The Big Handbook of Nature Study

by Anna Botsford Comstock

Part Five

Trees and Plant Life

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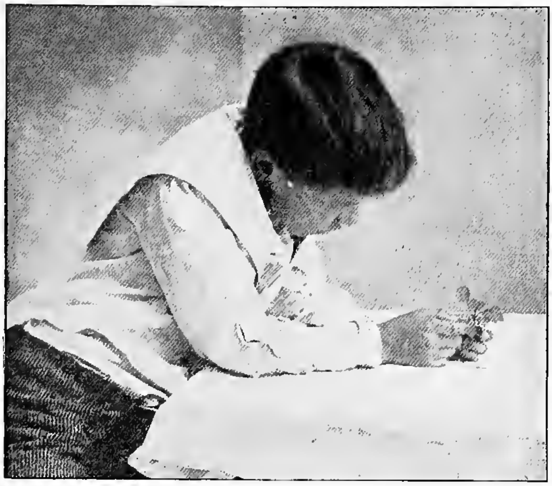


PART III

PLANT LIFE

HOW TO BEGIN THE STUDY OF PLANTS AND FLOWERS

THE only right way to begin plant study with young children is through awakening their interest in and love for flowers. Most children love flowers naturally; they enjoy bringing flowers to school, and here, by teaching the recognition of flowers by name, may be begun this delightful study. This should be done naturally and informally. The teacher may say: "Thank you, John, for this bouquet. Why, here is a pansy, a bachelor's button, a larkspur and a poppy." Or, "Julia has brought me a beautiful flower. What is its name, I wonder?" Then may follow a little discussion, which the teacher leads to the proper conclusion. If this course is consistently followed, the children will learn the names of the common flowers of wood, field and garden, and never realize that they are learning anything.

The next step is to inspire the child with a desire to care for and preserve his bouquet. The posies brought in the perspiring little hand may be wilted and look dejected; ask their owner to place the stems in water, and call attention to the way they lift their drooping heads. Parents and teachers should very early inculcate in children this respect for the rights of flowers which they gather; no matter how tired the child or how disinclined to further effort, when he returns from the woods or fields or garden with plucked flowers, he should be made to place their stems in water immediately. This is a lesson in duty as well as in plant study.

Attention to the behavior of the thirsty flowers may be gained by asking the following questions:

1. When a plant is wilted how does it look? How does its stem act? Do its leaves stand up? What happens to the flower?

2. Place the cut end of the stem in water and look at it occasionally during an hour; describe what happens to the stem, the leaves, the blossom.

3. To find how flowers drink, place the stem of a wilted plant in red ink; the next day cut the stem across and find how far the ink has been lifted into it.

HOW TO MAKE PLANTS COMFORTABLE

ANOTHER step in plant study comes naturally from planting the seeds in window-boxes or garden. This may be done in the kindergarten or in the primary grades. As soon as the children have had some experience in the growing of flowers, they should conduct some experiments which will teach them about the needs of plants. These experiments are fit for the work of the second or third grade. Uncle John says, "All plants want to grow; all they ask is that they shall be made comfortable." The following experiments should be made vital and full of interest, by impressing upon the children that through them they will learn to make their plants comfortable.

Experiment 1. To find out what kind of soil plants love best to grow in—Have the children of a class, or individuals representing a class, prepare four little pots or boxes, as follows: Fill one with rich, woods humus, or with potting earth from a florist's; another with poor, hard soil, which may be found near excavations; another with clean sand; another with sawdust. Plant the same kind of seeds in all four, and place them where they will get plenty of light. Water them as often as needful. Note which plants grow the best. This trial should cover six weeks at least and attention should now and then be called to the relative growth of the plants.

Experiment 2. To prove that plants need light in order to grow.—Fill two pots with the same rich soil; plant in these the same kind of seeds, and give them both the same amount of water; keep one in the window and place the other in a dark closet or under a box, and note what happens. Or take two potted geraniums which look equally thrifty; keep one in the light and the other in darkness. What happens?

Experiment 3. To show that the leaves love the light—Place a geranium in a window and let it remain in the same position for two weeks. Which way do all the leaves face? Turn it around, and note what the leaves have done after a few days.

Experiment 4. To show that plants need water—Fill three pots with rich earth, plant the same kinds of seeds in each, and place them all in the same window. Give one water as it needs it, keep another flooded with water, and give the other none at all. What happens to the seeds in the three pots?

The success of these four experiments depends upon the genius of the teacher. The interest in the result should be keen; every child should feel that every seed planted is a living germ and that it is struggling to grow; every look at the experiments should be like another chapter in a continued story. In the case of young children, I have gone so far as to name the seeds, "Robbie Radish" or "Polly Peppergrass." I did this to focus the attention of the child on the efforts of this living being to grow. After the experiments, the children told the story, personating each seed, thus: "I am Susie Sweet Pea and Johnny Smith planted me in sand. I started to grow, for I had some lunch with me which my mother put up for me to eat when I was hungry; but after the lunch was all gone, I could find very little food in the sand, although my little roots reached down and tried and tried to find something for me to eat. I finally grew pale and could not put out another leaf."

The explanations of these experiments should be simple, with no attempt to teach the details of plant physiology. The need of plants for rich, loose earth and for water is easily understood by the children; but the need for light is not so apparent, and Uncle John's story of the starch factory is the most simple and graphic way of making known to the children the processes of plant nourishment. This is how he tells it: "Plants are just like us; they have to have food to make them grow; where is the food and how do they find it? Every green leaf is a factory to make food for the plant; the green pulp in the leaf is the machinery; the leaves get the raw materials from the sap and from the air, and the machinery unites them and makes them into plant food. This is mostly starch, for this is the chief food of plants, although they require some other kinds of food also. The machinery is run by sunshine-power, so the leaf-factory can make nothing without the aid of light; the leaf-factories begin to work as soon as the sun rises, and only stop working when it sets. But the starch has to be changed to sugar before the baby, growing tips of the plant can use it for nourishment and growth; and so the leaves, after making the starch from the sap and the air, are obliged to digest it, changing the starch to sugar; for the growing parts of the plant feed upon sweet sap. Although the starch-factory in the leaves can work only during the daytime, the leaves can change the starch to sugar during the night. So far as we know, there is no starch in the whole world which is not made in the leaf-factories."

This story should be told and repeated often, until the children realize the work done by leaves for the plants and their need of light.

"*The clouds are at play in the azure space*
And their shadows at play on the bright green vale,
And here they stretch to the frolic chase;
And there they roll on the easy gale.

"*There's a dance of leaves in that aspen bower,*
There's a titter of winds in that beechen tree,
There's a smile on the fruit and a smile on the flower,
And a laugh from the brook that runs to the sea."

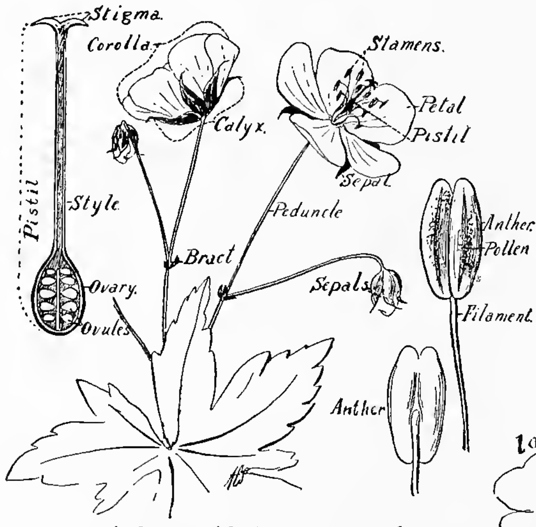
—Bryant.

HOW TO TEACH THE NAMES OF THE PARTS OF A FLOWER AND OF THE PLANT

THE scientific names given to the parts of plants have been the stumbling block to many teachers, and yet no part of plant study is more easily accomplished. First of all, the teacher should have in mind clearly the names of the parts which she wishes to teach; the illustrations here given are for her convenience. When talking with the pupils about flowers let her use these names naturally:

"See how many geraniums we have; the corolla of this one is red and of that one is pink. The red corolla has fourteen petals and the pink one only five," etc.

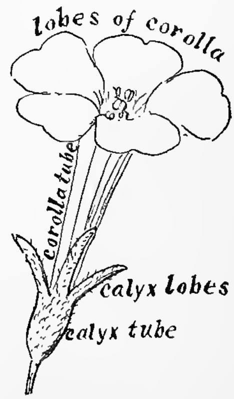
"This arbutus which James brought has a pretty little pink bell for a corolla."



A flower with the parts named.

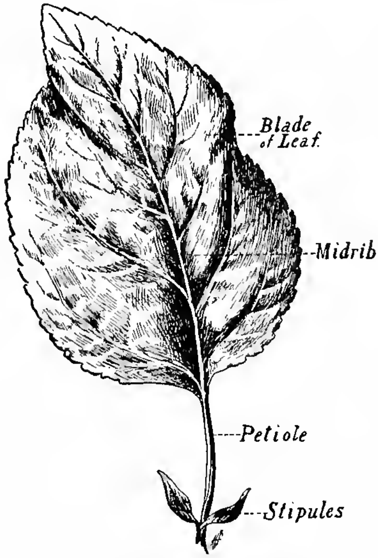
"The purple trillium has a purple corolla, the white trillium a white corolla; and both have green sepals."

The points to be borne in mind are that children like to call things by their names because they are *real* names, and they also like to use "grown up" names for things; but they do not like to commit to memory names which to them are meaningless. Circumlocution is a waste of breath; calling a petal a "leaf of a flower" or the petiole "the stem of a leaf," is like calling a boy's arm "the projecting part of James' body" or Molly's golden hair "the yellow



A flower with petals united forming a tube, and with sepals likewise united.

top" to her head. All the names should be taught gradually by constant unemphasized use on the part of the teacher; and if the child does not learn the names naturally then do not make him do it unnaturally.



A leaf with parts named.

The lesson on the garden, or horseshoe geranium with single flowers, is the one to be given first in teaching the structure of a flower since the geranium blossom is simple and easily understood.

TEACH THE USE OF THE FLOWER

FROM first to last the children should be taught that the object of the flower is to develop seed. They should look eagerly into the maturing flower for the growing fruit. Poetry is full of the sadness of the fading flower, while rightly it should be the gladness of the flower that fades, because its work is done for the precious seed at its heart. The whole attention of the child should be fixed upon the developing fruit instead of the fading and falling petals.

"In all places then and in all seasons,
Flowers expand their light and soul-like wings,
Teaching us by most persuasive reasons,
How akin they are to human things."

—LONGFELLOW.

FLOWERS AND INSECT PARTNERS

IT is undoubtedly true that while the processes of cross-pollenation and the complicated devices of flowers for insuring it can only be well taught to older pupils and only fully understood in the college laboratory, yet there are a few simple facts which even the young child may know, as follows:

1. Pollen is needed to make the seeds grow; some flowers need the pollen from other flowers of the same kind, to make their seeds grow; but many flowers also use the pollen from their own flowers to pollenate their ovules, which grow into seeds.

2. Flowers have neither legs like animals nor wings like butterflies, to go after pollen; so they give insects nectar to drink and pollen to eat, and thus pay them for fetching and carrying the pollen.

I taught this to a four-year-old once in the following manner: A pine tree in the yard was sifting its pollen over us and little Jack asked what the yellow dust was; we went to the tree and saw where it came from, then I found a tiny young cone and explained to him that this was a pine blossom, and that in order to become a cone with seeds, it must have some pollen fall upon it; and we saw how the wind sifted the pollen over it and then we examined a ripe cone and found the seeds. Then we looked at the clovers in the lawn. They did not have so much pollen and they were so low in the grass that the wind could not carry it for them; but right there was a bee. What was she doing? She was getting honey for her hive or pollen for her brood, and she went from one clover head to another; we caught her in a glass fruit jar, and found she was dusted with pollen and that she had pollen packed in the baskets on her hind legs; and we concluded that she carried plenty of pollen on her clothes for the clovers, and that the pollen in her baskets was for her own use. After that he was always watching the bees at work; and we found afterwards that flowers had two ways of telling the insects that they wanted pollen. One was by their color, for the dandelions and clovers hide their colors during dark, rainy days when the bees remain in their hives. Then we found the bees working on mignonette, whose blossoms were so small that Jack did not think they were blossoms at all, and we concluded that the mignonette called the bees by its fragrance. We found other flowers which called with both color and fragrance; and this insect-flower partnership remained a factor of great interest in the child's mind ever after.

"*Roly-poly honey-bee,*
Humming in the clover,
Under you the tossing leaves,
And the blue sky over,
Why are you so busy, pray?
Never still a minute,
Hovering now above a flower,
Now half buried in it!"

—JULIA C. R. DORR.

THE RELATION OF PLANTS TO GEOGRAPHY

THERE should be from first to last a steady growth in the intelligence of the child as to the places where certain plants grow. He finds hepaticas and trilliums in the woods, daisies and buttercups in the sunny fields, mullein on the dry hillsides, cat-tails in the swamp, and water lilies floating on the pond. This may all be taught by simply asking the pupils questions relating to the soil and the special conditions of the locality where they found the flowers they bring to school.

Egg-shell experiment farm.

The plants from left to right are: cabbage, field corn, popcorn, wheat, buckwheat.

SEED GERMINATION

Less than three decades ago, this one feature of plant life once came near "gobbling up" all of nature-study, and yet it is merely an incident in the growth of the plant. To sprout seeds is absurd as an object in itself; it is incidental as is the breaking of the egg-shell to the study of the chicken. The peeping into a seed like a bean or a pea, to see that the plant is really there, with its lunch put up by its mother packed all around it, is interesting to the child. To watch the little plant develop, to study its seed-leaves and what becomes of them, to know that they give the plant its first food and to know how a young plant looks and acts, are all items of legitimate interest in the study of the life of a plant; in fact the struggle of the little plant to get free from its seed-coats may be a truly dramatic story. (See "First Lessons with Plants," Bailey, page 79). But to regard this feature as the chief object of planting seed is manifestly absurd.

The object of planting any seed should be to rear a plant which shall fulfill its whole duty and produce other seed. The following observations regarding the germination of seeds should be made while the children are eagerly watching the coming of the plants in their gardens or window-boxes:

1. Which comes out of the seed first, the root or the leaf? Which way does the root always grow, up or down? Which way do the leaves always grow, no matter which side up the seed is planted?
2. How do the seed-leaves try to get out of the seed-coat, or shell? How do the seed-leaves differ in form from the leaves which come later? What becomes of the seed-leaves after the plant begins to grow?

References—First Lessons with Plants, L. H. Bailey; First Lessons in Plant Life, Atkinson; Plants and their Children, Dana; Plants, Coulter; How Plants Grow, Gray; How Plants Behave, Gray.

I. WILD-FLOWER STUDY

THE HEPATICA

Teacher's Story

"The wise men say the hepatica flower has no petals but has pink, white or purple sepals instead: and they say, too, that the three leaflets of the cup which holds the flower are not sepals but are bracts; and they offer as proof the fact that they do not grow close to the blossom, but are placed a little way down the stem. But the hepatica does not care what names the wise men give to the parts of its blossom: it says as plainly as if it could talk: 'The bees do not care whether they are sepals or petals since they are pretty in color, and show where the pollen is to be found. I will teach the world that bracts are just as good to wrap around flower-buds as are sepals, and that sepals may be just as beautiful as petals. Since my petticoat is pretty enough for a dress why should not I wear it thus?' "—"THE CHILD'S OWN BOOK OF WILD FLOWERS."

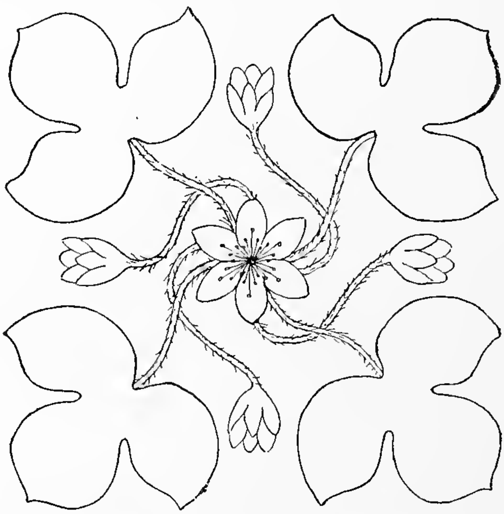
We seek the hepatica in its own haunts, because there is a longing for spring in our hearts that awakens with the first warm sunshine. As we thread our way into sodden woods, avoiding the streams and puddles which are little glacial rivers and lakes, having their sources in the snow-drifts still heaped on the north side of things, we look eagerly for signs of returning life. Our eyes slowly distinguish among the various shades of brown in the floor of the forest, a bit of pale-blue or pink-purple that at first seems like an optical delusion; but as we look again to make sure, Lo! it is the hepatica, lifting its delicate blossoms above its mass of purple-brown leaves. These leaves, moreover, are always beautiful in shape and color and suggest patterns for sculpture like the acanthus, or for rich tapestries like the palm-leaf in the Orient. It warms the heart to see these brave little flowers stand with their faces to the sun and their backs to the snow-drifts, looking out on a gray-brown world, nodding to it and calling it good.

The hepatica is forehanded in several ways. After the leaves have fallen from the trees in the autumn and let in the sunshine, it puts up new leaves which make food that is stored in the crown bud; the little flower buds are then started, and wrapped cozily, are cuddled down at the very

Hepaticas.

center of the plant. These buds, perfected in the autumn, are ready to stretch up and blossom when the first warmth of spring shall reach them. The stems and the bracts of the flower are soft and downy, and are much more furry than those which appear later; while this down is not for the purpose of keeping the plant at a higher temperature, yet it acts as a blanket to prevent too rapid transpiration, which is a cooling process, and thus it does, as a matter of fact, keep the flower warmer. As the stems lift up, the buds are bent, which position protects them from the beating storms. The hepatica flowers are white, pink and lavender. The latter are sometimes called "blue." The so-called "petals" number from six to twelve; there are usually six. The three outer ones are sepals and are exactly like the three inner ones, the petals, but may be distinguished by their outside position in the half-opened flower. The three green bracts which encase the flower bud, and later remain with the seed, are placed on the stem quite distinctly below the flower. On dark days and during the nights, the young blossoms close; but when they become old and faded, they remain open all the time. Thus, the flowers are closed except when bees are likely to visit them; but after they have shed their pollen, they do not need to remain closed any longer. Not all hepatica blossoms are fragrant; and those that are so, lose their fragrance as their colors begin to fade to white. If a snow-storm comes, the hepatica blossoms close and bow their heads.

There are many stamens with greenish white anthers and pollen. They stand erect around the many pistils at the center of the flower. The number of pistils varies from six to twenty-four. Each pistil holds aloft the little horseshoe-shaped, whitish stigma and, if pollenated, develops into a seed. The hepatica is a perennial and grows only in rich, moist woods. It is so adapted to the shade, that it dies if transplanted to sunny places. The leaves which have passed the winter under the snow are rich purple beneath, and mottled green and purple above, making beautiful objects for water-color drawings. The new leaves are put forth in spring before the leaves of the trees create too much shade. In the fall, after the trees are bare, the leaves again become active. The roots are quite numerous and fine.



Embroidery design from the hepatica.
The Child's Own Book of Wild Flowers, drawn by Evelyn Mitchell.

LESSON CXVII

The Hepatica

Leading thought—The hepatica flower buds are developed in the fall, so as to be ready to blossom early in the spring. This plant lives only in moist and shady woods.

Method—The pupils should have the questions before they go into the woods to gather spring flowers, and should answer them individually. However, the hepatica plant may be potted early in the spring, and the flowers may be watched during their development, and studied in the schoolroom.

Observations—1. Where do you find the hepaticas? Do you ever find them in the open fields? Do you ever find them in the pine woods?

2. How do the leaves look in early spring? Sketch in color one of these old leaves. How do the young leaves look? Are the leaves that come up late in the spring as fuzzy as those that appear early? What is the difference in texture and color between the leaves that were perfected in the fall and those that appear in the spring?

3. Find a hepatica plant before it begins to blossom. Look, if possible, at its very center. Describe these little flower buds. When were they formed?

4. How does the bud look when it begins to lift up? Describe the stems and the three little blankets that hold the bud. Ask your teacher how these fuzzy blankets keep the bud from being killed by cold.

5. Are the hepaticas in your woods all pink, or blue, or white? Do those which are at first pink or blue fade to white later? Do the blossoms keep open during the night and stormy weather? Why not? Are they all fragrant?

6. How many petals has your hepatica? Can you see that the outer ones are sepals, although they look just like the petals? Peel back the three sepal-like bracts and see that they are not a part of the flower at all but join the stem below the flower.

7. Describe the stamens in the hepatica. How many pistils are there? Does each pistil develop into a seed? How do the three bracts protect the seeds as they ripen?

8. What insects do you find visiting the hepaticas?

9. Describe a hepatica plant in the woods; mark it so that you will know it, and visit it occasionally during the summer and autumn, noting what happens to it.

THE YELLOW ADDER'S TONGUE

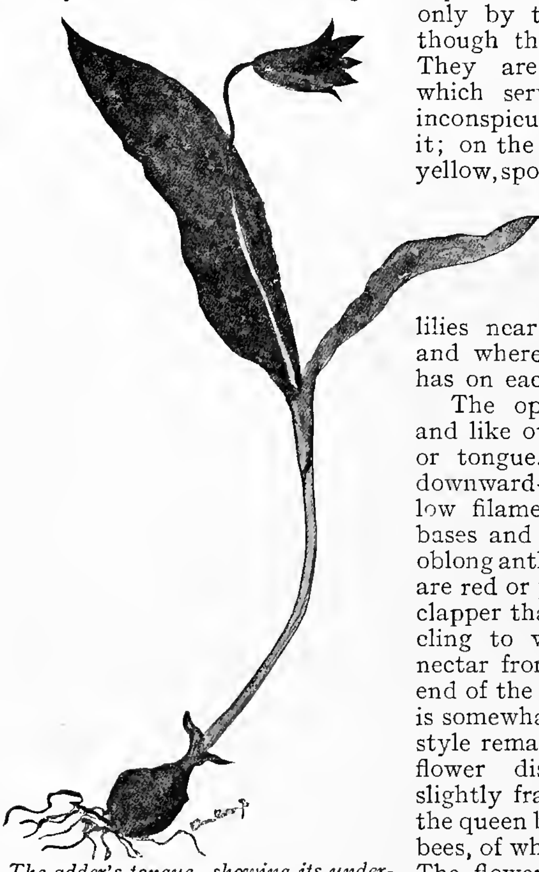
Teacher's Story

Adder's tongue.

"Once a prize was offered to a child if she would find two leaves of the adder's tongue that were marked exactly alike: and she sought long and faithfully, but the only prize she won was a lesson in Nature's book of variations, where no two leaves of any plant, shrub or tree are exactly alike: for even if they seemed so to our eyes, yet there would exist in them differences of strength and growth too subtle for us to detect. But this child was slow in learning this great fact, and, until she was a woman, the adder's tongue leaves, so beautifully embroidered with purple and green, were to her a miracle, revealing the infinite diversity of Nature's patterns."—"THE CHILD'S OWN BOOK OF WILD FLOWERS."

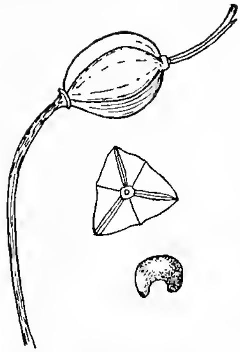
This little lily of the woods is a fascinating plant. Its leaves of pale green mottled with brownish purple often cover closely large irregular areas in the rich soil of our woodlands; and yet I doubt if the underground story of these forest rugs is often thought of. The leaves are twins, and to the one who plucks them carelessly they seem to come from one slender stem. It requires muscle as well as decision of character to follow this weak stem down several inches, by digging around it, until we find the corm at its base. A corm is the swollen base of a stem and is bulb-like in form; but it is not made up of layers, as is a bulb. It is a storehouse for food and also a means of spreading the species; for from the corms there grow little corms called cormels, and each cormel develops a separate plant. This underground method of reproduction is the secret of why the leaves of the adder's tongue appear in patches, closely crowded together.

Only a few of the plants in a "patch" produce flowers, and it is interesting to see how cleverly these lily bells hide from the casual eye. Like many of the lilies, the three sepals are petal-like and are identified as sepals only by their outside position, although they are thicker in texture. They are purplish brown outside, which serves to render the flower inconspicuous as we look down upon it; on the inner side, they are a pure yellow, spotted with darker yellow near where they join the stem. The three petals are pure yellow, paler outside than in, and they have dark spots like the tiger lilies near the heart of the flower; and where they join the stem, each has on each side an ear-shaped lobe.



The adder's tongue, showing its underground storehouse.
Drawn by F. Dana Gibson, a pupil in seventh grade.

