enter and rest; if sunny openings are filled with flowers, and shadowy retreats, with soft filmy sprays of leaves; if bare walls are banked with foliage, or festooned with the graceful drapery of vines; thrice happy, if some of the little wild things, nature's exquisite little tender things, planted and cared for by the wayside in places suited to them, tell us we have for neighbors some gentle souls who care for things as God made them.

Study 48. A Winding Country Road

The program of work for this study will consist of a walk along a short stretch of an old rural roadway, preferably among wooded hills, seeking out the natural beauties of the roadside. A road of long standing, little mowed or graded, should be chosen. A map of the portion to be examined may be provided.

Views, such as the following may be located:

1. An open vista along the roadway itself.
2. A forest aisle along the roadway itself.
3. An inviting side path or branch road.
4. A shadowy glade.
5. A distant display of tufted foliage on a steeply-rising wooded slope.

6. A near-by display of leaf-cover, of elegant design.
7. A display of wild flowers.

The record of this study may consist of:

1. The map above mentioned, with arrows marked upon it indicating such views as above noted.
2. Brief descriptive list of them, stating for each,
   (a) What elements of the view most appeal to you as being beautiful.
   (b) What kinds of wild things nature has chiefly used to make it so.

"The little cares that fretted me,
  I lost them yesterday
Among the fields above the sea
  Among the winds at play
Among the lowing of the herds
  The rustling of the trees
Among the singing of the birds,
  The humming of the bees.

"The foolish fears of what may happen
  I cast them all away
Among the clover-scented grass,
  Among the new mown hay,
Among the husking of the corn
  Where drowsy poppies nod
Where ill thoughts die and good are born
  Out in the fields with God.

—Elizabeth Barrett Browning

Individual Exercises for the Summer Term

Five studies follow, that, like those for the fall and spring terms (pages 126 and 228 *et seq.*), are intended to be made by the student working alone and at his own convenience. Four of them call for weekly observations extending over the entire term; but these are such observations as can be made on walks for health and pleasure with no great expenditure of time.

Optional Study 11. A Grass Calendar

The great grass family is one with which we ought to be acquainted, considering the importance of the role it plays. It furnishes a principal part of the food supply of man and beast. Of the thousands of species of grasses in the world, we know a few as cereals (wheat, corn, oats, barley, etc.), a few as pasture grasses, a few as noxious weeds, and a few as ornamental grasses.

There are other grasses, relatives of those we cultivate, growing wild in every locality. There are grasses for every situation, wet or dry, in sun or in shade; and they are of great diversity of form and habit, and of great beauty and interest.

The object of this study is to get on speaking terms with a dozen or more of the local grasses, wild or cultivated, and to observe their behavior through the summer season. Growing patches of several kinds should be located near at hand, where they may be visited at least once a week without too great expenditure of time, and where they are most likely to remain uncut. The list should include one or two of the thin straggling grasses that grow in the thickets, and one or two of the annual species that grow as weeds in fields and gardens; also, if convenient, one or two water-grasses, such as cut-grass, manna-grass or reed. Weekly observations should be made through the term on the activities of the whole plant—what it is doing in leaf or stem or flower or fruit production; what it is doing below ground in the way of production of stools or offsets; when starting growth or second growth; when distributing seeds, etc.

For record, these observations may be entered in the columns of a cross-ruled table, the left-hand column being reserved for the names of the grasses, and dates being written at the top of the other columns in proper order. Names of the grasses, if needed, will be supplied by the instructor when a flowering or fruiting specimen is furnished for identification. Following the name of each kind of grass, there should be written, in the proper date columns, the observations made upon it. Footnotes may include any observations for which there is not room in the table.

Optional Study 12. A Calendar of Summer Wild Flowers

This is a continuation, through the summer season, of the observations on spring flowers, outlined in Optional Study 8 on page 229, and may follow the plan there outlined. For the second table-heading, "Relation to leaf-unfolding," substitute: "Form and size of flower-cluster (diagram, and give measurements)".

Optional Study 13. A Calendar of Bird-nesting

Nothing is more delightful to observe than the skill with which birds hide and build their nests. A few, like those of the Baltimore oriole, are hung out in plain view, but most of them are so well hidden that we can find them only by most careful and unobtrusive watching of the coming and going of the parent birds.