The open flower is bell-shaped; and like other bells it has a clapper, or tongue. This is formed by six downward-hanging stamens, the yellow filaments of which have broad bases and taper to points where the oblong anthers join them. The anthers are red or yellow. It is this stamen clapper that the visiting insects must cling to when probing upward for nectar from this flower at the upper end of the bell. The pale green pistil is somewhat three-sided, and the long style remains attached long after the flower disappears. The flower is slightly fragrant, and it is visited by the queen bumblebees and the solitary bees, of which there are many species. The flower closes nights and during cloudy, stormy days. The seed capsule is plump and rather triangular,



Fruit capsule and seed.

and splits into three sections when ripe. The seeds are numerous and are fleshy and crescent-shaped.

But the adder's tongue, like many other early blooming flowers, is a child of the spring. The leaves, at first so prettily mottled, fade out to plain green; and by midsummer they have entirely disappeared, the place where they were, being covered with other foliage of far different pattern. But down in the rich woods soil are the plump globular corms filled with the food gathered by the spotted leaves during their brief stay, and next spring two pairs of spotted leaves may appear where there was but one pair this year.

The adder's tongue going to seed
Photo by Verne Morton.

LESSON CXVIII

Adder's Tongue, or Dog-tooth Violet

Leading thought—The adder's tongue is a lily, and its mottled leaves appear early in the spring, each pair coming from a corm deep in the soil below. It has two ways of spreading, one underground by means of new corms growing from the larger ones, and the other by means of seeds, many of which are probably perfected through the pollen carried by insects.

Method—This plant should be studied in the woods, notes being made on it there. But a plant showing corm, roots, leaves and blossom should be brought to the schoolhouse for detailed study, and then planted in a shady place in the school garden.

Observations—1. Where does the adder's tongue grow? Do you ever find it in open fields? How early do you find its leaves above ground? At what time does its blossoms appear?

2. How many leaves has each plant? What colors do you find in them? What is the color of their petioles? Do the leaves remain mottled later in the season?

3. Do the adder's tongue plants occur singly or in patches? Dig out a plant and see if you can find why the plants grow so many together?

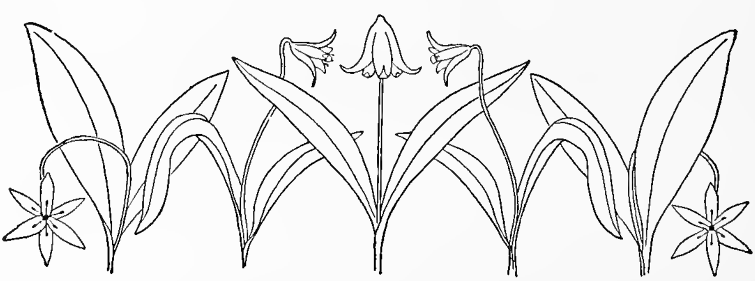
4. How far below the surface of the ground did you find the corm or bulb-like growth? Is this the root of the plant? How does it differ from the roots? How does it differ from a bulb? Of what use is it to the plant?

5. Is the flower lifted up, or is it drooping? What is its general shape? How many sepals? How would you know they were sepals? How do they differ in color, outside and in, from the petals? How are the petals marked? Can you see the lobes at the base of each petal? When sepals and petals are so much alike the botanists call them all together the perianth.

6. If the perianth, or the sepals and petals together, make a bell-shaped flower, what makes the clapper to the bell? How do the insects use this clapper when they visit the flower? Do the flowers stay open nights and dark days? Why?

7. How many stamens are there? Describe or sketch one, noting its peculiar shape. Are the stamens all the same length? Can you see the pistil and its stigma? Where is it situated in relation to the stamens? Do you think the stigma is ready for pollen at the time the anthers are shedding it?

8. After the petals and sepals fall what remains? How does the ripe seed-capsule look? How does it open to let out the seeds? Are there many seeds in a capsule? What is their shape?



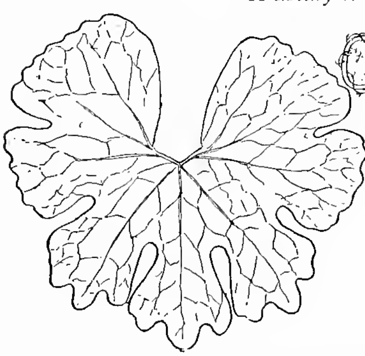
Design for embroidery from adder's tongue.
Drawn by Evelyn Mitchell for Child's Own Book of Wild Flowers.

"Bloodroots, whose rolled-up leaves ef you oncurl
Each on em's cradle to a baby pearl."—LOWELL.
Photo by O. L. Foster.

BLOODROOT

Teacher's Story

"What time the earliest ferns unfold,
And meadow cowslips count their gold;
A countless multitude they stood,
A Milky Way within the wood." —DANSKE DANDRIDGE.



ONLY a few generations ago, and this land of ours was peopled by those who found it fitting to paint their bodies to represent their mental or spiritual conditions or intentions. For this purpose they had studied the plants of our forests to learn the secrets of the dyes which they yielded, and a dye that would remain on the flesh permanently, or until it wore off, was highly prized. Such a dye was found in the bloodroot, a dye appropriate in its color to represent a thirst for blood; and with it they made their war paint, and with it they ornamented their tomahawks to symbolize their sanguinary purpose.

The Indian warriors have passed away from our forests, and the forests themselves are passing away, but the bloodroot still lingers, growing abundantly in rich moist woods or in shaded areas in glades, borders of meadows and fence corners. Its beautiful white flowers open to the morning sun in early April, calling the hungry bees to come for pollen; for, like many other early flowers, it offers no nectar. Probably many of the little wild bees prefer pollen to nectar at this time of year, for it is an important element in the food of all kinds of bee brood. But the bloodroot's fragile blossoms are elusive and do not remain long; like their relatives, the poppies, their petals soon fall, and their white masses disappear like the snow-drifts which so recently occupied the same nooks.

The way the bloodroot leaf enfolds the flower-bud seems like such an obvious plan for protection, that we are unthinkingly prone to attribute consciousness to the little plants.

Not only does the leaf enfold the bud, but it continues to enfold the flower stem after the blossom opens. There are two sepals which enclose the bud, but fall off as the flower opens. There are ordinarily eight white petals, although there may be twelve; usually every other one of the eight petals is longer than its neighbors, and this makes the blossom rather square than circular in outline. There are many stamens, often 24, and the anthers are brilliant yellow with whitish filaments. The two-lobed stigma opens to receive pollen before the pollen of its own flower is ripe. The stigma is large, yellow, and set directly on the ovary, and is quite noticeable in the freshly opened blossoms. It is likely to shrivel before its home-grown pollen is ripe. The blossoms open wide on sunny mornings; the petals rise up in the afternoon and close at night, and also remain closed during dark, stormy days until they are quite old, when they remain carelessly open; they are now ready to fall to the ground at the slightest jar, leaving the oblong, green seed-pod set on the stem at a neat bevel, and perhaps still crowned with the yellowish stigma. The seed-pod is oblong and pointed and remains below the protecting leaf. There are many yellowish or brownish seeds.

When the plant appears above ground, the leaf is wrapped in a cylinder about the bud, and it is a very pretty leaf, especially the "wrong side," which forms the outside of the roll; it is pale green with a network of pinkish veins, and its edges are attractively lobed; the petiole is fleshy, stout and reddish amber in color. The flower stem is likewise fleshy and is tinged with raw sienna; the stems of both leaf and flower stand side by side, and are held together at the base by two scapes with parallel veins. Later in the season, the leaf having done its full duty as a nurse waxes opulent, often measuring six inches across and having a petiole ten inches long. It is then one of the most beautiful leaves in the forest carpet, its circular form and deeply lobed edges rendering it a fit subject for decorative design.

The rootstock is large and fleshy, and in it is stored the food which enables the flower to blossom early, before any food has been made by the new leaves. There are many stout and rather short roots that fringe the rootstock. Once in clearing a path through a woodland, we happened to hack off a mass of these rootstocks, and we stood aghast at the gory results. We had admired the bloodroot flowers in this place in the spring, and we felt as guilty as if we had inadvertently hacked into a friend.

LESSON CXIX

Bloodroot

Leading thought—The bloodroot has a fleshy rootstock, in which is stored food for the nourishment of the blossom in early spring. The flower bud is at first protected by the folded leaf. The juice of the rootstock is a vivid light crimson, and was used by Indians as a war paint.

The juice is acrid, and the bloodroot is not relished as food by grazing animals, but it is used by us as a medicine.

Method—The bloodroot may, in the fall, be transplanted in a pot of woods earth, care being taken not to disturb its roots. It should be placed out of doors in a protected place where it may have natural conditions, and be brought to the schoolroom for study in March, so that the whole act of the unfolding of leaves and flowers may be observed by the pupils. Otherwise the questions must be given the pupils to answer as they find the plants blossoming in the woods in April. The blossoms are too fragile to be successfully transported for study at home or school.

Observations—1. At what time of year does bloodroot blossom? In what situations does it thrive?

2. What do we see first when the bloodroot puts its head above the soil? Where is the flower bud? How is it protected by the leaf? How does the leaf hold the flower stem after the flower is in blossom?

3. Study the flower. How many sepals has it? What is their color? What is the position of the sepals when the flower is in bud? What is their position when the flower opens? How many petals? What is their color and texture? Describe the position of the petals in the bud and in the open flower. Look straight into the flower; is its shape circular or square?

4. Do the flowers close nights and during dark days? Do the flowers longest open do this? Describe how the petals and sepals fall.

5. Describe the stamens. What is the color of the anthers? Of the pollen? Describe the pistil. Does the two-grooved stigma open before

Bloodroot.
Photographed by Verne Morton.

the pollen is shed, or after? What insects do you find visiting the bloodroot?

6. Sketch or describe a bloodroot leaf as it is wrapped around the stem of the flower. How are both flower stem and leaf petiole protected at the base? Describe or sketch a leaf after it is unfolded and open. Describe the difference between the upper and lower surfaces of the leaf. What sort of petiole has it? Break the petiole; what sort of juice comes from it? Describe and measure the leaf later in the season; do they all have the same number of lobes?

7. Break a bit off the root of the plant and note the color of the juice.

8. Compare the bloodroot with the poppies; do you find any resemblance in habits?

The white trillium. A white butterfly visiting the flower at the left.
Photo by Verne Morton.

THE TRILLIUM

Teacher's Story

It would be well for the designer of tapestries to study the carpets of our forests for his patterns, for he would find there a new carpet every month, quite different in plan and design from the one spread there earlier or later. One of the most beautiful designs from Nature's looms is a trillium carpet, which is at its best when the white trilliums are in blossom. It is a fine study of the artistic possibilities of the triangle when reduced to terms of leaves, petals and sepals.

The trillium season is a long one; it begins in April with the purple wake-robin or birthroot, the species with purple, red, or sometimes yellowish flowers. The season ends in June with the last of the great white trilliums, which flush pink instead of fading, when old age comes upon them.

The color of the trillium flower depends upon the species studied; there are three petals, and the white and painted trilliums have the edges of the petals ruffled; the red and nodding trilliums have petals and sepals nearly the same size, but in the white trillium the sepals are narrower and shorter than the petals. The sepals are alternate the petals, so that when we look straight into the flower we see it as a six-pointed star, three of the points being green sepals. The pistil of the trillium is six-lobed. It is dark red in the purple trillium and very large; in the white species, it is pale green and smaller; it opens at the top with three flaring stigmas. There are six stamens with long anthers, and they stand between the lobes of the pistil. The flower stalk rises from the center where three large leaves join. The flower stalk has a tendency to bend a little, and is rather delicate. The three leaves have an interesting venation, and make a good subject for careful drawing. The flower stem varies with different species, and so does the length of the stem of the plant, the latter being fleshy and green toward the top and reddish toward the root. The trilliums have a thick, fleshy, and much scarred rootstock from which extend rootlets which are often corrugated. The trilliums are perennial, and grow mostly in damp, rich woods. The painted trillium is found in cold, damp woods along the banks of brooks; the white trillium is likely to be found in large numbers in the same locality, while the purple trillium is found only here and there. Flies and beetles carry the pollen for the red trillium, being attracted to it by its rank odor, which is very disagreeable to us but very agreeable to them. The large white trillium is visited by bees and butterflies. The fruit of the trillium is a berry, that of the purple species is somewhat six-lobed and reddish. In late July the fruit of the white trillium is a cone with six sharp wings, or ridges, from apex to base, the latter being three-quarters of an inch across. These vertical ridges are not evenly spaced, and beneath them are packed as closely as possible the yellow-green seeds, which are as large as homeopathic pills. In cross section, it can be seen that the trillium berry is star-shaped with three compartments, the seeds growing on the partitions. This trillium fruit is very rough outside, but smooth inside, and the dried stamens often still cling to it.


The stemless trillium

The trilliums are so called from the word *triplum*, meaning three, as there are three leaves, three petals, and three sepals.

LESSON CXX

The Trillium

Leading thought—The trilliums are lilies, and are often called wood lilies, because of their favorite haunts. There are several species, but

The purple trillium.
Photo by Verne Morton.

they are all alike in that they have three sepals, three petals and three leaves.

Method—This lesson may be given from trilliums brought to the schoolroom by the pupils, who should be encouraged to watch the development of the berry and also to learn all the different species common to a locality.

Observations—1. How many leaves has the trillium? How are they arranged? Draw a leaf showing its shape and veins. Describe the stem of the plant below the leaves, giving the length and color.

2. How far above the leaves does the flower stem or pedicel extend? Does the flower stand upright or droop? Describe or sketch the colors, shape and arrangement of the petals and sepals. Do the petals have ruffled margins?

3. Describe the pistil and the stigmas. Describe the stamens and how they are placed in relation to the pistil.

4. Do the flowers remain open during cloudy days and nights?

5. What insects do you find visiting the trilliums? Do the same insects visit the purple and the white trilliums? What is the difference in odor between the purple and the white trillium? Would this bring different kinds of insects to each?

6. How does the color of the white trillium change as the blossom matures? What is the color and shape of the fruit of each different species of trillium? When is the fruit ripe?

7. What kind of a root have the wake-robins? Do they grow from seed each year, or are they perennial? Where do you find them growing?

Dutchman's breeches, or "boys and girls."
Photo by O. L. Foster.

DUTCHMAN'S BREECHES AND SQUIRREL CORN

Teacher's Story

"In a gymnasium where things grow,
Jolly boys and girls in a row,
Hanging down from cross-bar stem
Builded purposely for them.
Stout little legs up in the air,
Kick at the breeze as it passes there;
Dizzy heads in collars wide
Look at the world from the underside;
Happy acrobats a-swing,
At the woodside show in early spring."
A. B. C.

"And toward the sun, which kindlier burns,
The earth awaking, looks and yearns,
And still, as in all other Aprils,
The annual miracle returns."
ELIZABETH AKERS.

There are many beautiful carpets spread before the feet of advancing spring, but perhaps none of them are so delicate in pattern as those woven by these two plants that spread their fernlike leaves in April and May. There is little difference in the foliage of the two; both are delicate green and lacelike above, and pale, bluish green on the underside. And each leaf, although so finely divided, is, after all, quite simple; for it has three chief divisions, and these in turn are divided into three, and all the leaves come directly from the root and not from stems. These plants love the woodlands, and by spreading their green leaves early, before the trees are in foliage, they have the advantage of the spring sunshine. Thus they make their food for maturing their seeds, and also store some of it in their roots for use early the following spring. By midsummer the leaves have entirely disappeared, and another carpet is spread in the place which they once covered.

The underground store-house of Dutchman's breeches.

Dutchman's breeches and squirrel corn resemble each other so closely that they are often confused; however, they are quite different in form; the "legs" of the Dutchman's breeches are quite long and spread wide apart, while the blossoms of the squirrel corn are rounded bags instead of "legs." The roots of the two are quite different. The Dutchman's breeches grows from a little bulb made up of grayish scales, while the squirrel corn develops from a round, yellow tuber; these yellow, kernel-like tubers are scattered along the roots, each capable of developing a plant next year. The Dutchman's breeches likes thin woodlands and rocky hillsides, but the squirrel corn prefers rich, moist woods. The blossom of the Dutchman's breeches comes the earlier of the two. These flowers are white with yellow tips, and are not fragrant. The flowers of the squirrel corn are grayish with a tinge of magenta, and are fragrant.

The legs of the Dutchman's breeches are nectar pockets with tubes leading to them, and are formed by two petals. Opposite these two petals are two others more or less spoon-shaped, with the spoon bowls united to protect the anthers and stigma. There are two little sepals which are scalelike.

The seed capsule of the Dutchman's breeches is a long pod with a slender, pointed end, and it opens lengthwise. The seed capsules of the squirrel corn are similar and I have found in one capsule, 12 seeds, which were shaped like little kernels of corn, black in color and polished like patent leather.

Seed capsule of squirrel corn.

LESSON CXXI

Dutchman's Breeches and Squirrel Corn

Leading thought—The Dutchman's breeches, or "boys and girls," as it is often called, is one of the earliest flowers of rich woodlands. There are interesting differences between this flower and its close relative, squirrel corn. The flowers of both of these resemble in structure the flowers of the bleeding heart.

Method—As the Dutchman's breeches blossoms in April and May and the squirrel corn in May and June, we naturally study the former first and compare the latter with it in form and in habits. The questions

Squirrel corn.

should be given the pupils, for them to answer for themselves during their spring walks in the woodlands.

Observations—1. Where do you find Dutchman's breeches? Which do you prefer to call these flowers, Dutchman's breeches or boys and girls? Are there leaves on the trees when these flowers are in bloom?

2. Which blossoms earlier in the season, Dutchman's breeches or squirrel corn? How do the flowers of the two differ in shape? In odor?

3. In the flower of the Dutchman's breeches find two petals which protect the nectar. How do they look? What part do they form of the breeches? Find two other petals which protect the pollen and stigma.

4. Find the two sepals. How many bracts do you find on the flower stem?

5. What insects visit these flowers? Describe how they get the nectar.

6. What sort of root has the Dutchman's breeches? What is the difference between its root and that of the squirrel corn? Have you ever seen squirrels harvesting squirrel corn? What is the purpose of the kernels of the squirrel corn?

7. Study the leaf. How many main parts are there to it? How are these parts divided? Does the leaf come straight from the root or from a stem? What is the color of the leaf above? Below? Can you distinguish the leaves of the Dutchman's breeches from those of the squirrel corn?

8. Describe the seed capsule of Dutchman's breeches. How does it open? How many seeds has it? Compare this with the fruit of squirrel corn and describe the difference.

9. What happens to the leaves of these two plants late in summer. How do the plants manage to get enough sunlight to make food to mature their seed? What preparations have they made for early blossoming the next spring?

JACK-IN-THE-PULPIT

Teacher's Story

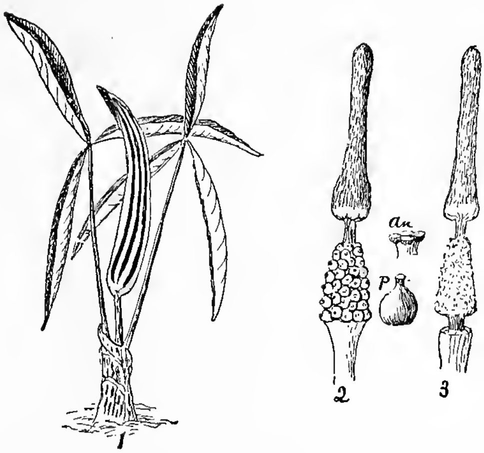
"With hooded heads and shields of green,
Monks of the wooded glen,
I know you well; you are, I ween,
Robin Hood's merry men."

—"CHILD'S OWN BOOK OF FLOWERS."

THIS little preacher is a prime favorite with all children, its very shape, like that of the pitcher plant, suggesting mystery; and what child could fail to lift the striped hood to discover what might be hidden beneath! And the interest is enhanced when it is discovered that the hood is but a protection for the true flowers, standing upon a club-shaped stem, which has been made through imagination into "Jack," the little preacher.

Jack-in-the-pulpit prefers wet locations but is sometimes found on dry, wooded hillsides; the greater abundance of blossoms occurs in late May. This plant has another name, which it earned by being interesting below ground as well as above. It has a solid, flattened, food-storehouse called a corm with a fringe of coarse rootlets encircling its upper portion. This corm was used as a food by the Indians, which fact gave the plant the name of Indian turnip. I think all children test the corm as a food for curiosity, and retire from the field with a new respect for the stoicism of the Indian when enduring torture; but this is an undeserved tribute. When raw, these corms are peppery because they are filled with minute, needle-like spicules which, however, soften with boiling, and the Indians boiled them before eating them.

Jack-in-the-pulpit is a near cousin to the calla lily; the white part of the calla and the striped hood over "Jack" are both spathes, and a spathe is a leaf modified for the protection of a flower or flowers. "Jack" has but one leg and his flowers are set around it, all safely enfolded in the lower part of the spathe. The pistillate flowers which make the berries are round and greenish, and are packed like berries on the stalk; they have purple stigmas with whitish centers. The pollen-bearing flowers are mere little projections, almost white in color, each usually bearing four purplish, cup-like anthers filled with white pollen. Occasionally both kinds of flowers may be found on one spadix, (as "Jack" is called in the botanies), the pollen-bearing flowers being set below the others; but usually they are on separate plants. Professor Atkinson has demon-



1. Jack-in-the-pulpit unfolding; 2. Spadix with pistillate flowers; P, pistillate flower enlarged; 3. Spadix with staminate flowers; an, a staminate flower enlarged, showing the four anthers.

strated that when a plant becomes very strong and thrifty, its spadix will be set with the pistillate flowers and its berries will be many; but if the same plant becomes weak, it produces the pollen-bearing flowers the next year.

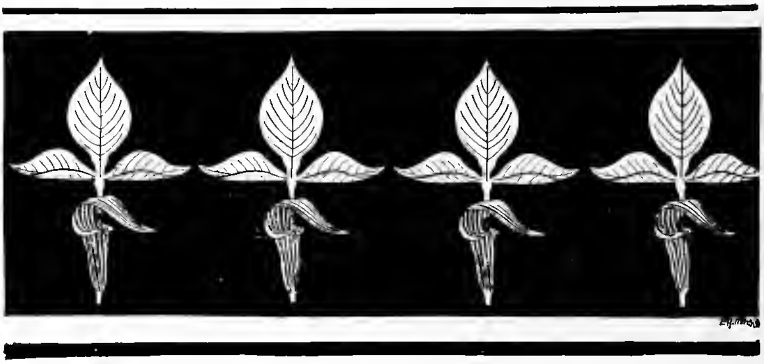
When "Jack" first appears in the spring it looks like a mottled, pointed peg, for it is well sheathed. Within this sheath the leaves are rolled lengthwise to a point, and at the very center of the rolled leaves is a spathe, also rolled lengthwise, and holding at its heart the developing flower-buds. It is a most interesting process to watch the unfolding of one of these plants. On the older plants there are two, or sometimes three leaves, each with three large leaflets; on the younger plants there may be but one of these compound leaves, but the leaflets are so large that they seem like three entire leaves.

The spathes, or pulpits, vary in color, some being maroon and white or greenish, and some greenish and white. They are very pretty objects for water-color drawings.

Small flies and some beetles seem to be the pollen carriers for this plant. Various ingenious theories have been suggested to prove that our Jack-in-the-pulpit acts as a trap to imprison visiting insects, as does the English species; but I have studied the flowers in every stage, and have seen the insects crawl out of the hoods as easily as they crawled in, and by the same open, though somewhat narrow, passage between the spadix and the spathe.

The berries of Jack-in-the-pulpit.

After a time the spathe falls away showing the globular, green, shining berries. In August even the leaves may wither away, at which time the berries are brilliant scarlet. Jack-in-the-pulpit is a perennial. It does not blossom the first year after it is a seedling. I have known at least one case where blossoms were not produced until the third year. Below ground, the main corm gives off smaller corms and thus the plant spreads by this means as well as by seeds.



Border design by Evelyn Mitchell.
From the Child's Own Book of Wild Flowers.

LESSON CXXII

Jack-in-the-pulpit

Leading thought—The real flowers of Jack-in-the-pulpit are hidden by the striped spathe which is usually spoken of as the flower. This plant has a peppery root which the Indians used for food.

Method—The questions should be answered from observation in the woods; a single plant may be dug up and brought to school for study, and later planted in some shady spot in the school garden.

Observations—1. Where do you find Jack-in-the-pulpit? Is the soil dry or damp? Do you ever find it in the fields?

2. How early in the season does this plant blossom? How late?

3. How does the Jack-in-the-pulpit look when it first pushes out from the ground? How are its leaves rolled in its spring overcoat?

4. How does the pulpit, or spathe, look when the plant first unfolds? Is its tip bent over or is it straight?

5. Describe or sketch the leaves of Jack-in-the-pulpit. How do they rise above and protect the flower? How many leaflets has each leaf? Sketch the leaflets to show the venation. How do these stand above the flower? Can you find any of the plants with only one leaf?

6. Why is the spathe called a pulpit? What are the colors of the spathe? Are all the spathes of the same colors?

7. Open up the spathe and see the rows of blossoms around the base of the spadix, or if you call the spadix, "Jack," then the flowers clothe his one leg. Are all the blossoms alike? Describe, if you can, those flowers which will produce the seed and those which produce the pollen. Do you find the two on the same spadix or on different plants?

8. What insects do you find carrying the pollen for "Jack?" Do you know how its seeds look in June? How do they look in August? Do the leaves last as long as the seeds?

9. What sort of a root has "Jack?" How does it taste? Do you think the Indians boiled it before they ate it? What other name has "Jack?" How does the plant multiply below the ground?

10. Compare the Jack-in-the-pulpit with the calla lily.

11. Write an English theme on "The Sermon that Jack Preached from His Pulpit."

The Long-spurred violet. Color of flowers, pale lavender.
Photo by Verne Morton.

THE VIOLET

Teacher's Story

It is interesting to note the flowers which have impinged upon the imagination of the poets; the violet more than most flowers has been loved by them, and they have sung in varied strains of its fragrance and lowliness.

Browning says:

"Such a starved bank of moss,
'Till that May morn,
Blue ran the flash across;
Violets were born."

And Wordsworth sings:

"A violet by a mossy stone,
Half hidden from the eye;
Fair as a star, when only one
Is shining in the sky."

And Barry Cornwall declares that the violet

"Stands first with most, but always with the lover."

But Shakespeare's tribute is the most glowing of all, since the charms of both the goddesses of beauty and of love are made to pay tribute to it:

"Violets dim, but sweeter than the lids of Juno's eyes, or Cytherea's breath."

However, the violets go on living their own lives, in their own way, quite unmindful of the poets. There are many different species, and they frequent quite different locations. Some live in the woods, others in meadows and others in damp, marshy ground. They are divided into two distinct groups—those where the leaf-stems come directly from the root, and those where the leaves come from a common stem, the latter being called the leafy-stemmed violets. Much attention should be given to sketching and studying the leaf accurately of the specimens under observation, for the differences in the shapes of the leaves, in many instances, determine the species; in some cases the size and shape of the stipules determines the species; and whether the leaves and stems are downy or smooth is another important characteristic. In the case of those species where the leaves spring from the root, the flower stems rise from the same situation; but in the leafy-stemmed violets the flower stems come off at the axils of the leaves. In some species the flower stems are long enough to lift the flowers far above the foliage, while in others they are so short that the flowers are hidden.

Common blue violet, showing two of the little flowers which never open, lying between the bare rootstocks. Note the three-valved seed capsules.
Photo by Verne Morton.

The violet has five sepals and their shape and length is a distinguishing mark. There are five petals, one pair above, a pair one at each side, and a broad lower petal which gives the bees and butterflies a resting place when they are seeking nectar. This lower petal is prolonged backward into a spur which holds the nectar.

The spur forms the nectary of the violet, and in order to reach the sweet treasure, which is at the rearmost point of the nectary, the insect must thrust its tongue through a little door guarded by both anthers and pistil; the insect thus becomes laden with pollen, and carries it from flower to flower. In many of the species, the side petals have at their bases a little fringe which forms an arch over the door or throat leading to the nectary. While this is considered a guard to keep out undesirable insects like ants, I am convinced that it is also useful in brushing the pollen from the tongues of the insect visitors.

Some species of violets are very fragrant, while others have little odor. The color of the anthers also differs with different species. The children should be interested in watching the development of the seeds from the flower. The seed-pods are three-lobed, each one of these lobes dividing lengthwise, with a double row of seeds within. Each lobe curls back and thus scatters the seed.

At the base of most of the species of violets can be found the small flowers which never open; they have no petals, but within them the pollen and the pistil are fully developed. The flowers seem to be developed purposely for self-pollenation, and in the botanies they are called cleistogamous flowers; in some species they are on upright stems, in others they lie flat. There is much difference in the shape of the rootstock in the different species of violet; some are delicate and others are strong, and some are creeping.

The Canada white violet, a leafy-stemmed species.

Photo by Verne Morton.

LESSON CXXIII

The Violet

Leading thought—Each violet flower has a well of nectar, with lines pointing to it so that the insects may find it. They also have down near their roots, flowers which never open, which are self-pollenated and develop seeds.

Method—To make this work of the greatest use and interest, each pupil should make a portfolio of the violets of the locality. This may be in the form of pressed and mounted specimens, or of water-color drawings. In either case, the leaf, leaf-stem, flower, flower stem, and rootstock should be shown, and each blossom should be neatly labelled with name, locality and date. From the nature-study standpoint, a portfolio of drawings is the more desirable, since from making the drawings the pupils become more observant of the differences in structure and color which distinguish the species. Such a portfolio may be a most beautiful object; the cover of thick cardboard may have an original, conventionalized design made from the flowers and leaves of the violets. Each drawing may be followed by a page containing notes by the pupil and some appropriate quotation from botany, poetry or other literature.

Observations—1. Describe the locality and general nature of the soil where the violet was found. That is, was it in the woods, dry fields or near a stream?

2. Sketch or describe the shape of the leaf, paying particular attention to its margin and noting whether it is rolled toward the stem at its base. Is the petiole longer or shorter than the leaf? Does the leaf stem spring directly from the root, or does it branch from another? If the latter, are the leaves opposite or alternate? Is there a stipule where the leaf joins the main stem? If so, is it toothed on the edge?

3. What is the color of the leaf above? Are the leaves and stems downy and velvety, or smooth and glossy?

4. Does the flower stem come from the root of the plant, or does it grow from the main stem at the axil of the leaf? Are the flower stems long enough to lift the flowers above the foliage of the plant?

5. How many sepals has the violet? Are they long or short; pointed or rounded? How many petals has the violet? How are they arranged? Is the lower petal shaped like the others? What is the use of this broad lower petal? Are there any marks upon it? If you should follow one of these lines, where would it lead to?

6. Look at the spur at the back of the flower. Of which petal is it a part? How long is it, compared with the whole flower? What is the use of this spur?

7. Find the door that leads to the nectar-spur and note what the tongue of the bee or butterfly would brush against when reaching for the nectar. Are the side petals which form the arch over the door that leads to the nectar fringed at their bases? If so, what is the use of this fringe?

8. What colors are the petals? Are they the same on both sides? How are they marked and veined? Are the flowers fragrant?

9. What color are the anthers? What color is the stigma? Examine a fading violet, and describe how the seed is developed from the flower.

10. Find the seed-pods of the violet. How are the seeds arranged within them? How do the pods open? How are the seeds scattered?

11. Look at the base of the violet and find the little flowers there which never open. Examine one of these flowers and find if it has sepals, petals, anthers and pistil. Are these closed flowers on upright stems or do the stems lie flat on the earth? Of what use to the plant are these little closed flowers?

12. What sort of rootstock has the violet? Is it short and thick or slender? Is it erect, oblique or creeping?

THE MAY APPLE, OR MANDRAKE

Teacher's Story

THIS is a study of parasols and, therefore, of perennial interest to the little girls who use the small ones for their dolls, and with many airs and graces hold the large ones above their own heads. And when this diversion palls, they make mandarin dolls of these fascinating plants. This is easily done by taking one of the small plant umbrellas and tying with a grass-sash all but two of the lobes closely around the stem, thus making a dress, the lobes left out being cut in proper shape for flowing sleeves; then for a head some other flower is robbed of its flower bud, which is put into place and surmounted with a clover leaflet hat, and a pin is then thrust through hat, head and neck into the stem of the dressed plant; the whole is properly finished by placing a small umbrella above the little green mandarin.

The mandrakes grow in open places where there is sun, and yet not too much of it; they like plenty of moisture, and grow luxuriantly in open glades or in meadows or pastures bordering woodlands, and they especially rejoice in the fence-corners, along roadsides. The first lesson of all should be how nature folds her little umbrellas. Study the plants when they first put their heads above ground, each parasol wrapped in its case, and note how similarly to a real umbrella it is folded around its stem. Later, after the umbrellas are fairly spread, they afford a most interesting study in varieties of form and size. Some of the parasols have only four lobes while others have many more. I have found them with as many as nine, although the botanies declare seven to be the normal number. One of the special joys afforded by nature-study is finding things different from the descriptions of them in the books.

One of these little parasols is a worthy object for careful observation. Its stem is stout and solid, and at its base may be seen the umbrella-case, now discarded like other umbrella-cases; the stem is pink wherever the sun touches it, but close up under the leaves it is likely to be green; it ends at the middle of the parasol by sending out strong, pale green, fuzzy ribs into each lobe. The lobes are narrow toward the stem but broad at the outer edge, each lobe being sparsely toothed on its outer margins and with a deep, smooth notch at the center. From the ribs of each lobe extend other ribs, an arrangement quite different from that we find in cloth umbrellas. The lobes of the mandrake parasol are divided almost to the center, and it is therefore evident that it is much better fitted for protection from the sun than from the rain. The parasol is a beautiful shining green on the upper side, and has a pale green lining that feels somewhat woolly.

In examining any patch of May apples, we find that many of the parasols are double; the secret of this is, that the mandrake baby needs

The blossom of the May apple.

two parasols to shield it from the sun; one of these twin parasols is always larger than the other and evidently belongs to the main stem, since its stem is stouter, and it is likely to have seven lobes while the smaller one may have but five. However, the number of lobes varies. Neither of these double parasols has its ribs extending out toward the other, and thus interfering; instead of having their "sticks" at the center of the parasol, they are at the side next each other, exactly as if the original single stem had been split and the whole parasol had been torn in twain.

But of greatest interest is the blossom-baby carried under this double parasol. At first it is a little, elongate, green ball on a rather stiff little stem, which droops because it wants to and not because it has to, and which arises just where the two branches fork. One of the strange things about this precocious baby-bud is, that when the plant is just coming from the ground, the bud pushes its head out from between the two folded parasols, and takes a look at the world before it retires under its green sunshade. As the bud unfolds, it looks as if it had three green sepals, each keeping its cup form and soon falling off, as a little girl drops her hood on a warm day; but each of these sepals, if examined, will be found to be two instead of one; the outer is the outside of the green hood while the inner is a soft, whitish membrane,

"A rabbit skin,
To wrap the Baby Bunting in."

As the greenish white petals spread out, they disclose a triangular mass of yellow stamens grouped about the big seed-box, each side of the triangle being opposite one of the inner petals. After the flower is fully open, the stamens spread and each anther is easily seen to be grooved, and each edge of the groove opens for the whole of its length; but because of its shape and position, it lets the pollen fall away from the pistil instead of toward it; nor do the tips of the anthers reach the waxy, white, ruffled stigma. There is no nectar in this flower; but the big queen bumblebee likes the pollen for her new nest, and she "bumbles" around in the flower while getting her load, so that she becomes well dusted with the pollen, and thus carries it from flower to flower. But the whole story of the pollen carriers of the May apple is, as yet, untold; and any child who is willing to give time and attention to discovering the different insects which visit this flower, may give to the world valuable and, as yet, unknown facts. It is said that a white moth is often found hanging to the flowers, but it is difficult to understand why the moth should be there if the flower does not have any nectar.

The seed-vessel at the center of the flower is large and chunky, and, although crowned with its ruffled stigma, looks as if it were surely going to "grow up" into a May apple. There are usually six wide, white, rounded petals, three on the outside and three on the inside; but sometimes there are as many as nine. There are usually twice as many stamens as petals, but I have often found thirteen stamens, which is not twice any possible number of petals. The petals soon fall, and, safely hidden from the eyes of enemies, the green fruit—which is a berry instead of an apple—has nothing to do but gather sweetness, until in July it is as juicy and luscious to the thirsty child as if it were the fruit of the gods. It is about two inches long, a rich yellow in color, and is sometimes called the "wild lemon," although it is not sour. It is also called the hog-apple because the clever swine of the South know how to find it, despite its parasol. Riley thus celebrates this fruit:

"And will any poet sing of a lusher, richer thing,
Than a ripe May apple, rolled like a pulpy lump of gold
Under thumb and finger tips; and poured molten through the lips?"

If the May apple itself is edible, certainly its root is not, except when given by physicians as a medicine, for it is quite poisonous when eaten. When we see plants growing in colonies or patches, it usually means that very interesting things are going on underground beneath them, and the mandrake is no exception to this. Each plant has a running underground stem, straight and brown and fairly smooth; at intervals of a few inches, there are attached to it rosettes of stout, white roots, which divide into tiny, crooked rootlets. There is a large rosette of these roots under the plant we are studying, and we can always find a rosette of them under the place where the plant stood last year. Beneath the present plant we can find the bud from which will grow the root-stem for the coming year. The working out of the branching and the peculiarities of these root-stems, is an excellent lesson in this peculiar and interesting kind of plant reproduction.

LESSON CXXIV

The Mandrake

Leading thought—These interesting plants grow in colonies because of the spreading of their underground stems. Their odor and poisonous qualities protect them from being eaten by animals, and their fruit is well hidden by its green parasol until it is ripe.

Method—Begin the study just as the mandrakes are thrusting their heads up through the soil in April, and continue the work at intervals until the fruit is ripe.

Observations—1. How do the mandrakes look when they first appear above the ground? How are the little umbrellas folded in their cases? What do the cases look like? How can you tell from the first, the plants which are to bear the flowers and fruit?

2. Study a patch of mandrakes, and see how many varieties of parasols you can find? Do they all have the same number of main ribs and lobes? How many lobes do most of them have? Are there more single or double parasols in the patch?

3. Take a single plant and study it carefully. What sort of stem has it? Can you find at its base the old umbrella case? How high is the stem? What is its color at the bottom and at the top? How many ribs does it divide into at the top? Are these ribs as smooth as the stem? How does the parasol lining differ from its outside in color and feeling?

4. Study the parasol lobes. What is their general shape? Are they all notched at the wide end? How close to the stem does the division between them extend? Do you not think they are better fitted for keeping off the sun than the rain?

5. Take one of the double parasols. Where is the flower bud to be found? How is it protected from the sun? Does the stem divide equally on each side of it or is one part larger than the other? Are the twin parasols of the same size? How many lobes has each? What are the chief differences in shape between one of these twin parasols and one of the parasols which has no flower bud?

6. How does the flower bud look? Does it droop because its stem is weak? What happens to the green hood or sepals when the flower opens? Can you find six sepals in the hood?

7. Does the open flower bow downward? As the flower opens, what is the shape of the group of stamens at the center? Are there the same number of white, waxy petals in all the flowers? Are there always about twice as many stamens as petals? How do the anthers open to shed the pollen? Do they let the pollen fall away from the ruffled stigma of the "fat" little seed box at the center of the flower?

8. Does the flower have a strong odor? Does not the plant itself give off this odor? Do you think it is pleasant? Do the cattle eat the mandrake when it is in pastures?

9. What insects do you find visiting the mandrake flowers?

10. Do you like the May apple? When is it ripe? Cut a fruit across and see how the seeds are arranged.

11. Where are mandrakes found? Do they always grow in patches? Dig up a few plants and find why this is so?

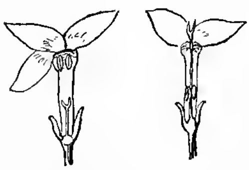
12. Describe the underground stem. Can you find where the last year's plant grew? How are the roots arranged upon the stem? Can you see places which will produce the stem for next year's growth? How does the underground stem differ in appearance from the true roots? Why must we not taste of the mandrake root?

13. In late July, visit the mandrake patch again. Are there any umbrellas now? What is left of the plants? Look at the underground stems again and see if there are new growths, and if they are larger and stored with food for next year's plants.

Bluets.
Photo by Cyrus Crosby.

THE BLUETS
Teacher's Story

During April, great patches of blue appear in certain meadows, seeming almost like reflections from the sky; and yet when we look closely at the flowers which give this azure hue to the fields, we find that they are more lavender than blue. The corolla of the bluet is a tube, spreading out into four long, lavender, petal-like lobes; each lobe is paler toward its base and the opening of the tube has a ring of vivid yellow about it, the tube itself being yellow even to its very base, where the four delicate sepals clasp it fast to the ovary until the flower has done its work; and after the corolla has fallen the sepals remain; standing guard over the growing seed.



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1. Section of a bluet blossom that has the anthers at the throat of the tube and the stigmas below.

2. Section of a bluet with the stigmas protruding and the anthers below.

If we look carefully at the bluets we find two forms of flowers: (a) Those with a two-lobed stigma protruding from the opening of the flower tube. (b) Those where the throat of the tube seems closed by four anthers which join like four finger-tips pressed together. In opening the flower, we observe that those which have the stigmas protruding from the tube, have four anthers fastened to the sides of the tube about half-way down; while those that have the four anthers near the opening of the tube, have a pistil with a short style which brings the stigmas about half-way up the tube. Thus an insect visiting flower (a) gets her tongue dusted with pollen from the anthers at the middle of the tube; and this pollen is applied at exactly the right place on her tongue to brush off against the stigmas of a flower of the (b) form. While a bee visiting a bluet of the (b) form receives the pollen at the base of her tongue, where it is conveniently placed to be brushed off by the protruding stigmas of the flowers of the (a) form.

This arrangement in flowers for the reciprocal exchange of pollen characterizes members of the primrose family also; it is certainly a very clever arrangement for securing cross-pollenation.

LESSON CXXV

The Bluets

Leading thought—The bluets have two forms of flowers, the anthers and stigmas being placed in different positions in the two, in order to secure cross-pollenation by visiting insects.

Method—Ask the children to bring in several bits of sod covered with bluets. During recess let the pupils, with the aid of a lens if necessary, find the two different forms of flowers. Later, let each see a flower of each form with the tube opened lengthwise.

Observations—1. Where do the bluets grow? Do they grow singly or in masses? On what kind of soil do they grow, in woods or meadows? At what time of year do they bloom?

2. Describe the bluet flower, its color, the shape of its sepals, the form of the corolla, the color of the corolla-tube and lobes.

3. Where is the nectar in the bluet? What color shows where the nectar is to be found?

4. Look directly into the flowers. Do you see any with the stigmas thrust out of the corolla-tube? Is there more than one style? Has it one or two stigmas? Open this flower-tube and describe where the anthers are situated in it. How many anthers are there?

5. Look for a flower where the stigmas do not protrude and the anthers close the throat of the tube. Where are the stigmas in this flower, below or above the anthers? Where are the anthers attached?

6. Work out this problem: How do the insects gathering nectar from one form of the bluets become dusted with pollen in such a way as to leave it upon the stigma of the other form of the bluet flower?

7. How many sepals are there? Do they fall off when the blossom falls?

"So frail, these smiling babies,
Near mossy pasture bars,
Where the bloodroot now so coyly
Puts forth her snowy stars;
And the maple tall and slender,
With blossoms red and sweet,
Looks down upon the bluets
Close nestled at her feet.

'Innocents', the children call them,—
These floral babies small,
Of Mother Nature olden,
Whose broad lap holds them all."

—Ray Laurance.

Showy ladies' slipper
Photo by Verne Morton.

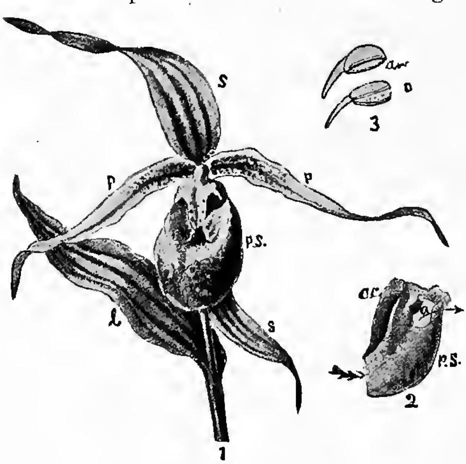
THE YELLOW LADY'S SLIPPER

Teacher's Story

"*Graceful and tall the slender drooping stem,*
With two broad leaves below,
Shapely the flower so lightly poised between,
And warm its rosy glow."—ELAINE GOODALE.

These showy flowers look so strange in our woodlands that we gaze at them as curiously as we might upon a veiled lady from the Orient who had settled in our midst. There is something abnormal and mysterious in the shape of this flower, and though it be called the lady's slipper, yet it would be a strange foot that could fit such a slipper; and if it is strange at the first glance, it is still more so as we try to compare it with other flowers. There are two long sepals that extend up and down, the lower one being made up of two grown together—but the "seam" does not show. The sepals are yellow, and are wider than the two long streamers that extend out at right angles to them, and which are petals; the brighter color of the latter, their markings of reddish dots, the hairs near their bases, all go to show that these petals, although so different in shape, belong to the same series as the big lower petal which is puffed out into a sac, shaped like a deep, long bowl, with its upper edges incurved. If we look carefully at this bowl, we find two openings besides the main one these two are near the stem, and their edges are not incurved. Extending out into each of these openings is a strange little round object, which is an anther; but if we try to get pollen from this anther with a pencil or a knife we get, instead of powdery pollen, a smear that sticks to what it touches, like melted rubber or gum. The secret of this is, that the lower side of the anther is gummy, and adheres to whatever touches it and brings with it, when pulled away, the mealy pollen which lies loose above it. Another strange thing is that, if this lower part of the anther is not carried away, it seems to partially harden and opens downward, letting the pollen escape in a way usual with other flowers. We have to remove a side of the bowl to see the stigma; it is fan-shaped, and is bent at right angles to the flower stem; and above it, as if to protect it, is a stiff triangular piece which is really a strangely modified stamen. I think one reason why the lady's slipper always is called "she" is because of this tendency on her part to divert an object from its natural use. Surely a hairpin used for a paper knife or a monkey-wrench for a hammer, is not nearly so feminine a diversion as a stamen grown wide and long to make an awning above a stigma.

The general color of the flower is yellow, and there are some seductive dark red spots on the stamen-awning and along the folded-in surface of the petal-sac which say plainly, "Come here, Madam Mining-bee, and see what these spots mean." And the little bee alights on the flower and soon crawls into the well at the center, the recurved edges preventing it from returning by the same door. At the bottom of the sac there are delectable vegetable hairs to be browsed upon; if there is nectar, I have never been able to detect it with my coarse organs of taste; and Mr. Eugene Barker who has examined hundreds of the flowers has not been able to detect the presence of nectar in them at any stage; but he made no histological study of the glands.



Detail of yellow lady's slipper.

1, *l*, *leaf; s,s, sepals; p.p, petals; p.s, petal-sac.* 2, *Side-view: ac, anther cover; p.s, petal-sac. a, anther. The arrow shows the path of the insect.* 3, *an, anther closed; a, anther open.*

After a satisfying meal the bee, which is a lively crawler, seeks to get out where it sees the light shining through one of the openings near to the stem. In doing this, she presses her head and back, first against the projecting stigma and then against the sticky anther, which smears her with a queer kind of plaster; and it sticks there until she brushes it off on the stigma of another flower, when crowding past it; and there she again becomes smeared with pollen plaster from this flower's anthers. Mr. Barker, who has especially studied these flowers, has found that the little mining bees of the genus *Andrena* were the most frequent visitors; he also found honey-bees and one stray young grasshopper in the sacs. The mining bees which he sent to me had their backs plastered with the pollen. Mr. Barker states that the flowers are not visited frequently by insects, and adds feelingly; "My long waiting was rewarded with little insect activity, aside from the mosquitoes which furnished plenty of entertainment."

The ovary looks like a widened and ribbed portion of the flower-stem, and is hairy outside; its walls are thick and obscurely three-angled; seen in cross-section the seeds are arranged in a triangular fashion which is very pretty.

The leaves of the yellow lady's slipper are oval or elliptic, with smooth edges and parallel veins; they often have narrow veins between each two heavier ones. The leaves are of vivid yellowish green and are scattered, in a picturesque manner, alternately along the stem, which their bases completely clasp. The stem is somewhat rough and ribbed and is likely to grow crooked; it grows from one to two feet in height. The roots are a mass of small rootlets. The species is found in woods and in thickets.

The pink moccasin flower, also called the stemless lady's slipper (*C. acaule*,) is perhaps prettier than the yellow species, and differs from it in several particulars. The sac opens by the merest crevice, and there are plenty of dark-pink guiding lines which lead to the little opening of the well. The downward-folded edges prevent the visiting insect from getting out by this door even more surely than in the other species. The side petals are not so long as in the yellow species, and they extend forward as if to guide the insect to the well in the lower petal. The sepals are greenish purple, and are likewise shorter; and the lower one is wide, indicating that it is made up of two grown together. At the base of the ovary there is a pointed green bract or leaf, which lifts up and bends above the flower. There are but two leaves on the stemless lady's slipper; they arise from the base of the stem. They are broadly ovate, and from six to seven inches long. This species grows in sandy or rocky woods.

Another species more beautiful than these is the showy lady's slipper, which is white with a pink entrance to the petal sac. This grows in peaty bogs, and is not so common as the others.