This is a study for those who know how to find the nests, and who know how to observe them without causing the parent birds to desert them. It would better be undertaken by those who have had some experience, for finding the nests will require too much time on the part of a beginner.

For record, the observations on bird-nesting may be written in the columns of a cross-ruled table, in which the first column is reserved for bird names, and the other columns are reserved each for the observations of one period, with the date written at the top. After the name of each bird there should be written, under proper date, a brief record of the building operations in which the species is engaged. as searching for sites, laying foundations, building walls, interweaving moss or feathers, completing lining, etc. Also subsequent nesting phenomena, such as: first egg, last egg, hatching, feeding, leaving nest, etc. Ample footnotes may contain data for which there is not room in the table.

Another form of calendar, that may oftentimes be preferable where one species of bird, favorable for observation, is abundant, may be made up of the observations on pairs of birds of a single species; the left-hand column of the table for record will then be reserved for the location of the several nests.

Optional Study 14. Best Crops on the Farm

The object of this study is to encourage personal observations on the growth of the products of the fields. A dozen or more such cultivated crops as corn, wheat, oats, hay, clover, potatoes, millet, apples, buckwheat, turnips, etc., are to be severally examined in all the fields of the farm, and the best found are to be set down for record in the columns of a table of the form of that shown on pages 130 and 131, having such headings as the following:

Name of crop.

Location (in what field or portion of same).

Kind of soil.

Preparation of soil (information may be obtained from farm records).

Condition (of crop at the conclusion of this study).

Method of planting (if not observed, see farm records).

Subsequent treatment (if not observed, see farm records).

Yield (actual or estimated; specify which).

Optional Study 15. A Corn Record

Corn is King!

This beautiful plant, that our forefathers, when they first came to America, found growing in little patches about the camps of the red men, has become our great staple. The following study of its natural history may be made in any convenient cornfield. It calls for careful observations at least once a week (oftener in flowering time) on germination, leaf-unfolding, stooling, prop-root formation, tasseling, "shooting" of ears, responses to drouth, or to wind, ripening, etc.; in short, on all phases of the behavior of the plant.

The record may be in the form of a diary with weekly (or more frequent) entries covering:

1. Physical factors of environment	temperature, rainfall, windstorms, and other relevant weather conditions. condition of soil as to tilth, weeds, etc. tillage.
2. Growth	average height at each date of record. details of its development and behavior.
3. Enemies	birds, animals, insects, fungi, etc., found causing injury.

Outdoor Equipment

It is a part of the public duty of those who know the value of our natural endowment to protect and preserve some portion of it wherever possible, and to put it to educational use. We, as a people, have had the American soil in our keeping for only a few generations; and yet we have well nigh extinguished its native life over large areas. It is well to have fields and stock-pens, for we must be fed and clothed: but, it is well, also, to have something to show of the richness and resourcefulness of nature, for we must be educated.

Coming generations will need the wild things. Without seeing them, they will never understand the history of their own country. They will never know what things confronted their forefathers to baffle them: what things gave them succor and enabled them to live here and establish a new nation. They will want to know what the native life of their native land was like.

There is plenty of wild life of many sorts in America still, but it is getting farther and farther from the haunts of men and lost to its former use. The attention of youth is occupied more and more with artificialities. The wild places near at hand are made unclean, and then are shunned. Our necessary "improvements" are made with much unnecessary waste and heedless despoiling of the beauties of nature.

This is largely due to ignorance. That anything wild is worth saving has hardly occurred to the average citizen; that anything wild may be saved without hindering improvements is an idea foreign to his experience. For he has been filled with zeal to make the world over; to cut down all the woods and drain all the bogs, and fill all the ravines with rubbish; to reduce it all to a neat pattern of cement sidewalks, encircling lawns and cabbage patches.

In the cities where the pressure for room has been greatest and the destruction of native wild life completest, men have cried out for nature and for green things growing, and parks have been made. But the average park is a stretch of grass to be kept off from, and the best of parks are good and wholesome and inspiring and informing in proportion as they reproduce the wildwood.