The interesting points for observation in these flowers are the careful noting of the kinds of insects which visit them, and how they enter and leave the "slipper," or sac.

LESSON CXXVI

The Yellow Lady's Slipper

Leading thought—The moccasin flower belongs to that famiiy of flowers known as orchids which especially depend upon insects for bringing and carrying pollen, and which have developed many strange devices to secure insect aid in pollenation.

Method—A bouquet of lady's slippers should be brought to the schoolroom. Children who bring them should describe the place where they were found.

Observations—1. Where does the yellow lady's slipper grow? Look carefully at its leaves and describe them. How do they join the stem? Are they opposite or alternate?

2. What is there peculiar about the sepals? How many are there?

3. Describe the three petals and the difference and likeness in their form and color. What is the shape of the lower petal? Is there a hole in this sac? Is there more than one hole leading into it? What is the color of the sac? Is there anything about it to attract insects? If an insect should enter the mouth of the well in the lower petal could it easily come out by the same opening? Why not? Where do you think it would emerge?

4. Note the two roundish objects projecting into the two openings of the sac near the stem. Thrust a pencil against the under side of one of these. What happens? How does this pollen differ from the pollen of ordinary flowers?

5. Cut away one side of the petal-sac and find the stigma. What shape is it? Where is it situated with relation to the anthers? How is the stigma protected above? Where is the ovary, or seed-box?

6. Explain how a bee visiting these flowers, one after another, must carry the pollen from one to another and deposit it on the waiting stigmas.

7. How is the insect attracted? How is it trapped and made to do the work?

8. Look at the seed-capsule and describe it from the outside. Cut it across, and describe the arrangement of the seeds. How many sides of the seed-capsule open, to let loose the seeds?

9. How many species of lady's slippers do you know? Do you know the pink, or stemless species? How does it differ from the yellow species in the following particulars: The shape of the sac; its color and markings; the length and shape of sepals; the number and position of the leaves.

THE COMMON BUTTERCUP

Teacher's Story

"The buttercups, bright-eyed and bold,
Held up their chalices of gold
To catch the sunshine and the dew."

Buttercups and daisies are always associated in the minds of the children, because they grow in the same fields; yet the two are so widely different in structure that they may reveal to the child something of the marvelous differences between common flowers; for the buttercup is a single flower, while the single daisy is a large family of flowers.

The buttercup sepals are five elongated cups, about one-half as long as the petals; they are pale yellow with brownish tips, but in the globular buds, they are green. The petals are normally five in number, but have a tendency to double, so that often there are six or more; the petals are pale beneath, but on the inside they are most brilliant yellow, and shine as if varnished. Probably it is due to this luminous color that one child is able to determine whether another likes butter or not, by noting when the flower is held beneath the chin, if it makes a yellow reflection; it would be a sodden complexion indeed that would not reflect yellow under this provocation. Each petal is wedge-shaped, and its broad outer edge is curved so as to help make a cuplike flower; if a fallen petal be examined, a tiny scale will be found at its base, as if its point had been folded back a

Do you like butter?

trifle. However, this is not a mere fold, but is a little scale growing there —a scale with a mission, for beneath it is developed the nectar.

When the buttercup first opens, all of the anthers are huddled in the center, so that it looks like a golden nest full of golden eggs. Later the filaments stretch up, lifting the anthers into a loose, rounded tuft, almost concealing the bunch of pistils which are packed close together beneath every stigma, like Bre'r Rabbitt, "laying low." Later, the filaments straighten back, throwing the anthers in a fringy ring about the pale green pistils; and each pistil sends up a short, yellowish stigma. The anthers open away from the pistils and thus prevent self-pollenation to some degree; they also seem to shed much of their pollen before the stigmas are ready to receive it.

Sometimes petals and sepals fall simultaneously and sometimes first one or the other; but they always leave the green bunch of pistils with a ragged fringe of old stamens clinging to them. Later the seeds mature, making a globular head. Each seed is a true akene; it is flattened and has at its upper end a short, recurved hook which may serve to help it to catch a ride on passers-by. However, the seeds are largely scattered by the winds.

The buttercup grows in sunny situations, in fields and along roadsides, but it cannot stand the shade of the woods. It is a pretty plant; its long stems are downy near the bottom, but smooth near the flower; the leaves show a variety of forms on the same plant; the lower ones have many, (often seven) deeply cut divisions, while the upper ones may have three irregular lobes, the middle one being the longest. Beetles are very fond of the nectar and pollen of buttercups, and therefore are its chief pollen carriers; but flies and small bees and other insects also find their food in these brilliant colored cups.

LESSON CXXVII

The Buttercup


Buttercup flower enlarged. Note the scale covering the nectar at the base of the falling petal.

Leading thought—The buttercup grows with the white daisies, in sunny places, but each buttercup is a single flower, while each daisy is a flower family.

Method—Buttercups brought by the pupils to school may serve for this lesson.

Observations—1. Look at the back of a flower of the buttercup. What is there peculiar about the sepals? How do the sepals look on the buttercup bud? How do they look later?

2. Look into the flower. How many petals are there? Are there the same number of petals in all the flowers of the same plant? What is the shape of a petal? Compare its upper and lower sides. Take a fallen petal, and look at its pointed base with a lens and note what is there.

3. How do the stamens look? Do you think you can count them? When the flower first opens how are the stamens arranged? How, later? Do the anthers open towards, or away, from the pistils?

4. Note the bunch of pistils at the center of the flower. How do they look when the flower first opens? How, later?

5. When the petals fall, what is left? Can you see now how each little pistil will develop into a seed?

6. Describe the seed-ball and the seed.

7. Look at the buttercup's stems. Are they as smooth near the base as near the flower? Compare the upper leaf with the lower leaf, and note the difference in shape and size.

8. Where do the buttercups grow? Do we find them in the woods? What insects do you find visiting the flowers?

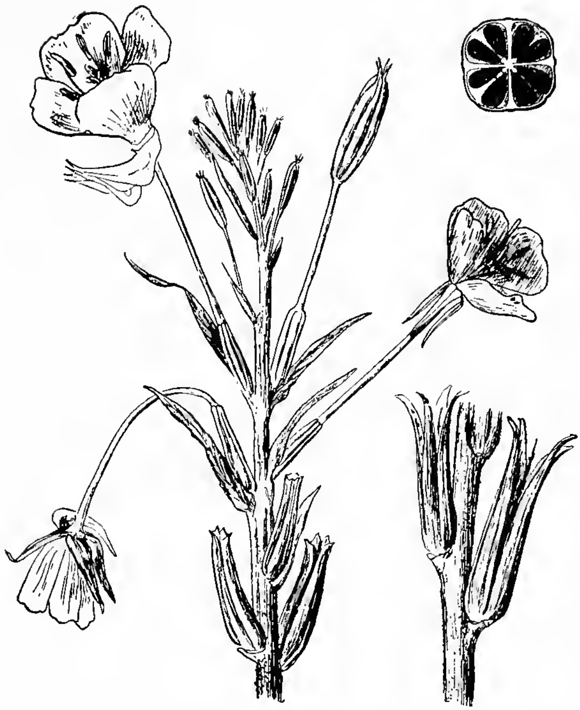
THE EVENING PRIMROSE

Teacher's Story

"Children came
To watch the primrose blow. Silent they stood,
Hand clasped in hand, in breathless hush around,
And saw her shyly doff her soft green hood
And blossom—with a silken burst of sound."

—Margaret Deland.

To the one who has seen the evening primrose unfold, life is richer by a beautiful, mysterious experience. Although it may be no more wonderful than the unfolding of any other flower, yet the suddenness of it makes it seem more marvelous. For two or three days it may have been getting ready; the long tube which looks like the flower stem has been turning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1, Evening primrose, showing buds, one ready to open, a flower just opened above at the left, an older flower at the right, a fading flower and seed-capsules below. 2, Seed-capsules. Cross section of seed-capsule with seeds above.

yellow; pushing up between two of the sepals, which clasp tips beyond it, there appears a row of petals. Then some warm evening, usually about sunset, but varying from four o'clock in the afternoon to nine or ten in the evening, the petals begin to unfurl; they are wrapped around each other in the bud as an umbrella is folded, and thus one edge of each petal becomes free first. The petal first in freeing its edge seems to be doing all the work, but we may be sure that all the others are pushing for freedom; little by little the sepals are pushed downward, until their tips, still clasped, are left beneath; and the petals now free, suddenly flare open before our delighted eyes, with a movement so rapid that it is difficult for us not to attribute to them consciousness of action. Three or four of these flowers may open on a plant the same evening; and they, with their fellows on the neighboring plants, form constellations of starry bloom that invite attention from the winged creatures of the twilight and the night. There is a difference in the time required for a primrose flower to unfold, probably depending upon its vigor; once I watched for half an hour to see it accomplished, and again I have seen it done in two or three minutes. The garden species seems to unfold more rapidly than the wild species, and is much more fragrant. The rapidity of the opening of the blossom depends upon the petals getting free from the sepals, which seem to try to repress them. The bud is long, conical, obscurely four-sided, and is completely covered by the four sepals, the tips of which are cylindrical and twisted together; this is an interesting habit, and one wonders if they hold the petals back until the latter are obliged to burst out with the force of repressed energy; after they let go of the petals, they drop below the flower angularly, and finally their tips open and each sepal turns back lengthwise along the seed-tube.

The four lemon-yellow petals are broad, with the outer margin notched. The eight stamens are stout, and set one at the middle of each petal and one between each two petals. The long, pale yellow anthers discharge their pollen in cobwebby strings. When the flower first opens, the stigma is egg-shaped and lies below the anthers; later, it opens into a cross and usually hangs off at one side of the anthers. If we try to trace the style back to the ovary, we find that it extends down into what seems to be the very base of the flower stem, where it joins the main stem. This base is enlarged and ribbed and is the seed-box, or ovary. The tube is rich in nectar, but only the long sucking-tubes of moths can reach it, although I have sometimes seen the ubiquitous bees attempting it. The butterflies may take the nectar in the daytime, for the blossoms of the wild species remain open, or partially open, for a day or two. But the night-flying moths which love nectar have the first chance, and it is on them the flower depends for carrying its pollen, threaded on filmy strings.

There are times when we may find the primrose blossoms with holes in the petals, which make them look very ragged. If we look at such plants carefully, we may find the culprit in the form of a green caterpillar very much resembling the green tube of the bud; and we may conclude, as Dr. Asa Fitch did, that this caterpillar is a rascal, because it crawls out on the bud-ends and nibbles into them, thus damaging several flowers. But this is only half the story. Later this caterpillar descends to the ground, digs down into it and there changes to a pupa; it remains there until the next summer, then, from this winter cell, emerges an exquisitely beautiful moth called the *Alaria florida;* its wings expand about an inch, and all except the outer edges of the front wings are rose-pink, slightly mottled with lemon-yellow, which latter color decorates the outer margins for about one-quarter of their length; the body and hind-wings are whitish and silky, the face and antennæ are pinkish. Coiled up beneath the head is a long sucking-tube which may be unfolded at will. This moth is the special pollen-carrier of the evening primrose; it flies about during the evening, and thrusts its long, tubular mouth into the flower to suck the nectar, meanwhile gathering strings of pollen upon the front part of its body. During the day, it hides within the partially closed flower, thus carrying the pollen to the ripened stigmas, its colors meanwhile protecting it almost completely from observation. The fading petals of the primrose turn pinkish, and the pink color of the moth renders it invisible when in the old flowers, while the lemon-yellow tips of its wings protruding from a flower still fresh and yellow, forms an equally perfect protection from observation.

The evening primrose is an ornamental plant in both summer and winter. It is straight, and is ordinarily three or four feet tall, although it sometimes reaches twice that height. It is branched somewhat, the lower portion being covered with leaves and the upper portion bearing the flowers. The leaves are pointed and lanceolate, with few whitish veins. The leaf edges are somewhat ruffled and obscurely toothed, especially in the lower leaves. The leaves stand up in a peculiar way, having a short, pink petiole, which is swollen and joins the stalk like a bracket. The upper leaves are narrower; the leafy bracts at the base of the flower grow from the merest slender leaflet at the base of the bud, to a leaf as long as the seed-pod, when the flower blooms.

The seed-capsules are four-sided, long and dark green. In winter they are crowded in purplish-brown masses on the dry stalks, each one a graceful vase with four flaring tips. At the center of each there projects a needlelike point; and within the flaring, pale, satin-lined divisions of these urns, we may see the brown seeds which are tossed by the winter winds far and near. The young plants develop into vigorous rosettes during the late summer and autumn, and thus discreetly pass the winter under the snow coverlet.

LESSON CXXVIII
The Evening Primrose

Winter rosette of evening primrose.
Photo by Verne Morton.

Leading thought—Some flowers have developed the habit of relying on the night-flying insects for carrying their pollen. The evening primrose is one of these; its flowers open in the evening and their pale yellow color makes them noticeable objects in the twilight, and even in the dark.

Method—The form of the evening primrose may be studied from plants brought to the schoolroom; but its special interest lies in the way its petals expand in the evening, so the study should be continued by the pupils individually in the field. This is one of the plants which is an especially fit subject for the summer note-book; but since it blossoms very late and the plants are available even in October, it is also a convenient plant to study during the school year. The garden species is well adapted for this lesson.

Observations—1. Look at the plant as a whole. How tall is it? Is the stem stiff and straight? Where do you find it growing? Does it grow in the woods?

2. Are the leaves near the base the same shape as those at the top of the plant? What is their shape? Are the edges toothed? What is there peculiar about the veins? How do the leaves join the stem? How

do the leaves look which are at the base of the flower stem? Those at the base of the buds?

3. Where on the plant do the flowers grow? Which flowers blossom first, those above or below? Take a bud nearly ready to open; what is there peculiar in the appearance of the bud stem? What is the general shape of the bud? Describe the sepals. Look at their tips carefully, and see how they hold together. Cut a bud across and see how the petals are folded within it.

4. Take an open flower; where are the sepals now? Describe the open petals, their shape and color.

5. How many stamens are there? How are they placed? What is the shape of the anthers? How does the pollen look?

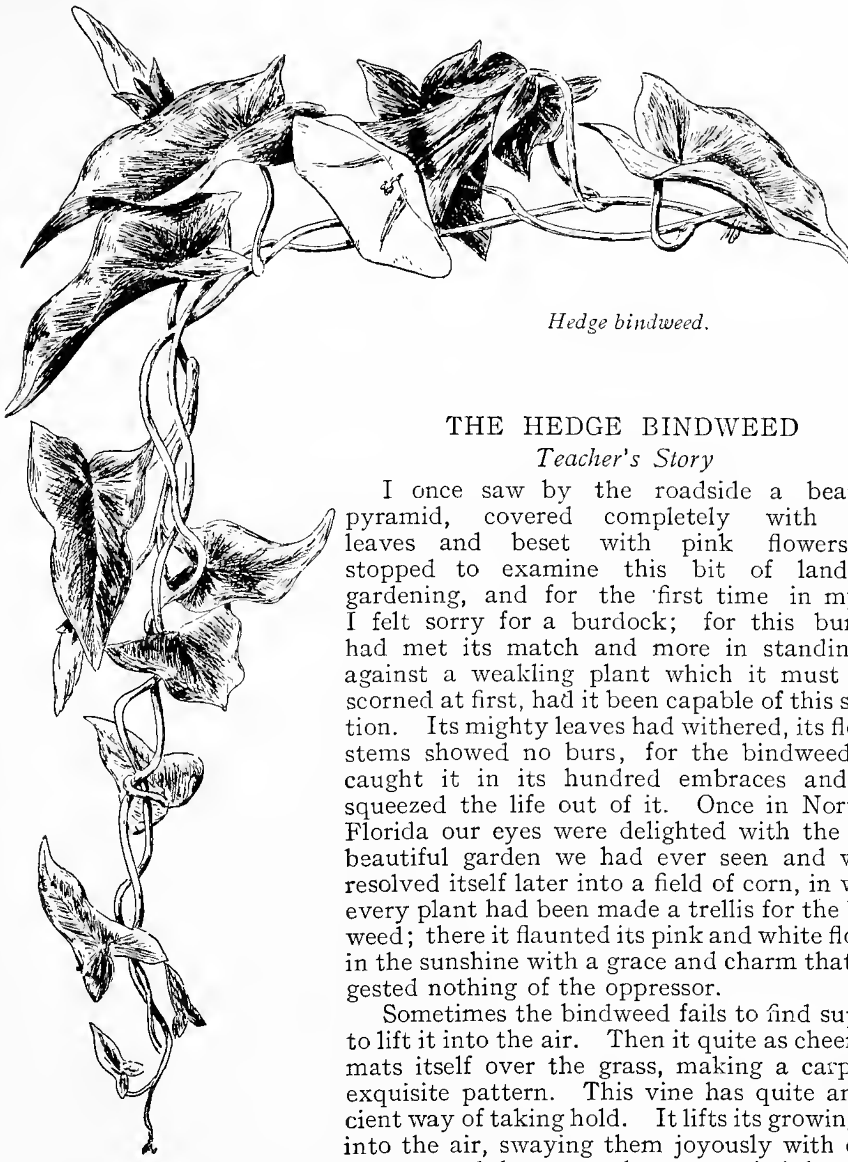
6. What is the shape and the position of the stigma in the freshly opened flower? Later? Open the flower-tube and find how far down the style extends. Where is the ovary? How does the ovary look on the outside? Taste the opened tube; can you detect the nectar? What sort of a tongue must an insect have to reach this nectar? How do the fading flowers look and act?

7. Describe the seed-pod. Cut it across, and see how many compartments there are within it. How are the seeds arranged in it? How do the pods open and how are the seeds scattered?

8. Watch the flower of the evening primrose open, and describe the process carefully. At what hour did it open? What was the movement of the petals? Can you see how they unfold in relation one to another? How do they get free from the sepals? How many minutes is required for the whole process of the opening of the flower? How many flowers on a plant expand during the same evening? Look at the open blossoms in the dark; can you see them? How do they look? What insects do you find visiting these flowers?

9. How long does the primrose blossom remain open? How do the young plants of the evening primrose pass the winter?

Supplementary reading—Blossom Hosts and Insect Guests, Gibson.



Hedge bindweed.

THE HEDGE BINDWEED

Teacher's Story

I once saw by the roadside a beautiful pyramid, covered completely with green leaves and beset with pink flowers. I stopped to examine this bit of landscape gardening, and for the first time in my life I felt sorry for a burdock; for this burdock had met its match and more in standing up against a weakling plant which it must have scorned at first, had it been capable of this sensation. Its mighty leaves had withered, its flower-stems showed no burs, for the bindweed had caught it in its hundred embraces and had squeezed the life out of it. Once in Northern Florida our eyes were delighted with the most beautiful garden we had ever seen and which resolved itself later into a field of corn, in which every plant had been made a trellis for the bindweed; there it flaunted its pink and white flowers in the sunshine with a grace and charm that suggested nothing of the oppressor.

Sometimes the bindweed fails to find support to lift it into the air. Then it quite as cheerfully mats itself over the grass, making a carpet of exquisite pattern. This vine has quite an efficient way of taking hold. It lifts its growing tips into the air, swaying them joyously with every breeze; and the way each extreme tip is bent into a hook seems just a matter of grace and beauty, as do the two or three loose quirls below it; when during its graceful swaying the hook catches to some object, it makes fast with amazing rapidity; later the young arrow-shaped leaves manage to get an ear over the support, and in a very short time the vine makes its first loop, and the deed is done. It is very particular to twine and wind in one way, following the direction of the hands of the clock—from the right, under, and from the left, over the object to which it clings. If the support is firm, it only makes enough turns around it to hold itself firmly; but if it catches to something as unstable as its own tendrils, they twist until so hard-twisted that they form a support in themselves.

It is rather difficult to perceive the alternate arrangement of the leaves on the bindweed stem, so skillful are they in twisting under or over in order to spread their whole graceful length and breadth to the sun; to the careless observer they seem only to grow on the upper or outer side of the vine. The leaves are arrow-shaped, with two long, backward, and outward projecting points, or "ears," which are often gracefully lobed. Early in the year the leaves are glossy and perfect; but many insects love to nibble them, so that by September, they are usually riddled with holes.

The flower bud is twisted as if the bindweed were so in the habit of twisting that it carried the matter farther than necessary. Enveloping the base of the flower bud are two large sepal-like bracts, each keeled like a duck's breast down the center; if these are pulled back, it is seen that they are not part of the flower, because they join the stem below it. There are five pale green sepals of unequal sizes, so that some look like fragments of sepals. The corolla is long, bell-shaped, opening with five, starlike lobes; each lobe has a thickened white center; and while its margins are usually pink, they are sometimes a vivid pink-purple and sometimes entirely white. Looking down into this flower-bell, and following the way pointed out by the white star-points which hold out the lobes, we find five little nectar-wells; and each two of these wells are separated by a stamen which is joined to the corolla at its base and at its anther-end presses close about the style of the pistil. When the flower first opens, it shows the spoon-shaped stigmas close together, pushing up through the anther cluster; later, the style elongates, bringing the stigmas far beyond the anthers. The pollen is white, and through the lens looks like tiny pearls.

When we study the maturing seed-capsule, we can understand the uneven size of the sepals better; for after the corolla with the attached stamens falls, the sepals close up around the pistil; the smallest sepal wraps it first, and the larger ones in order of size, enfolding the precious parcel; and outside of all, the great, leafy bracts with their strong keels provide protection. The pod has two cells and two seeds in each cell. But it is not by seeds alone that the bindweed spreads; it is the running rootstock which, when the plant once gets a start, helps it to cover a large area. The bindweed is a relative of the morning-glory and it will prove an interesting study to compare the two in methods of twining, in the time of day of the opening of the flowers, the shape of the leaves, etc. So far as my own observations go, the bindweed flowers seem to remain open only during the middle of the day, but Müller says the flowers stay open on moonlight nights to invite the hawk-moths. This is an interesting question for investigation, and it may be settled by a child old enough to make and record truthful observations.

There are several species of bindweed, but all agree in general habits. The field bindweed lacks the bracts at the base of the flower.

LESSON CXXIX

The Hedge Bindweed

Leading thought—There are some plants which have such weak stems that they are obliged to cling to objects for support. The bindweed is one of these, and the way that it takes hold of objects and grows upon them is an interesting story.

Method—It is better to study this plant where it grows; but if this is not practical, the vine with its support should be brought into the schoolroom, the two being carefully kept in their natural relative positions. Several of the questions should be given to the pupils for their personal observation upon this vine in the field. It is an excellent study for pencil or water-color drawing.

Observations—1. How does the bindweed get support, so that its leaves and its flowers may spread out in the sunshine? Why does its own stem not support it? What would happen to a plant with such a weak stem, if it did not twine upon other objects?

2. How does it climb upon other plants? Does its stem always wind or twist in the same direction? How does it first catch hold of the other plant? If the supporting object is firm, does it wind as often for a given space as when it has a frail support? Can you see the reason for this?

3. Look at the leaves. Sketch one, to be sure that you see its beautiful form and veins. Note if the leaves are arranged alternately on the stem, and then observe how and why they seem to come from one side of the stem. Why do they do this?

4. What is there peculiar about the flower bud? Look at its stem carefully and describe it. Cut it across and look at the end with a lens and describe it. Turn back two sepal-like bracts at the base of the flower or bud. Are they a part of the flower, or are they below it? Find the true sepals. How many are there? Are they all the same size?

5. Examine the flower in blossom. What is its shape? Describe its colors. Look down into it. How many stamens are there, and how are they set in the flower? How does the pistil look when the flower first opens? Later? Can you see the color of the pollen? Can you find where the nectar is borne? How many nectar-wells are there?

6. What insects do you find visiting bindweed flowers? Do the flowers remain open at night or on dark days?

7. Study the seed-capsule. How is it protected on the outside? What next enfolds it? Can you see now the uses of the sepals of several sizes? Cut a seed-capsule across with all its coverings, and see how it is protected. How many seeds are there in the capsule?