So, before the last bits of wildwood near us have been destroyed, it is time to think of preserving some of them for the sake of those who shall come after us. This was not necessary in the days of the pioneer, but with rising land values and more intensive agriculture, the extermination of the wild life is proceeding at an ever accelerating rate. The rich life of the Illinois prairies is a memory. The streams in all our settled parts have been made barren and unclean. The swamps—nature's own sanctuaries—are being drained. In the better agricultural areas of America, we have almost reached that day of desolation when the possession of a natural grove, or of a wild-flower preserve, however small, is enough to give a farm distinction—to mark it as a home of culture.

Three things a naturalist should do for the public good. He should endeavor: (1) to prevent unnecessary and ill-considered destruction of natural beauty everywhere: (2) to aid nature in the restoration of beauty to waste places: (3) to make the bits of nature near at hand more serviceable in the education of the public.

Saving the remnant. It will not do for those who best know the esthetic and educational values of wild life to merely sit back lamenting when its extinction is threatened. When natural beauty spots are about to be ravaged and stocked with artificial gewgaws; when the public roadsides are to be shorn of their copses of flowering shrubbery, only to be made into weed patches; when flower decked ravines are to be turned into rat-hatcheries by filling them with garbage and rubbish; when sparkling streams are to be fouled with stinking slops and oils by the slovenliness of some streamside factory; when public groves are to be cleared without any intelligent supervision, merely to provide work for a public labor-gang in the slack season:–whenever these or any other such things, as are occuring daily all over the land, are about to be committed, it is the duty of the naturalist to speak out in protest. He should endeavor to enlist the enlightened public sentiment of his community, to have the esthetic and educational values of such places considered, ere they are destroyed. They are sure to be undervalued because they have cost the public nothing. In this they are like all true gifts of heaven.

In city communities, there are Audubon societies, and wildflower preservation societies, and civic improvement societies, and conservation societies, etc., that include in their membership the best brains and culture of the place; and the aid of such organizations is easily enlisted in such a cause. In any community there are those that love the beauty and freshness of unspoiled nature, and who will gladly use their influence toward saving something for future enjoyment. The first thing to be done is to see that those administering the public works in question are informed of the value of the wild things about to be destroyed. Often, it is necessary that they be informed of the very existence of such things. Next there is need of eternal vigilance.

Improving waste places. When necessary public works, however destructive of natural scenery, have been completed, then a little careful forethought for the use of the things nature freely offers, will make the place beautiful again. The naturalist should assist in planning their betterment. He of all people, should know what things are most available, and best suited to every use and situation.

Suppose a bridge is to be built. Everybody knows that an old bridge, settled in the midst of clumps of greenery and spanning a clear stream makes a beautiful picture. A new bridge looks otherwise: it rises starkly from a sea of mud, joins two new-born dump heaps. For, when a bridge is built, usually just enough money is appropriated to do the necessary excavating, to dispose of the dirt in the easiest way and to put up the bridge itself: nothing is available for restoring beauty to the place. What are the things needed for this? Willows by the waterside: filmy pale green small-leaved wild willows, to nestle in soft masses by the abutments: elms and sycamores to cover the rising slopes; or vines, if the dump be of broken stone: swamp iris or water shamrock to cover the bare mud—things that do not cost a cent for they may be found in nature's wild nurseries; things that will grow without any coddling, that need only proper planting—in short the things that grow wild in such places. These will restore the beauty of the place in the minimum of time, and with the least expense. In the course of years, nature, if not prevented, will restore these things herself: but the effect will be better, and the desired results will be attained much more quickly for a little intelligent aid.

So, roadsides, that are considered "finished" when a roadbed is secured, may be refurnished: level filled lands may be made fresh green meadows, instead of being allowed to become wildernesses of weeds: slopes disfigured with stumpage may be reforested. It should be the privilege of the naturalist to enlist public spirited folk in the promotion of such betterments. It will help the good name of his community.

The greater the number of people who can be got to participate in this work, the better it will be established in public opinion: the more children helping, the better its results will be insured against future vandalism. About schools and colleges, things should be planted, not solely for ornament, as at present, but for their educational usefulness as well.

Making natural reserves servicable. Education began in "fresh air schools". Country folk have always been wont to meet in groves for public exercises. The fresh air and the open sky, the majesty of the trees, and the freshness of the unspoiled verdure have irresistibly drawn them out of doors. With the revival of interest in field work, we are going out doors in companies again and taking some of our work with us.

It is not so easy now, as once it was, to find a spot prepared by nature for a gathering place. The requisite conditions are that all who come together shall be able to see and to hear and to sit comfortably while listening or working. A grassy bank under a tree, when dry enough, may meet these conditions. For many years a few great trunks of fallen trees in the Renwick woods at Ithaca served as meeting places for classes in biological field work. But places better suited to the needs of classes may easily be arranged in the woods.

For more continuous use as an outdoor class room, "The Covert," at Ithaca was made. A natural hollow in the woods, over-arched and shaded by trees, was fitted with seats of flat field-stones, arranged in semi-circles. Aisles were left for passing and paths were made for entrance and exit. At the center a massive table, with a slate slab for a top, was built of hollow tile and plastered. A door was set in the back of its hollow base, and its interior is used for the storage of grass mats, between sessions. These mats are handed out for use by classes when the stones are damp and cold. "The Covert" is an excellent type of educational equipment that can be made in any woods. It is very substantial and permanent. It does not disfigure the woods (being hardly discernible from a distance of a few rods in any direction) and it is growing in beauty every year as its trees grow older, its paths become better turfed, and its surrounding plantings develop. It was made by a few weeks of labor on the part of two students, and it cost less than ten dollars for materials.

Gathering places for larger numbers may be made on the same general plan. The author once took a class in natural history out to a small grove, and set the members studying the trees and the slopes with a view to locating and arranging therein, with the least possible disturbance to the wild wood, an outdoor auditorium for public addresses, concerts and sylvan plays. The result is the simply arranged natural amphitheater shown in fig. 140: *A* is the floor plan; *B* is

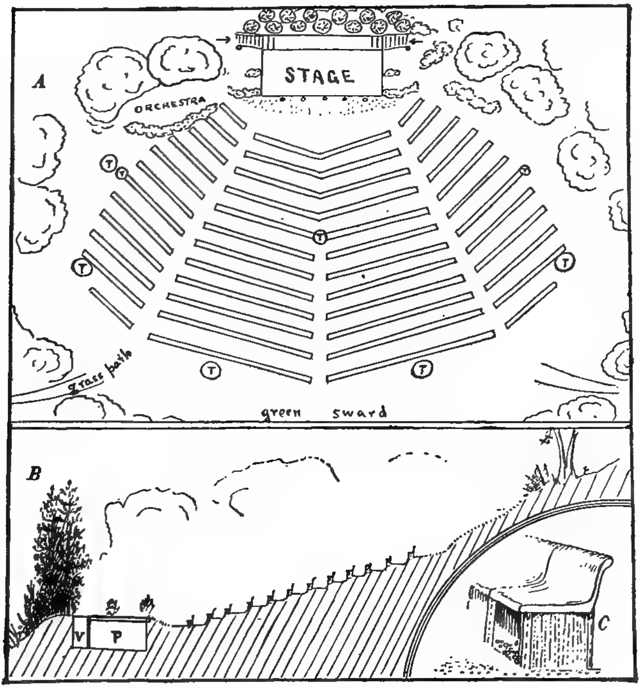


FIG. 140. Diagram of an outdoor auditorium.

a vertical section, showing a properties-room, *P* beneath the stage, and a vestibule, *V*, for entrance from the rear; and *C* is the end of a row of seats. In the floor plan *T*, *T*, *T*, etc., indicate the trunks of high-crowned trees, left standing to furnish shade. The artificialities of the plan are such only as are necessary: comfortable seats, conveniently arranged, and a good stage. These are made of cement on ribbed metal lath, plastered on both sides and colored green or gray or brown. The sylvan picture round about is carefully preserved. The aisles are grass paths. Under the seats are beds of violets. Greensward masks the stage and low evergreens define front and rear stage entrances. A bank of tall evergreens furnishes a background at the rear of the stage. All around are trees for shade. A rising turf covered bank at the rear of the seats provides for overflow on great occasions, the limit of capacity being set by a bank of evergreens fronted with thorny barberry. Vines added for grace, and flowering trees and shrubs for color are used to fill surrounding niches. Thick walls of verdure round about exclude outside distractions. Grass paths of ample width, well defined by border plantings, give easy access, and invite pedestrians to keep off the other vegetation.

No community will long gather in such places without coming to feel an interest in the wild things. By the possession and use of such outdoor places, the public may be educated in the appreciation of nature.

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