8. Has the bindweed other methods of spreading than by seeds? Look at the roots and tell what you observe about them.

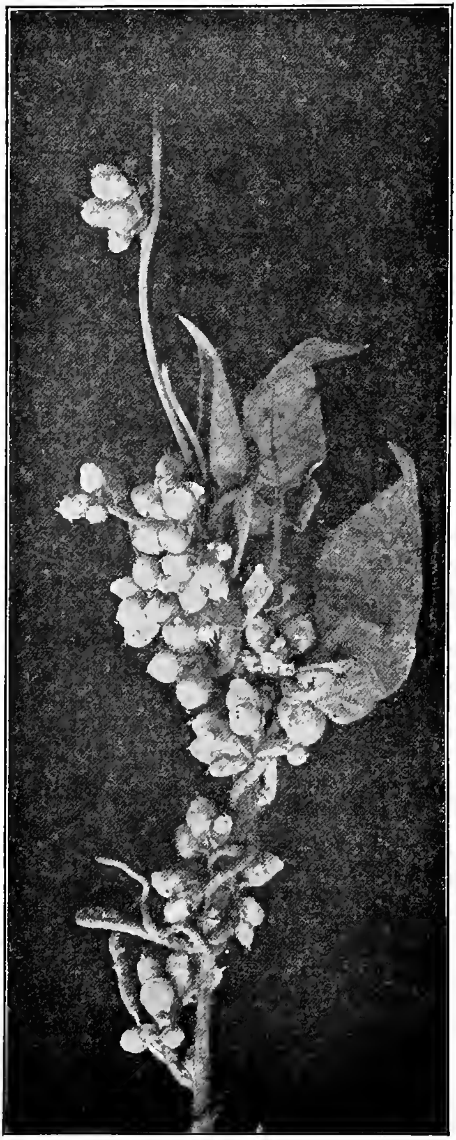
9. Make a study of the plant on which the bindweed is climbing, and tell what has happened to it.

10. Compare the bindweed with the morning-glory, and notice the differences and resemblances.

Supplementary reading: "Morning-Glory Stories," in Flowers and Their Friends, Morley; Botany Reader, Newell, Chap. 10; Golden Numbers, page 74.

THE DODDER

Teacher's Story



Dodder in blossom.
Photo by Cyrus Crosby.

If Sinbad's "Old Man of the Sea" had been also a sneak thief, then we might well liken him to dodder. There is an opportunity for an excellent moral lesson connected with the study of dodder and its underhand ways. When a plant ceases to be self-supporting, when it gets its own living from the food made by other plants for their own sustenance, it loses its own power of food-making; and the dodder is an excellent example of the inevitable punishment for "sponging" a living. The dodder has no leaves of its own for it does not need to manufacture food nor to digest it. Its dull yellow stems reach out in long tendrils, swayed by every breeze, until they come in contact with some other plant to which they at once make fast. One of these tendrils seizes its victim plant as a serpent winds its prey, except that it always winds in the same direction—it passes under from the right side and over from the left. Who knows whether the serpents are always so methodical! After dodder gets its hold, little projections appear upon its coiled stems, which look like the prolegs of a caterpillar; but they are not legs, they are suckers, worse than those of the devil-fish; for the latter uses its suckers only to hold fast its prey; but the dodder uses its suckers to penetrate the bark of its victim, and reach down to the sap channels where they may, vampirelike, suck the blood from their victims, or rather the matured sap which is flowing from the leaves to the growing points of the host plant. Not having anything else to do, dodder devotes its energies to the producing of seeds, in order to do more mischief. The species which attack clover and other farm crops seem to manage to get their seeds harvested with the rest; and the farmer who does not know how to test his clover seed for impurities, sows with it the seeds of its enemy.

The dodder flowers are small, globular and crowded together. The calyx has five lobes; the corolla is globular, with five little lobes around its margin and a stamen set in each notch. A ew of the species have a four-lobed calyx and corolla; but however many the lobes, the flowers are shiftless looking and are yellowish or greenish white; despite its shiftless appearance, however, each flower manages to mature four perfectly good, plump seeds.

There are, according to Gray, nine species of dodder more or less common in America. Some of the species, among which is the flax dodder, live only upon certain other species of plant life, while others take almost anything that comes within reach. Where it flourishes, it grows so abundantly that it makes large yellow patches in fields, completely choking out the leaves of its victims.

LESSON CXXX

The Dodder

Leading thought—There are some plants which not only depend upon other plants to hold them up, but they suck the life-juice from these plants and thus they steal their living.

Method—Bring in dodder with the host plant for the pupils to study in the schoolroom, and ask them to observe afterwards the deadly work of this parasite in the field.

Observations—1. What is the color of the stem? In which direction does it wind?

2. How is the stem fastened to the host plant? Tear off these suckers and examine the place where they were attached with a lens, and note if they enter into the stem of the host plant.

3. How does the dodder get hold of its victim? Has the dodder any leaves of its own? How can it get along and grow without leaves?

4. How do the flowers look through a lens? Are there many flowers? Can you see the petal lobes and the stamens?

5. How many seeds does each flower develop? How do the seeds look? In what way are they a danger to our agriculture?

I should also avoid the information method. It does a child little good merely to tell him matters of fact. The facts are not central to him and he must retain them by a process of sheer memory; and in order that the teacher may know whether he remembers, the recitation is employed,—re-cite, to tell over again. The educational processes of my younger days were mostly of this order,—the book or the teacher told, I re-told, but the results were always modified by an unpredictable coefficient of evaporation. Good teachers now question the child to discover what he has found out or what he feels, or to suggest what further steps may be taken, and not to mark him on what he remembers. In other words, the present-day process is to set the pupil independently at work, whether he is young or old, and the information-leaflet or lesson does not do this. Of course, it is necessary to give some information, but chiefly for the purpose of putting the pupil in the way of acquiring for himself and to answer his natural inquiries; but information-giving about nature subjects is not nature-study.—L. H. Bailey in "The Outlook to Nature."

THE MILKWEED

Teacher's Story

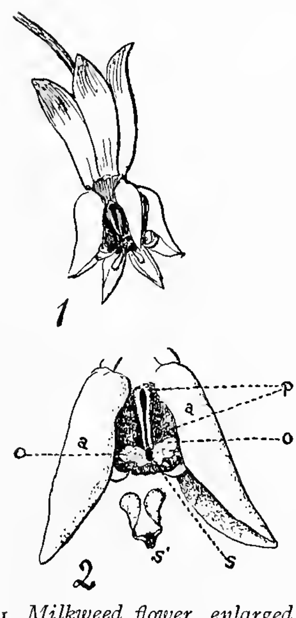
> "*Little weavers of the summer, with sunbeam shuttle bright,*
> *And loom unseen by mortals, you are busy day and night,*
> *Weaving fairy threads as filmy, and soft as cloud swans, seen*
> *In broad blue sky-land rivers, above earth's fields of green.*"
>
> —Ray Laurance.

IS there any other young plant that shows off its baby-clothes as does the young milkweed! When it comes up through the soil, each leaf is folded lengthwise around the stem, flannel side out, and it is entirely soft and white and infantile. The most striking peculiarity of the milkweed plant is its white juice, which is a kind of rubber. Let a drop of it dry on the back of the hand, and when we try to remove it we find it quite elastic and possessed of all of the qualities of crude rubber. At the first trial it seems quite impossible to tell from which part of the stem this white juice comes, but by blotting the cut end once or twice, the hollow of the center of the stem is seen to have around it a dark green ring, and outside this is a light green ring. It is from the dark green ring encircling the stem cavity that the milk exudes. This milk is not the sap of the plant any more than resin is the sap of the pine; it is a special secretion, and is very acrid to the taste, rendering milkweed disgusting to grazing animals. If a milkweed stem be broken or gashed, this juice soon heals the wound and keeps out germs, and thus is of great use to the plant, since many insects feed upon it. If cut across, every vein in every leaf produces "milk", and so does every small flower pedicel. When the "milk" is by chance smeared on cloth and allowed to dry, soap and water will not remove it, but it yields readily to chloroform, which is a solvent of rubber.

Milkweed in blossom.
Photo by Verne Morton.

The milkweed leaves are in stately conventional pairs; if one pair points east and west, the pair above and the pair below point north and south. The leaf is beautiful in every particular; it has a dark green upper surface, diversified with veins that join in scallops near the border; it is soft to the touch on the upper surface, and is velvety below. The lens reveals that the white under surface, or the nap of the velvet, is a cover of fine white hairs.

The flower of the milkweed is too complicated for little folks even to try to understand; but for the pupils of the seventh and eighth grades it will prove an interesting subject for investigation, if they study it with the help of a lens. In examining the globular bud, we see the five hairy sepals, which are later hidden by the five long, pinkish green petals which bend back around the stem. When we look into the flower, we see five little cornucopias—which are really horns of plenty, since they are filled with nectar; from the center of each is a little, fleshy tongue, with its curved point resting on the disk at the center of the flower. Between each two of these nectar-horns can be seen the white bordered opening of a long pocket—like a dress-pocket—at the upper end of the opening of which is a black dot. Slip a needle into the pocket opening until it pushes against the black dot, and out pops a pair of yellow saddle-bags, each attached to the black dot which joins them. These are the pollen-bags, and each was borne in a sac, shaped like a vest-pocket, one lying either side of the upper end of the long pocket. These pollen-bags are sticky, and they contract so as to close over the feet of the visiting bee.



1, *Milkweed flower, enlarged.* 2, *Same more enlarged. a,a, nectar-horns; p, pocket; o,o, openings to the pocket; s, pollen-bags in place; s', pollen-bags removed.*

Since the stem of the flower cluster droops and each flower pedicel droops, the bee is obliged to cling, hanging back down, while getting the nectar, and has to turn about as if on a pivot in order to thrust her tongue into the five cornucopias in succession; she is then certain to thrust her claws into a long pocket, and it proceeds to close upon them, its edges being like the jaws of a trap. The bee, in trying to extricate her feet, leaves whatever pollen-bags she had inadvertently gathered in this trap-pocket, which gives them passage to the stigma. But the milkweed flower, like some folks, is likely to overdo matters, and sometimes these pockets grasp too firmly the legs of the bee and hold her a prisoner. We often find insects thus caught and dead—a result as far from the plan of the flower as from that of the insect victim, had both been conscious. Sometimes bees become so covered with these pollen-bags, which they are unable to scrape off, that they die because of the clogging. But for one bee that suffers there are thousands that carry off the nectar triumphantly, just as thousands of people travel by water for one that is drowned.

The milkweed pod has been the admiration of nature students from the beginning, and surely there is no plant structure that so interests the child as this house in which the milkweed carries its seeds. When we look at a green pod, we first admire its beautiful shape; on either side of the seam, which will sometime open, are three or four rows of projecting points rising from the felty surface of the pod in a way that suggests embossed embroidery. We open the pod by pulling it apart along the seam; and this is not a seam with a raw edge but is finished with a most perfect selvage. When we were children we were wont to dispossess these large green pods of their natural contents, and because they snapped shut so easily, we imprisoned therein bumblebees "to hear them sing," but we always let them go again. We now know that there is nothing so interesting as to study the contents of the pod just as it is. Below the opening is a line of white velvet; at one end, and with their "heads all in one direction," are the beautiful, pale-rimmed, brown, overlapping seeds; and at the other end we see the exquisite milkweed silk with the skein so polished that no human reel could give us a skein of such luster. If we remove the contents of the pod as a whole, we see that the velvety portion is really the seed-support and that it joins the pod at either end. It is like a hammock full of babies, except that the milkweed babies are fastened on the outside of the hammock.

No sooner is our treasure open to the air than the shining silk begins to separate into floss of fairy texture. But before one seed comes off, let us look at the beautiful pattern formed by the seeds overlapping—such patterns we may see in the mosaics of mosques.

Pull off a seed, and with it comes its own skein of floss, shining like a pearl; but if we hold the seed in the hand a moment the skein unwinds itself into a fluff of shining threads as fine as spiders' silk, and each individual thread thrusts itself out and rests upon the air; and altogether there are enough of the threads to float the seed, a balloon of the safest sort. If we wreck the balloon by rubbing the floss through our fingers, we shall feel the very softest textile fiber spun by Mother Nature.

If we look closely at our seed we see a margin all around it. Well, what if the balloon should be driven over sea, and the seed dropped upon the water? It must then drown unless it has a life preserver; this margin that we have noted is of the safest cork, and is warranted to float; if you do not believe it, try it.

If we pull off all the seeds, we can see that the velvety support is flat and that all of the seeds are attached to it, but before we stop our admiring study we should look carefully again at the inside of the pod, for never was there a seed cradle with a lining more soft and satiny.

LESSON CXXXI

The Milkweed

Leading thought—The milkweed when wounded secretes a milky juice which is of a rubberlike composition; it flows out of the wounded plant and soon hardens, thus protecting the wound from germs. Milkweed flowers depend entirely upon insects for pollenation; the pollen is not a free, yellow powder, but it is contained in paired sacs, which are joined in V-shape. The seeds are carried by balloons, and they can float on water as well.

Method—Begin the study of the plant when it first appears above ground in April or May. Give the pupils the questions about the blossom

Milkweed seed-balloons just leaving the sheltering pod.

for a vacation study, and ask that their observations be kept in their note-books. The study of the pods and seeds may be made in September or October. When studying the milky juice, add a geography lesson on rubber trees and the way that rubber is made.

Observations—1. *The plant.* How does the milkweed look as it appears above ground in the spring? How are its leaves folded when it first puts its head up? Cut off a fully expanded plant a few inches above the ground. What flows out of the stem? Blot off the "milk" and study the cross-section of the stem. What is at the center? How many layers do you see around this center? Can you see from which the milkweed juice comes? How does the juice feel as it dries on your fingers? How does it look when dry? Place a few drops on a piece of paper and when it is dry pull it off and see if it is elastic. Break the edge of the leaf. Does the milky juice flow from it? Does it come from the veins? Do you think that this is the sap of the milkweed? Cut a gash in the milk-weed stem and see how the "milk" fills the wound. How does this help the plant? Do cattle feed upon the milkweed when it grows in pastures? If not, why?

2. How are the leaves arranged on the stem? How do the upper and under sides of the leaves differ? Examine with a lens, and see what makes the nap of the velvet. What gives the light color to the under side? Sketch a leaf showing its shape and venation, noting especially the direction of the veins as they approach the edge of the leaf.

3. *The flower.* Where do the flower clusters come off the stems in relation to the leaves? Does the stem of the flower cluster stand stiff or droop? Take a good sized flower cluster and count the flowers in it. What would happen if all these flowers should develop into pods? How many flower clusters do you find on one plant? Which of these clusters open first? Last?

4. Take off a single bud with its stem, or pedicel. Does the milky juice come at the break? Is the bud stem stiff or drooping? What is its color and how does it feel? What is the shape of the bud? How many sepals has it? Look at the stem, sepals and bud with a lens and describe their covering. Look for a flower just opening where the petals stand out around it like a five-pointed star. What is their color? What happens to the petals when the flower is fully expanded? Can you see the sepals then? Look straight into the flower. Do you see the five nectar-horns? Look at them with a lens and describe them. What do you suppose is the use of the little curved tongue coming out of each? Where does the tip of the tongue rest? With a lens, look between two of the nectar horns; can you see a little slit or pocket, with white protruding edges? Note just above the pocket a black dot; thrust a needle into this pocket near its base and lift it toward the crown of the flower, touching the black dot. What happens?

5. Describe the little branched object that came out when you touched it with a needle. These are the pollen saddle-bags and each bag comes from a pocket at one side of, and above the long pocket. Do these saddle-bags cling to the needle? Look with a lens at some of the older flowers, and see if you can find the pollen-bags protruding from the long pocket. See if you can find how the long pocket is a passageway to the stigma. To see how the little saddle-bags were transported, watch a bee gathering nectar. Describe what happens.

6. Since the flowers bend over, how must the bee hold on to the flower while she gathers nectar from the horns? As she turns around, would she naturally pull out some of the saddle-bags? Catch a bee in a collecting tube and see if her feet have upon them these pollen-sacs. After gathering these pollen-sacs upon her feet, what happens to them when she visits the next flower? Is the opening of the long pocket like a trap to scrape the sacs off? Can you find on milkweed flowers any bees or other insects that have been entangled in these little traps and have thus perished? Try the experiment of drawing a thread into one of these traps and with your lens see if the opening closes over it.

7. How many kinds of insects do you find visiting the milkweed flowers? Can you detect the strong odor of the flowers? Why must the milkweed develop so many flowers and offer such an abundance of nectar?

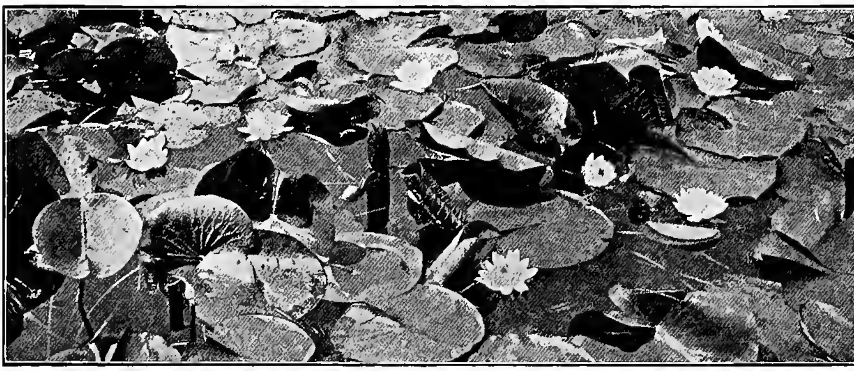


Photo by Verne Morton.

THE WHITE WATER LILY

Teacher's Story

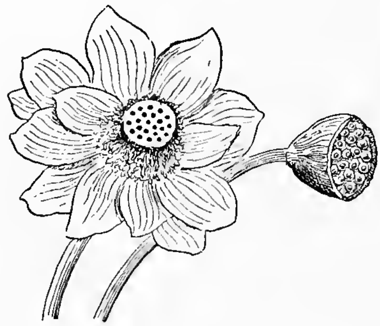
"Whence O fragrant form of light,
Hast thou drifted through the night
Swanlike, to a leafy nest,
On the restless waves at rest."

Thus asks Father Tabb, and if the lily could answer it would have to say: "Through ages untold have the waves upheld me until my leaves and my flowers have changed into boats, my root to an anchor, and my stems to anchor-ropes."

There is no better example for teaching the relation between geography and plant life than the water lily. Here is a plant that has dwelt so long in a certain situation that it cannot live elsewhere. The conditions which it demands are quiet water, not too deep, and with silt bottom. Every part of the plant relies upon these conditions. The rootstock has but few root hairs; and it lies buried in the silt, not only because this gives it food, but because it can there act as an anchor. Rising from the rootstock is a stem as pliable as if made of rubber, and yet it is strong;

its strength and flexibility are gained by having at its center four hollow tubular channels, and smaller channels near the outside. These tubes extend the whole length of the stem, making it light so that it will float, and at the same time giving it strength as well as flexibility. At the upper end of the stem is a leaf or flower, which is fashioned as a boat. The circular leaf is leathery and often bronze-red below, with prominent veins, making an excellent bottom to the boat; above, it is green with a polished surface, and here are situated its breathing-pores, although the leaves of most plants have these stomata in the lower surface. But how could the water lily leaf breathe, if its stomata opened in the water? The leaf is large, circular and quite heavy; it would require a very strong, stiff stem to hold it aloft, but by its form and structure it is fitted to float upon the water, a little green dory, varnished inside, and waterproof outside.

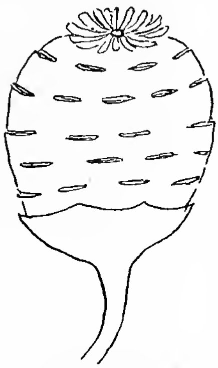
The bud is a little, egg-shaped buoy protected by its four pinkish brown, leathery sepals; as it opens, we can see four rows of petals, each overlapping the space between the next inner ones; at the center there is a fine display of brilliant yellow anthers. Those hanging over the greenish yellow pit, which has the stigma at its center, are merely golden hooks. When the flower is quite open, the four sepals, each a canoe in form, lie under the lily and float it; although the sepals are brownish outside, they are soft white on the inside next the flower. Between each two sepals stands a large petal, also canoe-shaped, and perhaps pinkish on the outside; these help the sepals in floating the flower. Inside of these there is a row of large creamy white petals which stand upright; the succeeding rows of petals are smaller toward the center and grade into the outer rows of stamens, which are petallike at the base and pointed at the tip. The inner rows of stamens make a fine golden fringe around the cup-shaped pistil. This flower is of great use in teaching that sepals, petals and stamens have the same origin and grade into each other, showing the intermediate stages.



Egyptian lotus flower and seed-vessel.

It has been stated that pond lilies, in the state of nature, have an interesting way of opening in the early morning, closing at noon and opening again toward evening. If we knew better the habits of the insects which pollenate these flowers, we should possibly have the key to this action. In our ponds in parks and grounds we find that each species of pond lily opens and closes at its own particular time each day. Each flower opens usually for several consecutive days, and the first day of its blooming it opens about an hour later and closes an hour earlier than on the days following. After the lilies have blossomed, the flower stem coils in a spiral and brings the ripening seeds below the surface of the water. The reason for this has not yet been discovered. After about two months the pod bursts letting the seeds out in the water. Each seed is in a little bag, which the botanists call an aril, and which serves as a life preserver floating the seed off for some distance from the parent plant. The aril finally decays and the seed falls to the bottom where, if the conditions are favorable, it develops into a new plant.

To emphasize the fact that the water lily is dependent upon certain geographical conditions, ask the pupils to imagine a water lily planted upon a hillside. How could its roots, furnished with such insufficient rootlets, get nourishment there? How could its soft, flexible stems hold aloft the heavy leaves and blossoms to the sunlight? In such a situation it would be a mere drooping mass. Moreover, if the pupils understand the conditions in which the water lilies grow in their own neighborhood, they can understand the conditions under which the plant grows in other countries. Thus, when they read about the great *Victoria regia* of the Amazon,—that water lily whose leaves are large enough to support a man,—they would have visions of broad stretches of still water and they should realize that the bottom must be silt. If they read about the lotus of Egypt, then they should see the Nile as a river with borders of still water and with bottom of silt. Thus, from the conditions near at hand, we may cultivate in the child an intelligent geographical imagination.



Seed vessel of white pond lily.

LESSON CXXXII

The Water Lily

Leading thought—The water lily has become dependent upon certain conditions in pond or stream, and has become unfitted in form to live elsewhere. It must have quiet waters, not too deep, and with silt bottom.

Method—The study should be made first with the water lilies in a stream or pond, to discover just how they grow. For the special structure, the leaves and flowers may be brought to the schoolroom and floated in a pan of water. The lesson may easily be modified to fit the yellow water lily, which is in many ways even more interesting, since in shallow water it holds its leaves erect while in deeper water its leaves float.

Observations—1. Where is the water lily found? If in a pond, how deep is the water? If in a stream, is it in the current? What kind of bottom is there to the stream or pond? Do you find lilies in the water of a limestone region? Why?

2. What is the shape of the leaf? What is the color above and below? What is the texture? How is it especially fitted to float? How does it look when very young?

3. Examine the petiole. How long is it? Is it stiff enough to hold up the leaf? Why does it not need to hold up the leaf? How does it serve as an anchor? Cut a stem across and describe its inside structure. How does this structure help it float?

4. Examine the open flower. How many sepals? How many rows of petals? How do the stamens resemble the petals? Can you see in the water lily how the sepals, petals and stamens may all be different forms of the same thing? How are the sepals fitted to keep the flower afloat? At what times of the day does the lily open? At what hours does it close?

5. Describe the pistil. When the lily first opens, how are the stamens placed around the pistil? What happens to the seed-box after the blossoms have faded? Does the seed-pod float upon the water as did the flower? What sort of stem has the flower? How does this stem hold the seed-pod below the water?

6. What sort of seed has the water lily? Sketch the seed-pod. How does the seed escape from it? How is it scattered and planted?

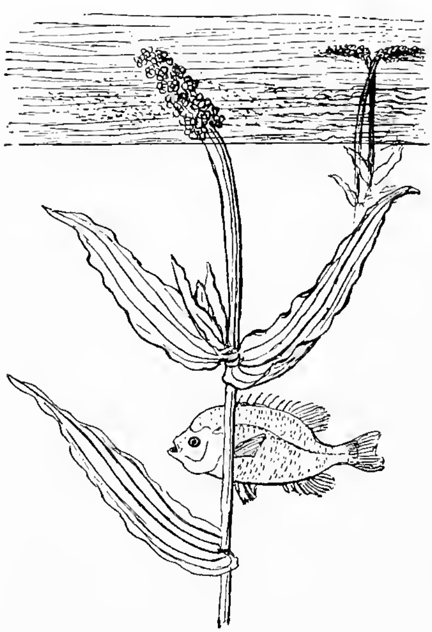
7. What sort of a root has the water lily? Are there many fine rootlets upon it? Why? How does this rootstock serve the plant aside from getting food?

8. Imagine a water lily set on a dry hillside. Could the stems uphold the flowers or leaves? Is the petiole large enough to hold out such a thick, heavy leaf? Could the root get food from a dry location? Why?

9. Judging from what you know of the places where water lilies grow and the condition of the water there, describe the Nile where the lotus grows. Describe the Amazon where the *Victoria regia* grows.

PONDWEED

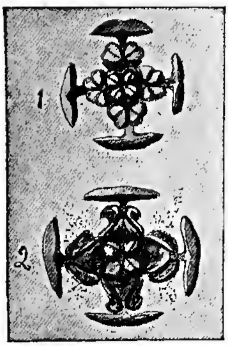
Teacher's Story



THE study of any plant which has obvious limitations as to where it may grow should be made a help in the study of geography. Pondweed is an excellent subject to illustrate this principle; it grows only in quiet beds of sluggish streams or in ponds, or in the shallow protected portions of lakes. It has tremendous powers of stretching up, which render it able to grow at greater depth than one would suppose possible, often flourishing where the water is from ten to twenty feet deep. Often, when the sun is shining, it may be seen like a bed of seaweed on the bottom. Its roots, like those of most water plants, have less to do with the matter of absorbing water and nourishment than do the roots of land plants, one of their chief functions being to anchor the plant fast; they have a firm grip on the bottom; and if pondweed is cut loose, it at once comes to the surface, floats helplessly on its side, and soon dies.

The stem is very soft and pliable and the plant relies entirely on the water to keep it upright. A cross-section of the stem shows that its substance is spongy, with the larger open cells near the outer edge, thus helping it to float. The leaves are two or three inches long, their broad bases encircling the stem, their tips tapering to slender points. They have parallel veins and ruffled edges. They are dull olive green in color, much darker than the stems; in texture they are very thin, papery, and so shining as to give the impression of being varnished. No land plants have such leaves; they remind us at once of kelp or other seaweeds. The leaves are scattered along the stems, by no means thickly, for water plants do not seem to need profuse foliage.

In blossom time the pondweed shows its real beauty. The stems grow and grow, like Jack's bean stalk, and what was a bed of leaves on the pond bottom suddenly changes into a forest of high plants, each one standing tall and straight and with every leaf extended, as if its stems were as strong and stiff as ironwood; but if a wave disturbs the water the graceful undulations of the plant tell the true story of the pliant stems. There is something that arouses our admiration when we see one of these pondweeds grown so straight and tall, often three or four yards high, in order to place its little, greenish-brown flower-head above the water's surface. We have spent hours looking down into such a submerged forest, dreaming and wondering about the real meaning of such adaptations.



1, *Flower of a pondweed enlarged, early stage,* 2, *Same at later stage.*

Although the stem is flexible, the somewhat curved, enlarged portion of it just below the flower-head is rigid; it is also more spongy than the lower part of the stem and is thus fitted to float the flower. The flower itself is one of the prettiest sights that nature has to show us through a lens. It is a Maltese cross, the four reddish stigmas arranged in a solid square at the center; at each side of this central square is a double-barrelled anther, and outside of each anther is a queer, little, dipper-shaped, green sepal. When the anthers open, they push away from the stigmas and throw their pollen toward the outside. There may be thirty or more of these tiny, cross-shaped flowers in one flower-head. In the bud, the cup-shaped sepals shut down closely, exposing the stigmas first, which would indicate that they ripen before the pollen is shed. The pollen is white, and is floated from plant to plant on the surface of the water; often the water for yards will be covered with this living dust.

LESSON CXXXIII

Pondweed

Leading thought—The pondweed lives entirely below the water; at blossom time, however, it sends up its flower stems to the surface of the water, and there sheds its pollen, thus securing cross-pollenation.

Method—As this is primarily a lesson that relates to geography, the pondweed should be studied where it is growing. It may be studied in the spring or fall, and the pupils asked to observe the blossoming which occurs in late July. After the pupils have seen where it grows, the plants themselves may be studied in an aquarium, or by placing them in a pail or basin of water. There are confusing numbers of pondweeds but any of them will do for this lesson. The one described in the Teacher's Story is probably *P. perfoliatus.*

Observations—1. Where is the pondweed found? Does it ever grow out of water? Does it ever grow in very deep water? Does it ever grow in swiftly flowing water?

2. Has the pondweed a root? Does the pondweed need to have water carried to its leaves, as it would if it were living in the air? What is one of the chief uses of the roots to the pondweed? Break off a plant, does it float? Do you think it would float off and die, if it was not anchored by its root?

3. Compare the stem of pondweed with that of any land plant standing straight. What is the chief difference? Why does the pondweed not need a stiff stem to hold it up? Cut the stem across, and see if you can observe why it floats?

4. Examine the leaves. Are all of them below the surface of the water? If some float, how do they differ in texture and form from those submerged? How are they arranged on the stem? Are they set close together? What is the difference in texture between its leaves and those of the jewelweed, dock or any other land plant? If any leaves project out of the water are they different in form and texture from those submerged? Sketch the leaf, showing its shape, its edges, and the way it joins the stem.

5. How far below the surface of the water does the pondweed usually lie? Does it ever rise up to the water's surface? When? Have you ever noticed the pondweed in blossom? How does the blossom look on the water? Can you see the white pollen floating on the surface of the water? Look down into the water and see the way the pondweed stands in order to float its blossoms.

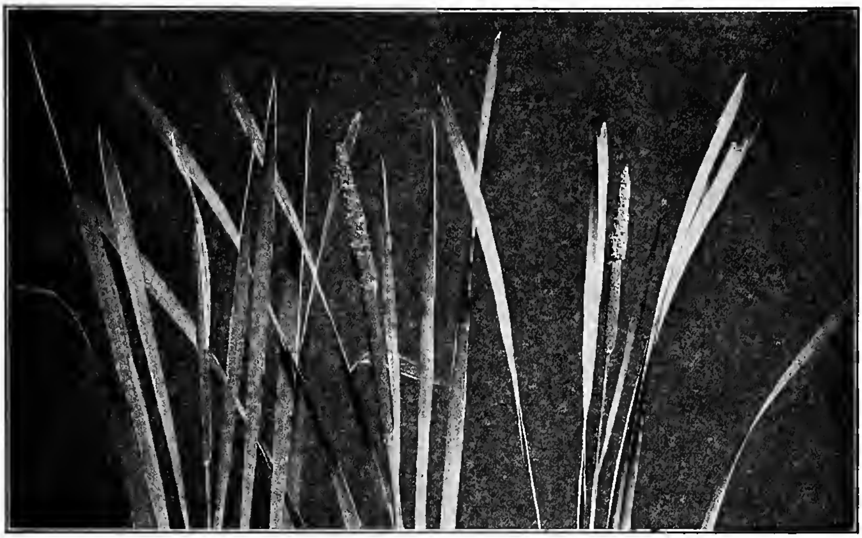
6. Study the blossom. Note the stem that bears it. Is the part that bears the flower enlarged and stiffer than the stem below? Do you think that this enlarged part of the stem acts like the bob on a fish-line? Examine a flower cluster with a lens. How many flowers upon it? Study one flower carefully. Describe the four stigmas at the center. Describe the anthers arranged around them. Describe the sepal which protects each anther. When the anthers open do they discharge the pollen toward or away from the stigmas?

7. What happens after the flowers are pollenated? Do they still float? What sort of seed-capsule has the pondweed? Do the seeds break away and float?

"Again the wild cow-lily floats
Her golden-freighted, tented boats,
In thy cool caves of softened gloom,
O'ershadowed by the whispering reed,
And purple plumes of pickerel weed,
And meadow-sweet in tangled bloom.

"The startled minnows dart in flocks,
Beneath thy glimmering amber rocks,
If but a zephyr stirs the brake;
The silent swallow swoops, a flash
Of light, and leaves with dainty plash,
A ring of ripples in her wake."

—"Birch Stream", ANNA BOYNTON AVERILL.

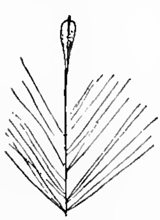


Cat-tail flag in blossom.
The staminate flowers are massed at the tip, and the pistillate flowers which form the "cat-tail" are massed lower down on the stalk.
Photo by Verne Morton.

THE CAT-TAIL

Teacher's Story

In June and early July, if the cat-tail be closely observed, it will be seen to have the upper half of the cat's tail much narrower and different in shape from the lower half—as if it were covered with a quite different fur. It seems to be clothed with a fine drooping fringe of olive-yellow. With the aid of a lens, we can see that this fringe is a mass of crowded anthers, two or three of them being attached to the same stalk by a short filament. These anthers are packed full of pollen, which is sifted down upon the pistillate flowers below by every breeze; and with every puff of stronger wind, the pollen is showered over all neighboring flowers to the leeward. There is not much use in trying to find the pistillate flowers in the plush of the cat-tail. They have no sepals nor petals, and are so imbedded in the thick pappus which forms the plush that the search is hardly worth while for nature-study, unless a microscope is used. The ovary is rather long, the style slender, and the stigma reaches out to the cut-plush surface of the cat-tail. The pupils can find what these flowers are by studying the seed; in fact, the seed does not differ very much from the flower, except that it is mature and is browner in color.



A cat-tail seed with its balloon.

It is an interesting process to take apart a cat-tail plant; the lower, shorter leaves surround the base of the plant, giving it size and strength. All the leaves have the same general shape, but vary in length. Each leaf consists of the free portion, which is long and narrow and flat towards its tapering tip but is bent into a trough as it nears the plant, and the lower portion of the leaf, which clasps the plant entirely or partially, depending upon whether it is an outer or inner leaf, and thus adds to its strength. We almost feel as if these alternate leaves were consciously doing their best to protect the slender, flower stem. The free part of the leaves is strengthened by lengthwise veins, and they form edges that never tear nor break. They are very flexible, and therefore yield to the wind rather than defy it. If we look at a leaf in cross-section, we can see the two thick walls strengthened by the framework of stiff veins which divide the interior into long cells. If we cut the leaf lengthwise we can see that these long cells are supported by stiff, coarse partitions.

Where the leaf clasps the stem, it is very stiff and will break rather than bend. The texture of the leaf is soft and smooth, and its shade of green is attractive. The length of the leaves is often greater than that of the blossom stalk, and their graceful curves contrast pleasantly with its ramrod-like stiffness. It is no wonder that artists and the decorators have used the cat-tail lavishly as a model. It is interesting to note that the only portion of the leaves injured by the wind is the extreme tip.

The cat-tail is adapted for living in swamps where the soil is wet but not under water all the time. When the land is drained, or when it is flooded for a considerable time, the cat-tails die out and disappear. They usually occur in marshy zones along lakes or streams; and such a zone is always sharply defined by dry land on one side and water on the other. The cat-tail roots are fine and fibrous and are especially fitted, like the roots of the tamarack, to thread the mud of marshy ground and thus gain a foothold. The cat-tails form one of the cohorts in the phalanx of encroaching plants, like the reeds and rushes, which surround and, by a slow march of years, finally conquer and dry up ponds. But in this they overdo the matter, since after a time the soil becomes too dry for them and they disappear, giving place to other plants which find there a congenial environment. The place where I studied the cat-tails as a child is now a garden of joe pye weed and wild sunflowers.

Reference—Plant Life, Coulter.

LESSON CXXXIV

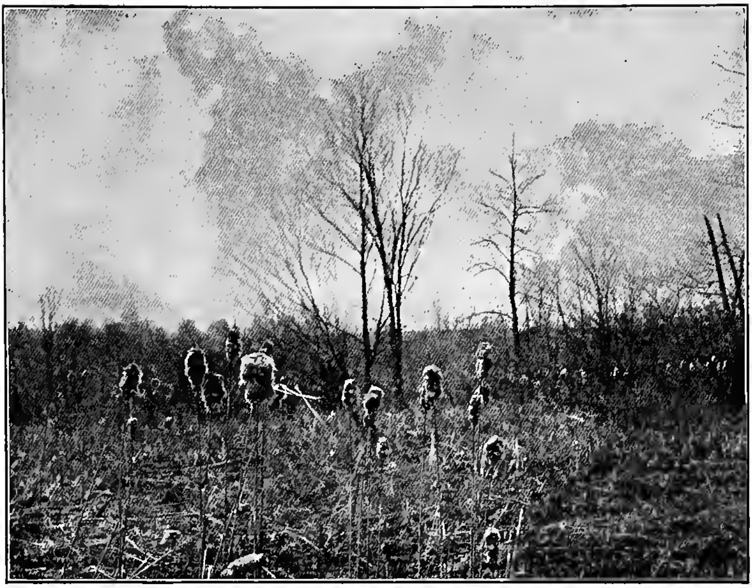
The Cat-tail

Leading thought—The cat-tail is adapted to places where the soil is wet but not under water; its pollen is scattered by the wind, and its seeds are scattered by wind and water. Its leaves and stalks are not injured nor broken by the wind.

Method—As this is primarily a geography lesson, it should be given in the field if possible; otherwise the pupils must explore for themselves to discover the facts. The plant itself can be brought into the schoolroom for study. When studying the seeds, it is well to be careful, or the schoolroom and the pupils will be clothed with the pappus for weeks.

Observations—1. Where are the cat-tails found? Is the land on which they grow under water all the year? At any part of the year? Is it dry land all the year? What happens to the cat-tails, if the land on which they grow is flooded for a season? What happens to them, if the land is drained?

2. How wide a strip do the cat-tails cover, where you have found them? Are they near a pond or brook or stream Do they grow out in



Cat-tails sending off their seed balloons.
Photo by Verne Morton.

the stream? Why do they not extend further inland? What is the character of the soil on which they grow?

3. What sort of a root has the cat-tail? Why is this root especially adapted to the soil where cat-tails grow? Describe the rootstock.

4. *The cat-tail plant.* Are the leaves arranged opposite or alternate? Tear off a few of the leaves and describe the difference between the lower and the upper end of a leaf as follows: How do they differ in shape? Texture? Pliability? Color? Width? Does each leaf completely encircle the stalk at its base? Of what use is this to the plant? Of what use is it to have the plant stiffer where the leaves clasp the stalk? What would happen in a wind storm if this top-heavy, slender seed stalk was bare and not supported by the leaves? What is the special enemy of long, tall, slender-leafed plants?

5. Take a single leaf, cut it across near where it joins the main stalk and also near its tip. Look at the cross-section and see how the leaf is veined. What do its long veins or ribs do for the leaf? Split the leaf lengthwise and see what other supports it has. Does the cat-tail leaf break or tear along its edges easily? Does the wind injure any part of the leaf?

6. Study the cat-tail flowers the last half of June. Note the part that will develop into the cat's tail. Describe the part above it. Can you see where the pollen comes from? The pistillate flowers which are in the plush of the cat-tail have no sepals, petals, odor nor nectar. Do you think that their pollen is carried to them by the bees? How is it carried?

7. Examine the cat-tail in fall or winter. What has happened to that part of the stalk above the cat-tail where the anthers grew? Study

two or three of the seeds, and see how they are provided for traveling. What scatters them? Will the cat-tail seed balloons float? Would the wind or the water be more likely to carry the cat-tail seeds to a place where they would grow? Describe the difference between the cat-tail balloon and the thistle balloon.

8. How crowded do the cat-tail plants grow? How are they arranged to keep from shading each other? In how many ways is the wind a friend of the cat-tails?

9. How do the cat-tails help to build up land and make narrower ponds and streams?

Daises and grasses.

LESSON CXXXV

A Type Lesson for a Composite Flower

Leading thought—Many plants have their flowers set close together to make a mass of color, like the geraniums or the clovers. But there are other plants where the flowers of one flower-head act like the members of a family, those at the center doing a certain kind of work for the production of seed, and those around the edges doing another kind of work. The sunflower, goldenrod, asters, daisies, cone-flower, thistle, dandelion, burdock, everlasting, and many other common flowers have their blossoms arranged in this way. Before any of the wild-flower members of this family are studied, the lesson on the garden sunflower should be given. (See Lesson CLXII).

Method—These flowers may be studied in the schoolroom with suggestions for field observations. A lens is almost necessary for the study of most of these flowers.

Observations—1. Can you see that what you call the flower consists of many flowers set together like a beautiful mosaic? Those at the center are called disk-flowers; those around the edges banner or ray-flowers.

2. Note that the flowers around the edges have differently shaped corollas than those at the center. How do they differ? Why should these be called the banner flowers? Why should they be called the ray-flowers? How many banner-flowers are there in the flower family you are studying? How are the banners arranged to make the flower-head more attractive? Cut off or pull out all the banner-flowers and see how the flower-head looks. What do the banner-flowers hold out their ban-

ners for? Is it to attract us or the insects? Has the banner-flower any stigma or stamens?

3. Study the flowers at the center. Are they open, or are they unfolded, buds? Can you make a sketch of how they are arranged? Are any of the florets open? What is the shape and the color of the corolla? Can you see the stamen-tubes pushing out from some? What color are the stamen-tubes? Can you see the two-parted stigmas in others? What color is the pollen. Do the florets at the center or at the outside of the disk open first? When they first open, do you see the stamen-tube or the stigma?

4. The flower-heads are protected before they open with overlapping bracts, which may be compared to a shingled house protecting the flower family. As the flower-head opens, these bracts are pushed back beneath it. Describe the shape of these bracts. Are they set in regular, overlapping rows? Are they rough or smooth? Do they end bluntly, with a short point, with a long point, with a spine, or a hook? How do the bracts act when the flower family goes to sleep? Do they remain after the seeds are ripened?

5. Take a flower-head apart, and examine the florets. Can you see what part of the floret will be the seed? Is there a fringe of pappus above it? If so, what will this be on the seed?

6. Study the ripe seeds. How are they scattered? Do they have balloons? Is the balloon close to the seed? Is it fastened to all parts of it?

THE GOLDENROD

Teacher's Story

Goldenrod.

Once I was called upon to take some children into the field to study autumn flowers. The day we studied goldenrod, I told them the following story on the way, and I found that they were pleased with the fancy and through it were led to see the true purpose of the goldenrod blossoming:

"There are flowers which live in villages and cities, but people who also live in villages and cities are so stupid that they hardly know a flower city when they see it. This morning we are going to visit a golden city where the people are all dressed in yellow, and where they live together in families; and the families all live on top of their little, green, shingled houses, which are set in even rows along the street. In each of these families, there are some flowers whose business it is to furnish nectar and pollen and to produce seeds which have fuzzy balloons; while there are other flowers in each family which wave yellow banners to all the insects that pass by and signal them with a code of their own, thus: 'Here, right this way is a flower family that needs a bee or a beetle or an insect of some sort to bring it pollen from abroad, so that it can ripen its seed; and it will give nectar and plenty of pollen in exchange.' Of course, if the flowers could walk around like people, or fly like insects, they could fetch and carry their own pollen, but as it is, they have to depend upon insect messengers to do this for them. Let us see who of us will be the first to guess what the name of this golden city is, and who will be the first to find it."

A street in goldenrod city.

The children were delighted with this riddle and soon found the goldenrod city. We examined each little house with its ornate, green "shingles." These little houses, looking like cups, were arranged on the street stem, right side up, in an orderly manner and very close together; and where each joined the stem, there was a little, green bract for a doorstep. Living on these houses we found the flower families, each consisting of a few tubular disk-flowers opening out like bells, and coming from their centers were the long pollen-tubes or the yellow, two-parted stigmas. The ray-flowers had short but brilliant banners; and they, as well as the disk-flowers, had young seeds with pretty fringed pappus developing upon them. The banner-flowers were not set so regularly around the edges as in the asters; but the families were such close neighbors, that the banners reached from one house to another. And all of the families on all of the little, green streets were signalling insects, and one boy said, "They must be making a very loud yellow noise." We found that very many insects had responded to this call—honeybees, bumblebees, mining and carpenter bees, blue-black blister beetles with short wings and awkward bodies, beautiful golden-green chalcid flies, soldier beetles and many others; and we found the spherical gall and the spindle-shaped gall in the stems, and the strange gall up near the top which grew among the leaves.

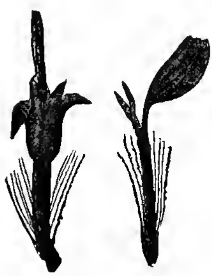
Unless one is a trained botanist it is wasted energy to try to distinguish any but the well-marked species of goldenrod; for, according to Gray, we have 56 species, the account of which makes twelve pages of most uninteresting reading in the new Manual. The goldenrod family is not in the least cliquish, the species have a habit of interbreeding to the confusion of the systematic botanist. Matthew's Field Book serves as well as any for distinguishing the well-marked species.

LESSON CXXXVI

The Goldenrod

Leading thought—In the goldenrod the flower-heads or families are so small that, in order to attract the attention of the insects, they are set closely together along the stem to produce a mass of color.

Method—Bring to the school-room any kind of goldenrod, and give the lesson on the flowers there. This should be followed by a field excursion to get as many kinds of goldenrod as possible. The following observations will bring out differences in well-marked species:



Disk-flower and banner-flower of goldenrod.

Observations—1. Use Lesson CXXXV to study the flower. How many banner-flowers in the family? How many disk-flowers? Are the banners arranged as regularly around the edges as in the asters and daisies? How are the flower-heads set upon the stems? Which flower-heads open first—those at the base or at the tip of the stem? Do the upper stems of the plant blossom before those lower down?

2. Do the stems bearing flowers come from the axils of the leaves? What is the general shape of the flower branches? Do they come off evenly at each side, or more at one side? Are the flower branches long or short? Make a sketch of the general shape of the goldenrod you are studying.

3. Is the stem smooth, downy, or covered with bloom? What is its color? In cross-section, is it circular or angular?

4. What is the shape and form of the edges of the lower leaves? The upper ones? Are they set with, or without, petioles on the stem? Do they have a heart-shaped base? Are the leaves smooth or downy? Are they light, or dark green?

5. *Field notes.* Where do you find the goldenrod growing? Do you find one kind growing alone or several kinds growing together? Do you find any growing in the woods? If so, how do they differ in shape from those in the field?

6. How many kinds of insects do you find visiting goldenrod flowers? How many kinds of galls do you find on the goldenrod stems and leaves?

7. Study the goldenrods in November. Describe their seeds and how they are scattered.

"I am alone with nature,
With the soft September day;
The lifting hills above me,
With goldenrod are gay.
Across the fields of ether
Flit butterflies at play;
And cones of garnet sumac
Glow down the country way.

"The autumn dandelion
Beside the roadway burns;
Above the lichened boulders
Quiver the plumèd ferns.
The cream-white silk of the milkweed
Floats from it's sea-green pod;
From out the mossy rock-seams
Flashes the goldenrod."

—Mary Clemmer Ames.

THE ASTERS

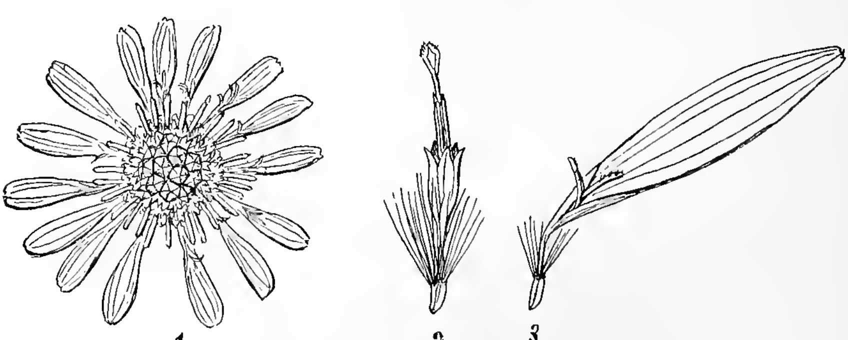
Teacher's Story

LET us believe that the scientist who gave to the asters their Latin name was inspired. Aster means *star* and these, of all flowers, are most starlike; and in beautiful constellations they border our fields and woodsides. The aster combination of colors is often exquisite. Many have the rays or banners lavender, oar-shaped and set like the rays of a star around the yellow disk-flowers; these latter send out long, yellow anther tubes, overflowing with yellow pollen, and add to the stellar appearance of the flower-head.

"And asters by the brookside make asters in the brook."

Thus sang H. H. of these beautiful masses of autumn flowers. But if H. H. had attempted to distinguish the species, she would have said rather that asters by the brookside make more asters in the book: for Gray's Manual assures us that we have 77 species including widely different forms, varying in size, color and also as to the environment in which they will grow. They range from the shiftless woodland species, which has a few whitish ray-flowers hanging shabbily about its yellow disk and with great, coarse leaves on long, gawky petioles climbing the zigzag stem, to the beautiful and dignified New England aster, which brings the glorious purple and orange of its great flower-heads to decorate our hills in September and October.

Luckily, there are a few species which are fairly well marked, and still more luckily, it is not of any consequence whether we know the species or not, so far as our enjoyment of the flowers themselves is concerned. The outline of this lesson will call the attention of the pupils to the chief points of difference and likeness in the aster species, and they will thus learn to discriminate in a general way. The asters, like the goldenrods, begin to bloom at the tip of the branches, the flower-heads nearest the central stem, blooming last. All of the asters are very sensitive, and the flower-heads will close promptly as soon as they are gathered. The ray or banner-flowers are pistillate, and therefore develop seed. The seed has



1, an aster flower-head enlarged; 2, a disk-flower; 3, a banner-flower.

attached to its rim a ring of pappus, and is ballooned to its final destination. In November, the matured flower-heads are fuzzy, with seeds ready for invitations from any passing wind to fly whither it listeth.

LESSON CXXXVII
The Asters

Leading thought—There are very many different kinds of asters, and they all have their flowers arranged similarly to those of the sunflower.


Asters.

Method—Have the pupils collect as many kinds of asters as possible, being careful to get the basal leaves and to take notes on where each kind was found—that is, whether in the woodlands, by the brooksides or in the open fields. This lesson should follow that on the sunflower.

Observations—1. What was the character of the soil and surroundings where this aster grew? Were there large numbers of this kind growing together? Were the flowers wide open when you gathered them? How soon did they close?

2. How high did the plants stand when growing? Were there many flowers, or few, on each plant?

3. Study the lower and the upper leaves. Describe each as follows: the shape, the size, the edges, the way it was joined to the stem.

4. Is the stem many-branched or few? Do the branches bearing flowers extend in all directions? Are the stems hairy or smooth, and what is their color?

5. What is the diameter of the single flower-head? What is the color of the ray-flowers? How many ray or banner-flowers are there? What is the shape of a single banner as compared with that of a sunflower? What are the colors of the disk-flowers? Of the pollen? Do the disk-flowers change color after blossoming?

6. Look at the bracts below the flower-head. Are they all the same shape? What is their color? Do they have recurved tips or do they overlap closely? Are they sticky?

7. Take the aster flower-head apart and look at it with a lens. In a disk-flower, note the young seed, the pappus, the tubular five-parted corolla, the anther tube and the stigmas. In the ray-flower, find the young seed, the pappus and the stigma.

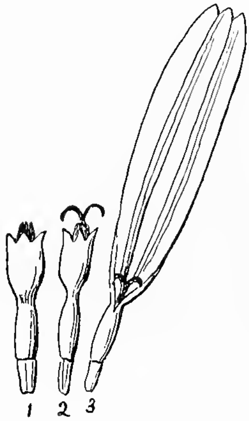
8. Watch the bees working on asters, and find where they thrust their tongues to reach the nectar.
9. Study an aster plant in November, and describe the seeds and how they are scattered.

Gathering daisies.
Photo by Verne Morton

THE WHITE DAISY

Teacher's Story

Every child loves this flower, and yet it is not well understood; it is always at hand for study from June until the frosts have laid waste the fields. However much enjoyment we get from the study of this beautiful flower-head, we should study the plant as a weed also, for it is indeed a pest to those farmers who do not practice a rotation of crops. Its root is long and tenacious of the soil, and it ripens many seeds which mingle with the grass seed, and thus the farmer sows it to his own undoing. The bracts of the involucre, or the shingles of the daisy-house, are rather long, and have parchment like margins. They overlap in two or three rows. In the daisy flower-head, the banner-flowers are white; there may be twenty or thirty of these, making a beautiful frame for the golden-yellow disk-flowers. The banner is rather broad, is veined, and toothed at the tip. The banner-flower has a pistil which shows its two-parted stigma at the base of the banner, and it matures a seed. The disk-flowers are brilliant yellow, tubular, rather short, with the five points of the



Daisy florets.

1, Disk-flower in pollen-stage; 2, Disk-flower in stigma-stage; 3, Ray-flower. All enlarged.

corolla curling back. The anther-tubes and the pollen are yellow, so are the stigmas. The arrangement of the buds at the center is exceedingly pretty. The flowers develop no pappus, and therefore the seeds have no balloons. They depend upon the ignorance and helplessness of man to scatter their seeds far and wide with the grass and clover seed, which he sows for his own crops. It was thus that it came to America, and in this manner still continues to flaunt its banners in our meadows and pastures. The white daisy is not a daisy, but a chrysanthemum. It has never been called by this name popularly, but has at least twenty other common names, among them the ox-eye daisy, moon-penny, and herb-Margaret.

LESSON CXXXVIII

The White Daisy

Leading thought—The white-daisy is not a single flower but is made up of many little flowers and should be studied by the outline given in Lesson CXXXV.

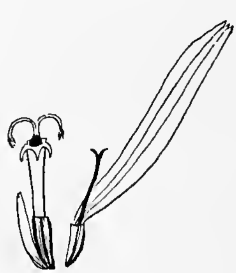
A daisy meadow.

THE YELLOW DAISY, OR BLACK-EYED SUSAN

Teacher's Story

These beautiful, showy flowers have rich contrasts in their color scheme. The ten to twenty-ray flowers wave rich, orange banners around the cone of purple-brown disk-flowers. The banners are notched and bent downward at their tips; each banner-flower has a pistil, and develops a seed. The disk-flowers are arranged in a conical, button-like center; the corollas are pink-purple at the base of the tube, but their five recurved, pointed lobes are purple-brown. The anther-tube is purple-brown and the stigmas show the same color; but the pollen is brilliant orange, and adds much to the beauty of the rich, dark florets when it is pushed from the anther-tubes. There is no pappus developed, and the seeds are carried as are the seeds of the white daisy, by being harvested with the seeds of grain.

The stem is strong and erect; the bracts of the involucre, or "shingles", are long, narrow and hairy, the lower ones being longer and wider than those above; they all spread out flat, or recurve below the open flower-head. In blossoming, first the ray-flowers spread wide their banners; then the flowerets around the base of the cone open and push out their yellow pollen through the brown tubes; then day by day the blossoming circle climbs toward the apex—a beautiful way of blossoming upward.



Disk-flower and ray-flower.

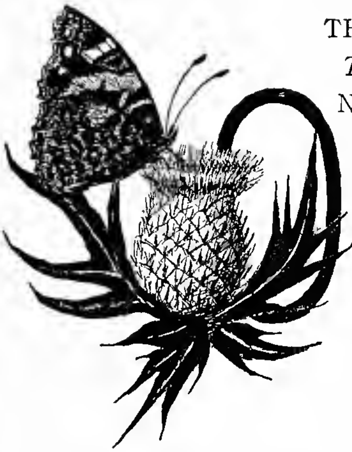
LESSON CXXXIX

THE BLACK-EYED SUSAN

Leading thought—This flower should be studied by the outline given in Lesson CXXXV.

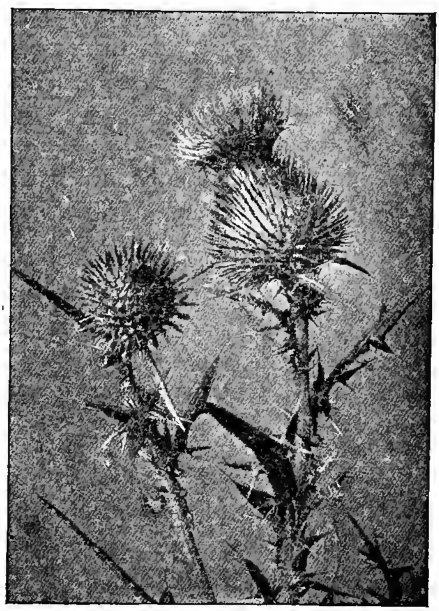
THE THISTLE

Teacher's Story



IN looking at the thistle from its own standpoint, we must acknowledge it to be a beautiful and wonderful plant. It is like a knight of old encased in armor and with lance set, ready for the fray. The most impressive species is the great pasture, or bull, thistle (*C. pumilis*), which has a blossom-head three inches across. This is not so common as the lance-leaved thistle, which ornaments roadsides and fence corners, where it may remain undisturbed for the necessary second year of growth before it can mature its seeds. The most pernicious species, from the farmer's standpoint, is the Canada thistle. Its roots are perennial, and they invade garden, grain field and meadow. They creep for yards in all directions, just deep enough to be sure of moisture, and send up new plants here and there, especially if the main stalk is cut off. Roots severed by the plow, send up shoots from both of the broken parts. Not so with the common thistle, which has a single main root, with many fibrous and clustered branches but with no side shoots.

The stalk of the lance-leaved thistle is strong and woody, and is closely hugged by pricky leaf stems, except for a few inches above the root. The leaves are placed alternately on the stalk; they are deep green, covered above with rough and bristling hairs, and when young are covered on the under side with soft, gray wool which falls away later. The spines grow on the edges of the leaves, which are deeply lobed and are also somewhat wavy and ruffled, thus causing the savage spears to meet the enemy in any direction. The ribs and veins are without spines. Small buds or branches may be found at the axils of the leaves; and if a plant is beheaded, those axiliary buds nearest the top of the stem will grow vigorously.



Lance-leaved thistle.

The thistle flowers are purple in color and very fragrant; they grow in single heads at the summit of the stalk, and from the axils of the upper leaves. The topmost heads open first. Of the individual flowers in the head, those of the outer rows first mature and protrude their pistils; the pollen grains are white. In each flower, the corolla is tube-shaped and purple, parting into five fringelike lobes at the top, and fading to white at its nectar-filled base.

The stamens have dark purple anthers, united in a tube in which their pollen is discharged. The pistil, ripening later, shoves out the pollen with its stigma, which at first is blunt at the end, its two-parted lips so tightly held together that not a grain of its own flower's pollen can be taken. But when thrust far out beyond the anther-tube, the two-parted stigma opens to receive the pollen which is brought by the many winged visitors; for of all flowers, the thistles with their abundant nectar are the favorites of insects. Butterflies of many species, moths, beetles and bees —especially the bumblebees—are the happy guests of the thistle blooms.

The thistles believe in large families; a single head of the lance-leaved thistle has been known to have 116 seeds. The seeds are oblong, pointed, little akenes, with hard shells. Very beautiful and wonderful is the pappus of the thistle; it is really the calyx of the flower, its tube being a narrow collar, and the lobes are split up into the silken floss. At the larger end of the seed is a circular depression with a tiny hub at its center; into this ring, and around the knob, is fitted the collar which attaches the down to the seed. Hold the balloon between the eye and the light, and it is easy to see that the down is made of many-branched plumes which interlace and make it more buoyant. When first taken from its crowded position on the flower-head, the pappus surrounds the corolla in a straight, close tube; but if placed for just a few moments in the sun, the threads spread, the filmy branchlets open out, and a fairy parachute is formed, with the seed hanging beneath; if no breath of air touches it while spreading, it will sometimes form a perfect funnel; when blown upon, some of the silken threads lose their places on the rim and rise to the center. When driven before the breeze, this balloon will float for a long distance. When it falls, it lets go of the seed as the wind moves it along the rough surface of the ground, and when it is thus unburdened the down fluffs out in every direction, making a perfect globe.

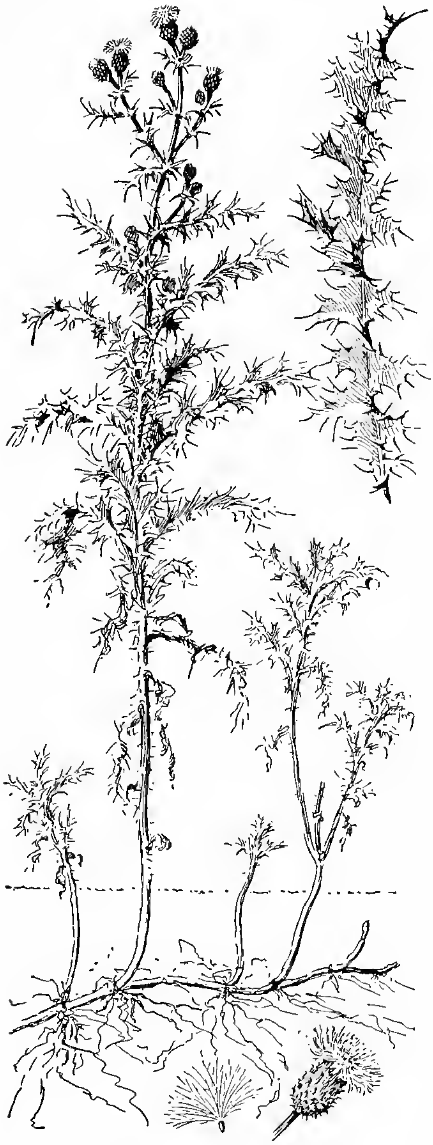
A floret from a thistle flower-head.

For the first season after the seed has rooted, the thistle develops only rosettes, meanwhile putting down roots and becoming permanently established. The next season, the flowers and seeds are developed, and then the plant dies. Would that this fact were true of the Canada thistle; but that, unfortunately, is perennial, and its persistent roots can only be starved out by keeping the stalks cut to the ground for the entire season. This thistle trusts to its extensively creeping rootstocks more than to its seeds for retaining its foothold and for spreading. While it develops many seed balloons, a large number of its seeds are infertile and will not grow.

LESSON CXL

The Common, or Lance-leaved, Thistle

Leading thought—The thistle is covered with sharp spines, and these serve to protect it from grazing animals. It has beautiful purple flowers, arranged in heads similar to those of the sunflower.



The Canada thistle.
Drawing by W. C. Baker.

Method—A thistle plant brought into the schoolroom—root and all—and placed in water will serve well for this lesson. The questions should be given the pupils as to where thistles are found. Any thistle will do for the lesson.

Observations—1. Where do you find the thistles growing? Do you find more than one species growing thickly together? Do you find any of the common thistles growing in soil which has been cultivated this season?

2. Describe the stalk, is it smooth? Is it weak or strong and woody? What sort of root has it?

3. Do the leaves grow alternately or opposite? Are they smooth or downy on one or both sides? Do the spines grow around the margins, or on the leaves and veins? Are the leaf edges flat, or wavy and ruffled?

4. How does this affect the direction in which the spines point? Are the leaves entire or deeply lobed? Have they petioles, or are they attached directly to the stalk?

5. Note if any buds or small branches nestle in the axils of the lower leaves. What effect does cutting the main stalk seem to have on each side shoot?

6. Do the flower-heads of the thistle grow singly or in clusters? Do they come from the summit of the stalk, or do they branch from its sides? Which blossom-heads open first—the topmost or those lowest on the stalk? Are the flowers fragrant? What insects do you most often see visiting thistle blossoms for pollen or nectar? Study the thistle flower according to Lesson CXXXV.

7. Carefully study a thistle balloon. How is the floss attached to the seed? Is it attached to the smaller, or the larger end? Hold the thistle balloon between your eye and the light. Does the down consist of single separate hairs, or have they many fine branches? How is the down

arranged when all the flowers are packed together in the thistle-head? Take a seed from among its closely packed fellows in the thistle-head, and put it in the sun or in a warm, dry place where it cannot blow away. How long does it take for the balloon to open out? What is its shape? Is there any down at the center of the balloon or is it arranged in a funnel-shaped ring? Can you find a perfectly globular thistle balloon with the seeds still attached to it? How far do you think the thistle balloons might travel?

8. If a thistle seed finds a place for planting during the autumn, how does the young plant look the next season? Describe the thistle rosette. What growth does it make the second summer? What happens to it then?

9. Why can you not cultivate out the Canada thistles as you can the other species?

A successful life.

THE BURDOCK

Teacher's Story

Psychologists say that all young things are selfish, and the young burdock is a shining example of this principle. Its first leaves are broad and long, with long petioles by means of which they sprawl out from the growing stem in every direction, covering up and choking out all the lesser plants near them. In fact, the burdock remains selfish in this respect always, for its great basal leaves see to it that no other plants shall get the good from the soil near its own roots. One wonders at first how a plant with such large leaves can avoid shading itself; but there are some people very selfish toward the world who are very thoughtful of their own families, and the burdock belongs to this class. We must study carefully the arrangement of its leaves in order to understand its cleverness. The long basal leaves are stretched out flat; the next higher, somewhat smaller ones are lifted at a polite angle so as not to stand in their light. This courtesy characterizes all the leaves of the plant, for each higher leaf is smaller and has a shorter petiole, which is lifted at a narrower angle from the stalk; and all the leaves are so nicely adjusted as to form a pyramid, allowing the sunlight to sift down to each part. While some of the uppermost leaves may be scarcely more than an inch long, the lower ones are very large. They are pointed at the tip and wide at the base; where the leaf joins the petiole it is irregular, bordered for a short distance on each side with a vein, and then finished with a "flounce," which is so full that it even reaches around the main stem—another device for getting more sunlight for itself and shutting it off from plants below. On the lower side, the leaf is whitish and feltlike to the touch; above it is a raw green, often somewhat smooth and shining. The leaf is in quality poor, coarse and flimsy, and it hangs—a web of shoddy—on its strong supporting ribs; lucky for it that its edges are slightly notched and much ruffled, else they would be torn and tattered. The petiole and stems are felty in texture; the petiole is grooved, and expands at its base to grasp the stems on both sides with a certain vicious pertinacity which characterizes the whole plant.

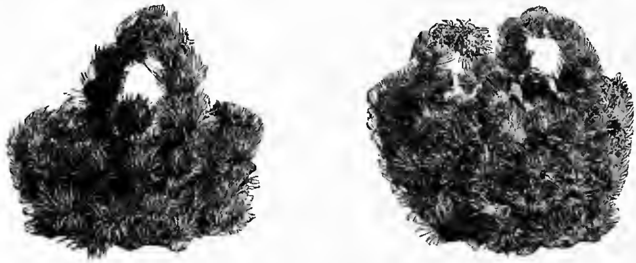
The flower-heads come off at the axils of the upper leaves, and are often so crowded that the leaf is almost lost to sight. It is amazing to behold the number of flower-heads which develop on one thrifty plant. The main stem and the pyramid of lower branching stems, are often crowded with the green balls beset with bracts which are hooked, spiny, and which hold safe the flowers. This composite flower-house is a fortress bristling with spears which are not changed to peaceful pruning-hooks, although they are hooked at the sharp end, every hook turning toward the flowers at the center; the lower bracts are shorter and stand out at right angles, while the others come off at lesser angles, graded so as to form a globular involucre—a veritable block-house. The flower might be a tidbit for the grazing animal; but, if so, he has never discovered it, for these protective hooks have kept him from ever enjoying a taste. The bracts protect, not only by hooks at the tip, but by spreading out at the bases so as to make a thickly battened dwelling for the flower-family.

A burdock floret with hooked bract.

But if we tear open one of these little fortresses, we are well repaid in seeing the quite pretty florets. The corollas are long, slender, pink tubes, with five, pointed lobes. The anther-tubes are purple, the pistils and the stigmas white; the stigmas are broad and feathery when they are dusting out the pollen from the anther-tubes, but later they change to very delicate pairs of curly Y's. The young seed is shining white, and the pappus forms a short, white fluff at the upper margin; but this is simply a family trait, for the burdock seeds never need to be ballooned to their destination; they have a surer method of travel. When in full bloom, the burdock flower-heads are very pretty and the skillful child weaver makes them into beautiful baskets. When I was a small girl, I made whole sets of furniture from these flowers; and then, becoming more ambitious, wove some into a coronet which I wore proudly for a few short hours, only to discover later, from my own experience, that great truth which Shakespeare voiced,—"uneasy lies the head that wears the crown."

In winter, the tough, gray stalks of the burdock still stand; although they may partially break, if they can thus better accomplish their purpose,—always falling toward the path. In this way, they may be sure of inserting the hooks of their seed storehouses into the clothing or covering of the passer-by; and when one gets a hold, mayhap a dozen others will hold hands and follow. If they catch the tail of horse or cow, then indeed they must feel their destiny fulfilled; for the animal, switching about with its uneasy appendage, threshes out the seeds, and unheedingly plants them by trampling them into the ground. Probably some of the livestock of our Pilgrim Fathers came to America thus burdened; for the burdock is a European weed, although now it flourishes too successfully in America. The leaves of the burdock are bitter, and are avoided by grazing animals. Fortunately for us, certain flies and other insects like their bitter taste, and lay eggs upon them, which hatch into larvæ that live all their lives between the upper and lower surfaces of the leaf. Often the leaves are entirely destroyed by the minute larvæ of a fly, which live together cozily between these leaf blankets, giving the leaves the appearance of being afflicted with large blisters.

The burdocks have long vigorous taproots, and it is therefore difficult to eradicate them without much labor. But persistent cutting off the plant at the root will, if the cut be deep, finally discourage this determined weed.



Baskets made from the burdock flower-heads.

LESSON CXLI

The Burdock

Leading thought—The burdock wins because its great leaves shade down plants in its vicinity, and also by having taproots. It scatters its seed by hooking its seed-heads fast to the passer-by.

Burdock blossoming.

Method—Study a healthy burdock plant in the field, to show how it shades down other plants and does not shade itself. The flowers and the seed-heads may be brought into the schoolroom for detailed study.

Observations—1. Note a young plant. How much space does its leaves cover? Is anything growing beneath them? How are its leaves arranged to cover so much space? Of what advantage is this to the plant?

2. Study the full-grown plant. How are the lower leaves arranged? At what angles to the stalks do the petioles lie? Are the upper leaves as large as the lower ones? Do they stand at different angles to the stalk?

3. Study the arrangement of leaves on a burdock plant, to discover how it manages to shade down other plants with its leaves and yet does not let its own upper leaves shade those below.

4. Study a lower and an upper leaf. What is the general shape? What peculiarity where it joins the petiole? What is the texture of the leaf above and below? The color? Describe the petiole and how it joins the stem.

5. Where do the flowers appear on the stem? Are there many flowers developed? Count all the flower-heads on a thrifty burdock.

6. The burdock has its flowers gathered into families, like the sunflower and thistle. Describe the burdock flower-family according to Lesson CXXXV.

7. What insects visit the burdock flowers? Can you make baskets from the flower-heads?

8. Study the burdock again in winter, and see what has happened to it. Describe the seed and the seed-heads. How are the seed-heads carried far away from the parent plant? How many seeds in a single "house?" How do they escape?

9. Write the biography of a burdock plant which came to America as a seed, attached to the tail of a Shetland pony.

PRICKLY LETTUCE, A COMPASS PLANT

Teacher's Story

The more we know of plants, the more we admire their ways of attaining success in a world where it is only attained by a species after a long struggle. While plants may not be conscious of their own efforts for living on successfully, they have developed them just the same, and they merit our admiration perhaps even more, than as if their strategy was the result of conscious thought. The prickly lettuce has a story to tell us about success attained by the prevention of exhaustion from thirst. In fact, the success of this weed depends much upon its being able to live in dry situations and withstand the long droughts of late summer. The pale green stems grow up slim and tall, bearing leaves arranged alternately and from all sides, since between two, one of which is exactly above the other, two other leaves are borne. Thus, if the leaves stood out naturally, the shape of the whole plant would be a somewhat blunt pyramid. But during the hot, dry weather, the leaves do not stand out straight from the stem; instead, they twist about so that they are practically all in one plane, and usually point north and south, although this is not invariably the case. The way this twisting is accomplished is what interests us in this plant. The long spatulate leaf has a thick, fleshy midrib, and at the base are developed two pointed lobes which clasp the stalk. The leaf is soft and leathery and always seems succulent, because it retains its moisture; it has a ruffled edge near its base, which gives it room for turning without tearing its margin. Each leaf tips over sidewise toward the stem, and as far as necessary to bring one edge uppermost. Thus the sun cannot reach its upper surface to pump water from its tissues. The ruffled margin of the upper edge is pulled out straight when the leaf stands in this position, while the lower margin is more ruffled than ever. Thus, it stands triumphantly, turning edgewise to the sun, retaining its moisture and thriving when cultivated plants are dry and dying.

A common compass plant.
Photo by Cyrus Crosby.

It also has another "anchor to the windward." A plant so full of juice would prove attractive food for cattle when pastures are dry. The leaves of this perhaps escape, because each has a row of very sharp spines on the lower side of the midrib. At first we might wonder why they are thus placed; but if we watch a grazing animal, as a cow, reach out her tongue to pull the herbage into her mouth, we see that these spines are placed where they will do the most efficient work. The teasel has the same clever way of warning off meddlesome tongues. The prickly lettuce also has spines on its stem, and the leaves are toothed with spines at their points.

LESSON CXLII

Prickly Lettuce

Leading thought—The sunshine sets the machinery in the leaf-factories going, and incidentally pumps up water from the soil, which pours out into the air from the leaves; but if the soil is dry the pump works just the same, and the plant thus robbed of its water soon withers and dies. The young plants of wild lettuce prevent the sun from pumping them dry during drought, by turning the edges of their leaves toward the sun, and thus not exposing the leaf surface to its rays. The leaves thus lifted stand in one plane. They are usually directed north and south. The lettuce also has spines to protect it from grazing animals.

Method—The lettuce should be studied in the field, and is a good subject for a lesson in late summer or September. This lesson should supplement the one on transpiration. The young plants show this arrangement of the leaves best. The flowers may be studied by the outline given in Lesson CXXXV.

Observations—1. Where does the prickly lettuce grow? What sort of a stem has it? How are the leaves arranged on the stem?

2. If the leaves stood straight out from the stem, what would be the shape of the plant? How do the leaves stand? Is their upper surface exposed to the rays of the sun? Which portion of the leaf is turned toward the sun?

3. If the leaves turn sideways and stand in one plane, do they stand north and south or east and west. How does the edgewise position of the leaf protect the plant during drought? Why does any plant wither during drought? If the leaves of the lettuce should extend east and west instead of north and south, would they get more sun? (See lesson on the Sun.)

4. What is the shape of the lettuce leaf? How does it clasp the stalk? How is the base shaped so that the leaf can turn without tearing its edges? Sketch a leaf thus turned fully, showing how it is done. Does the leaf turn toward the stem or away from it?

5. How are the leaves protected against grazing cattle? How does the cow use her tongue to help bring herbage to her mouth? How are the prickly spines placed on the lettuce leaf, to make the cow's tongue uncomfortable? Sketch a leaf showing its shape, its venation and its spines.

THE DANDELION

Teacher's Story

THIS is the most persistent and indomitable of weeds, yet I think the world would be very lonesome without its golden flower-heads and fluffy seed-spheres. Professor Bailey once said that dandelions in his lawn were a great trouble to him until he learned to love them, and then the sight of them gave him keenest pleasure. And Lowell says of this "dear common flower"—

"Tis Spring's largess, which she scatters now
To rich and poor alike, with lavish hand;
Though most hearts never understand
To take it at God's value, and pass by
The offered wealth with unrewarded eye."

It is very difficult for us, when we watch the behavior of the dandelions, not to attribute to them thinking power, they have so many ways of getting ahead of us. I always look at a dandelion and talk to it as if it were a real person. One spring when all the vegetables in my garden were callow weaklings, I found there, in their midst, a dandelion rosette with ten great leaves spreading out and completely shading a circle ten inches in diameter; I said, "Look here, Madam, this is my garden!" and I pulled up the squatter. But I could not help paying admiring tribute to the taproot, which lacked only an inch of being a foot in length. It was smooth, whitish, fleshy and, when cut, bled a milky juice showing that it was full of food; and it was as strong from the end-pull as a whip-cord; it also had a bunch of rather fine rootlets about an inch below the surface of the soil and an occasional rootlet farther down; and then I said "Madam, I beg your pardon; I think this was your garden and not mine."

Dandelion leaves afford an excellent study in variation of form. The edges of the leaf are notched in a peculiar way, so that the lobes were, by some one, supposed to look like lions' teeth in profile; thus the plant was called in France "dents-de-lion" (teeth of the lion), and we have made from this the name dandelion. The leaves are so bitter that grazing animals do not like to eat them, and thus the plants are safe even in pastures.

The hollow stem of the blossom-head from time immemorial has been a joy to children. It may be made into a trombone, which will give to the enterprising teacher an opportunity for a lesson in the physics of sound, since by varying its length, the pitch is varied. The dandelion-curls, which the little girls enjoy making, offer another lesson in physics—that of surface tension, too difficult for little girls to understand. But the action of this flower stem is what makes the dandelion seem so endowed with acumen. If the plant is in a lawn, the stem is short, indeed so short that the lawn-mower cannot cut off the flower-head. In this situation it will blossom and seed within two inches of the ground; but if the plant is in a meadow or in other high grass, the stem lifts up sometimes two feet or more, so that its blossom may be seen by bees and its seeds be carried off by the breeze without let or hindrance from the grass. We found two such stems each measuring over 30 inches in height.

Before a dandelion head opens, the stem, unless very short, is likely to bend down to protect the young flowers, but the night before it is to bloom it straightens up; after the blossoms have matured it may again bend over, but straightens up when the seeds are to be cast off.

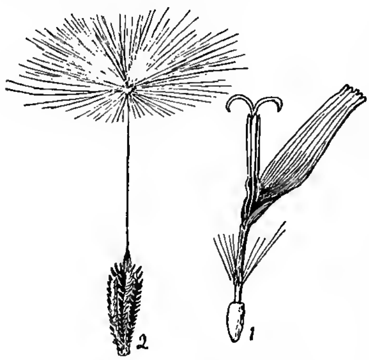
It often requires an hour for a dandelion head to open in the morning and it rarely stays open longer than five or six hours; it may require another hour to close. Usually not more than half the flowers of the head open the first day, and it may require several days for them all to blossom. After they have all bloomed and retired into their green house and put up the shutters, it may take them from one to two weeks to perfect their seeds.

In the life of the flower-head the involucre, or the house in which the flower family lives, plays an important part. The involucral bracts, in the row set next to the flowers, are sufficiently long to cover the unopened flowers; the bracts near the stem are shorter and curl back, making a frill. In the freshly opened flower-head, the buds at the middle all curve slightly toward the center, each bud showing a blunt, five-lobed tip which looks like the tips of five fingers held tightly together. The flowers in the outer row blossom first, straightening back and pushing the banner outward; and now we can see that the five lobes in the bud are the five notches at the end of the banner. All the flowers in the dandelion-head have banners, but those at the center, belonging to the younger flowers, have shorter and darker yellow banners. After a banner is unfurled, there pushes out from its tubular base a darker yellow anther-tube; the five filaments below the tube are visible with a lens. A little later, the stigma-ramrod pushes forth from the tube, its fuzzy sides acting like a brush to bring out all the pollen; later it rises far above the anther-tube and quirls back its stigma-lobes, as if every floret were making a dandelion curl of its own. The lens shows us, below the corolla, the seed. The pappus is not set in a collar upon the dandelion seed, as it is in the aster seed; there is a short stem above the seed which is called the "beak" and the pappus is attached to this.

Every day more blossoms open; but on dark, rainy days and during the night the little green house puts up its shutters around the flower-family, and if the bracts are not wide enough to cover the growing family, the banners of the outer flowers have thick or brownish portions along their lower sides which serve to calk the chinks. It is interesting to watch the dandelion stars close as the night falls, and still more interesting to watch the sleepy-heads awaken long after the sun is up in the morning; they often do not open until eight o'clock. The dandelion flower-families are very economical of their pollen and profuse nectar, and do not expose them until the bees and other insects are abroad ready to make morning calls.

After all the florets of a dandelion family have blossomed, they retire again into their green house and devote themselves to perfecting their seeds. They may stay thus in retirement for several days, and during this period the flower stem often grows industriously; and when the shutters of the little green house are again let down, what a different appearance has the dandelion family! The seeds with their balloons are set so as to make an exquisite, filmy globe; and now they are ready to coquette with the wind and, one after another, all the balloons go sailing off. One of these seeds is well worth careful observation through a lens.

The balloon is attached to the top of the beak as an umbrella frame is attached to the handle, except that the "ribs" are many and fluffy; while the dandelion youngster, hanging below, has an overcoat armed with grappling hooks, which enable it to cling fast when the balloon chances to settle to the ground.



1, Floret of dandelion; 2, seed of dandelion. Both enlarged.

Father Tabb says of the dandelion,—"With locks of gold today; tomorrow silver gray; then blossom bald." But not the least beautiful part of the dandelion is this blossom-bald head after all the seeds are gone; it is like a mosaic, with a pit at the center of each figure where the seed was attached. There is an interesting mechanism connected with this receptacle. Before the seeds are fully out this soon-to-be-bald head is concave at the center, later it becomes convex, and the mechanism of this movement liberates the seeds which are embedded in it.

Each freshly opened corolla-tube is full to overflowing with nectar, and much pollen is developed; therefore, the dandelion has many kinds of insect visitors. But perhaps the bee shows us best where the nectar is found; she thrusts her tongue down into the little tubes below the banners, working very rapidly from floret to floret. The dandelion stigmas have a special provision for securing cross-pollenation; and if that fails, to secure pollen from their own flower-family; and now the savants have found that the pistils can also grow seeds without any pollen from anywhere. It surely is a resourceful plant!

The following are the tactics by which the dandelion conquers us and takes possession of our lands: (a) It blossoms early in the spring and until snow falls, producing seed for a long season. (b) It is broad-minded as to its location, and flourishes on all sorts of soils. (c) It thrusts its long tap-roots down into the soil, and thus gets moisture and food not reached by other plants. (d) Its leaves spread out from the base, and crowd and shade many neighboring plants out of existence. (e) It is on good terms with many insects, and so has plenty of pollen carriers to insure strong seeds; it can also develop seeds from its own pollen, and as a last resort it can develop seeds without any pollen. (f) It develops almost numberless seeds, and the wind scatters them far and wide and they thus take possession of new territory. (g) It forms vigorous leaf-rosettes in the fall. and thus is able to begin growth early in the spring.

LESSON CXLIII

The Dandelion

Leading thought—The dandelions flourish despite our determined efforts to exterminate them. Let us study the way in which they conquer.

Method—The study should be made with the dandelions on the school grounds. Questions should be given, a few at a time, and then let the pupils consult the dandelions as to the answers.

The dandelion is a composite flower and may be studied according to Lesson CXXXV. All the florets have banners or rays.

Observations 1. Where do you find dandelions growing? If they are on the lawn, how long are their blossom or seed stems? If in a meadow or among high grass, how long is the blossom stem? Why is this? Is the blossom stem solid or hollow? Does it break easily?

2. Dig up a dandelion root and then explain why this weed withstands drought, and why it remains, when once planted.

3. Sketch or describe a dandelion leaf. Why was the plant named "lion's teeth?" How are the leaves arranged about the root? How does this help the dandelion and hinder other plants? In what condition do the leaves pass the winter under the snow? Why is this useful to the plant?

4. Take a blossom not yet open. Note the bracts that cover the unopened flower-head. Note the ones below and describe them.

5. Note the dandelion flower-head just open. Which flowers open first? How do the buds look at the center? Do all the florets have banners? Are the banners of the central florets the same color and length as of those outside? Examine a floret and note the young seed. Is the pappus attached to it or above it?

6. What happens to the dandelion blossom on rainy or dark days? How is the dandelion family hidden during the rain? When does it appear again? Do you think that this has anything to do with the insect visitors? Do bees and other insects gather nectar during dark or rainy days?

7. Note at what hour the dandelions on the lawn go to sleep and at what hour they awaken on pleasant days?

8. Make notes on a certain dandelion plant three times a day: How long does it take the dandelion head to open fully on a sunny morning? How long does it remain open? How long does it take the flower-head to close? What proportion of the flowers in the head, blossoms during the first day? What proportion of the flowers in the head, blossoms during the second day? How long before they all blossom? Does the flower-head remain open longer in the afternoon on some days than on others, equally sunny? Does the stem bend over before the blossom-head opens?

9. After all the little flowers of a dandelion family have blossomed, what happens to it? How long does it stay shut up in its house? Measure the stem, and see if it stretches up during the time. How does the dandelion look when it opens again? Look at a dandelion-head full of seed, and see how the seeds are arranged to make a perfect globe. Shake the seeds off and examine the "bald head" with a lens. Can you see where the seeds were set?

10. Examine a dandelion seed with a lens. Describe the balloon, the beak or stem of the balloon, and the seed. Why do you suppose the seed has these hooks?

11. How early in the spring, and how late in the fall, do dandelions blossom?

12. Watch a bee when she is working on a dandelion flower, and see where she thrusts her tongue and which flowers she probes.

13. Tell all the things that you can remember which the dandelion does in order to live and thrive in spite of us.

14. What use do we make of the dandelions?

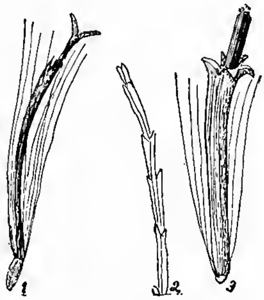
THE PEARLY EVERLASTING

Teacher's Story

These wraithlike flowers seem never to have been alive, rather than to have been endowed with everlasting life. The cattle share this opinion and would no sooner eat these plants than if they were made of cotton batting. The stems are covered with white felt; the long narrow leaves are very pale green, and when examined with a lens, look as if they were covered with a layer of cotton which disguises all venation except the thick midrib. The leaves are set alternate, and become shorter and narrower and whiter toward the top of the plant, where they are obliged to give their sustenance to the flower stems borne in their axils. All this cottony covering has its uses to prevent the evaporation of water from the plant during the long droughts. The everlasting never has much juice in its leaves but what it has, it keeps.

The pistillate flower-heads of the pearly everlasting.
Photo by Verne Morton.

The flower stems are rather stout, woolly, soft and pliable. They come off at the axils of the threadlike whitish leaves. The pistillate and the staminate flowers are borne on separate plants, and usually in separate patches. The pistillate, or seed-developing, plants have globular flower buds, almost egg-shaped, with a fluffy lemon-yellow knob at the tip; this fluff is made up of stigmas split at the end. At the center of this tassel of lemon-yellow stigma-plush, may often be seen a depression; at the bottom of this well, there are three or four perfect flowers. One of the secrets of the everlasting is, evidently, that it does not put all of its eggs in one basket; it has a few perfect flowers for insurance. This pistillate or seed-bearing flower has a long, delicate tube, ending in five needlelike points and surrounded by a pretty pappus. The bracts of the flower-cluster seem to cling around the base of the beautiful yellow tassel of fertile flowers, as if to emphasize it. They look as if they were made of white Japanese paper, and when looked at through a lens, they resemble the petals of a water lily They are dry to begin with, so they cannot wither.



1, *Pistillate floret, 2, pappus, 3, staminate floret. All enlarged.*

The staminate, or pollen-bearing, flower-heads are like white birds' nests, the white bracts forming the nest and the little yellow flowers the eggs. The flower has a tubular, five-pointed starlike corolla, with five stamens joined in a tube at the middle, standing up like a barrel from the corolla. The anther-tube is ocher-yellow with brown stripes, and is closed at first with five little flaps, making a cone at the top. Later, the orange-yellow pollen bulges out as if it were boiling over. The flowers around the edges of the flower-disk open first.

LESSON CXLIV

The Pearly Everlasting

Leading thought—There are often found growing on the poor soil in dry pastures, clumps of soft, whitish plants which are never eaten by cattle. There is so little juice in them that they retain their form when dried and thus have won their name.

Method—The pupils should see these plants growing, so that they may observe the staminate and pistillate flowers, which are on separate plants and in separate clumps. If this is not practicable, bring both kinds of flowers into the schoolroom for study.

The staminate flower-head of pearly everlasting.

Observations—1. Where does the pearly everlasting grow? Do cattle eat it? Why is this? What is the general color of the plant? What is the stem covered with?

2. What is the shape of the leaves? How are they veined? With what are they covered? How are they placed on the stem? What is the relative size of the lower and upper leaves? Why is there a difference?

3. Do you see some plants which have egg-shaped blossoms, each with a yellow knob at the tip? Take one apart and look at it with a lens, and see what forms the white part and what forms the yellow knob. Do you see other flowers that look like little white birds' nests filled with yellow eggs? Look at one of them with a lens, and tell what kind of a flower it is.

4. Except that the pistillate and staminate flowers are on different plants, the flowers of the pearly everlasting should be studied according to Lesson CXXXV.

5. What do you know of the edelweiss of the Alps? How does it resemble the pearly everlasting? Do you know another common kind of everlasting called pussy's toes?

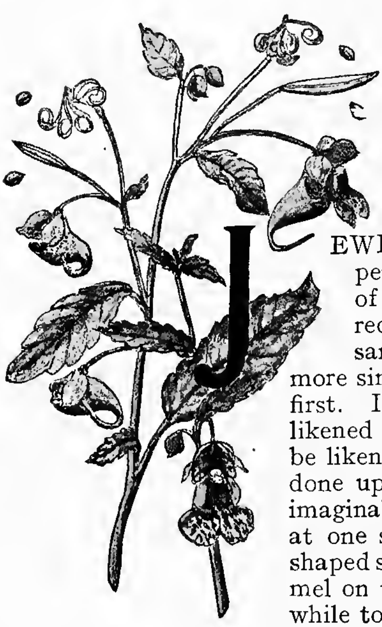
THE JEWELWEED, OR TOUCH-ME-NOT

Teacher's Story

"Cup bearer to the summer, this floral Hebe shy
Is loitering by the brookside as the season passes by;
And she's strung her golden ewers with spots of brown all flecked,
O'er dainty emerald garments, like a queen with gems bedecked.

She brooks not condescension from mortal hand, you know,
For, touch her e'er so gently, impatiently she'll throw
Her tiny little jewels, concealed in pockets small
Of her dainty, graceful garment, and o'er the ground they fall."

—Ray Laurance



JEWELS for the asking at the brookside, pendant jewels of pale-gold or red-gold and of strange design! And the pale and the red are different in design, although of the same general pattern. The pale ones seem more simple and open, and we may study them first. If the flowers of the jewelweed have been likened to ladies' earrings, then the bud must be likened to the old-fashioned ear-bob; for it is done up in the neatest little triangular knob imaginable, with a little curly pig-tail appendage at one side, and protected above by two cup-shaped sepals, their pale green seeming like enamel on the pale gold of the bud. It is worth while to give a glance at the stem from which this jewel hangs; it is so delicate and so gracefully curved; and just above the twin sepals is a tiny green bract, elongate, and following the curve of the stem as if it were just a last artistic touch; and though the flowers fall, this little bract remains to keep guard above the seed-pod.

It would take a Yankee, very good at guessing, to make out the parts of this flower, so strange are they in form. We had best begin by looking at the blossom from the back side. The two little, greenish sepals are lifted back like butterfly wings, and we may guess from their position that there are two more sepals, making four in all. These latter are yellow; one is notched at the tip and is lifted above the flower; the other is below and is made into a wide-mouthed triangular sac, ending in a quirl at the bottom, which, if we test it, we shall find is the nectary, very full of sweetness. Now, if we look the flower in the face, perhaps we can find the petals; there are two of them "holding arms" around the mouth of the nectar-sac. And stiff arms they are too, two on a side, for each petal is two-lobed, the front lobe being very short and the posterior lobe widening out below into a long frill, very convenient for the bee to cling to, if she has learned the trick, when prospecting the nectar-sac behind for its treasure. The way this treasure-sac swings backward from its point of attachment above when the insect is probing it, must make the lady bee feel that the joys of life are elusive. Meanwhile, what is the knob projecting down above the entrance to the nectar-sac, as if it were a chandelier in a vestibule? If we look at it with a lens, we can see that it is made up of five chubby anthers, two in front, one at each side and one behind; their short, stout little filaments are crooked just right to bring the anthers together like five closed fingers holding a fist full of pollen-dust, just ready to sift it on the first one that chances to pass below. Thus it is that Madame Bumblebee, who dearly loves the nectar from these flowers, gets her back well dusted with the creamy-white pollen and does a great business for the jewelweed in transferring it. But after the pollen is shed, some day the bumblebee pushes up too hard against the anthers and they break loose, all in a bunch, looking like a crooked legged table; and there in their stead, thus left bare and ready for pollen, is the long green pistil with its pointed stigma ready to rake the pollen out of the fur of any bumblebee that calls.

The red-gold jewelweed is quite different in shape from the pale species. The sepal-sac is not nearly so flaring at the mouth, and the nectar-spur is half as long as the sac and curves and curls under in a most secretive fashion. The shape of the nectar-spur suggests that it was meant for an insect with a long, flexible sucking tube that could curl around and probe it to the bottom; and some butterflies do avail themselves of the contents of this bronze pitcher. Mr. Mathews mentions the *Papilio troilus*, and I have seen the yellow roadside butterfly partaking of the nectar. Professor Robertson believes that the form of the nectar-spur is especially adapted for the hummingbird. But I am sure that the flowers which I have had under observation are the special partners of a small species of bumblebee, which visits these flowers with avidity, celerity, and certainty, plunging into the nectar-sac "like a shot," and out again and in again so rapidly that the eye can hardly follow. One day, one of them accommodatingly alighted on a leaf near me, while she combed from her fur a creamy-white mass of pollen, which matched in color the fuzz on her back, heaping it on her leg baskets. She seemed to know that the pollen was on her back, and it was comical to see her contortions to get it off. The action of these bumblebees in these flowers is in marked contrast to those of the large bumblebees and the honey-bees. One medium-sized species of bumblebee has learned the trick of embracing with the front legs the narrow, stiff portion of the petals which encircles the opening to the sac, thus holding the flower firm while thrusting the head into the sac. While the huge species—black with very yellow plush—does not attempt to get the nectar in a legitimate manner, but systematically alights, back downward, below the sac of the flower, with head toward the curved spur, and cuts open the sac for the nectar. A nectar-robber of the most pronounced type! The honey-bees, Italian hybrids, are the most awkward in their attempts to get nectar from these flowers; they attempt to alight on the expanded portion of the petals and almost invariably slide off between the two petals. They then circle around and take observations with a note of determination in their buzzing, and finally succeed, as a rule, in gaining a foothold and securing the nectar. But the midget bumblebees show a *savoir faire* in probing the orange jewelweed that is convincing; they are so small that they are quite out of sight when in the nectar-sacs.

The jewelweed flowers of the pale species and the pale flowers of the orange species—for this latter has sometimes pale yellow flowers—are not invariably marked with freckles in the nectar-sac. But the most common forms are thus speckled. There is something particularly seductive to insects in these brownish or reddish flecks, and wherever we find them in flowers, we may with some confidence watch for the insects they were meant to allure. The orange jewelweed flower is a model for an artist in its strange, graceful form and its color combination of yellow spotted and marbled with red.

Gray's Manual states that in the jewelweeds are often flowers of two sorts "The large ones which seldom ripen seeds, and very small ones which are fertilized early in the bud, their floral envelopes never expanding but forced off by the growing pod and carried upward on its apex." My jewelweed patch has not given me the pleasure of observing these two kinds of flowers; my plants blossom luxuriously and profusely, and a large proportion of the flowers develop seed. The little, straight, elongated seed-pods are striped prettily and become quite plump from the large seeds within them. Impatiens? We should say so! This pod which looks so smug and straight-laced that we should never suspect it of being so touchy, at the slightest jar when it is ripe, splits lengthwise into five ribbon-like parts, all of which tear loose at the lower end and fly up in spirals around what was once the tip of the pod, but which now looks like a crazy little turbine wheel with five arms. And meanwhile, through this act the fat, wrinkled seeds have been flung, perhaps several feet away from the parent plant, and presumably to some congenial place for growth the following spring. This surprising method of throwing its seeds is the origin of the popular name touch-me-not, and the scientific name *Impatiens* by which these plants are known.

The jewelweed has other names—celandine and silver-leaf, and ladies' ear-drop. It is an annual with a slight and surface-spreading growth of roots, seeming scarcely strong enough to anchor the branching stems, did not the plants have the habit of growing in a community, each helping to support its neighbor. The stem is round, hollow and much swollen at the joints; it is translucent, filled with moisture, and its outer covering is a smooth silken skin, which may be readily stripped off. Both species of jewelweed vary in the color of their stems, some being green, others red and some dark purple; and all the differing colors may be found within a few yards of each other.

The leaves are alternate, dark green above and a lighter shade below, ovate in form with scalloped edges, with midrib and veins very prominent beneath and depressed on the upper side; they are smooth on both sides to the unaided eye, but with a lens a film of fine, short hairs may be seen, particularly on the under side. When plunged beneath clear water, they immediately take on the appearance of burnished silver; when removed, no drop remains on their surface.

The flower stems spring from the axils of the leaves and are very slender and thread-like, and the flowers nod and swing with every breeze. They grow in open, drooping clusters, few blossoms open at a time, and with buds and seed-capsules present in various stages of growth.

The jewelweed is involuntarily most hospitable, and always houses many uninvited guests, as well as the bee-callers which are invited. Galls are formed on the leaves and flowers; the hollow stems are inhabited by stalk-borers; leaf-miners live between the upper and under surfaces of the leaves, making curious arabesque patterns and initials as if embroidering milady's green gown.

LESSON CXLV

The Jewelweed, or Touch-me-not

Leading thought—The jewelweed may be found by the brookside, in swamps, or in any damp and well-shaded area. It is provided with a remarkable contrivance for scattering its seeds far afield. It has no liking for open sunny places, unless very damp. There are two kinds, often found growing together, though the spotted touch-me-not (*Impatiens biflora*) is said to be more widely distributed than its relative—the golden, or pale, touch-me-not (*Impatiens aurea*).

Method—The jewelweeds should be studied where they are growing; but if this is impracticable, a large bouquet of both kinds (if possible), bearing buds, blossoms, and seed-capsules, and one or two plants with roots, may be brought to the schoolroom.

In the fields the children may see how well the plant is provided with means to sustain itself in its chosen ground, and thus lead them to look with keener eyes at other common weeds.

Observations—1. Do you think the jewelweed is an annual, sustaining life in its seeds during winter, or do its roots survive?

2. Do the roots strike deeply into the soil, or spread near the surface?

3. Study the stem; is it hard and woody or juicy and translucent, rough or smooth, solid or hollow?

4. Note the shape and position of the leaves; do they grow opposite or alternately on the stalk? Are their edges entire, toothed or scalloped? Do they vary in color on upper and lower surface? Are they smooth or in the least degree rough or hairy? Plunge a plant under clear water in a good light and observe the beautiful transformation. Does the water cling to the leaves?

5. Where do the flower-stems spring from the main stalk? Do the flowers grow singly or in clusters? Do the blossoms all open at nearly the same time or form a succession of bud, flower and seed on the same stem?

6. Study the parts of the flower. Find the four sepals and describe the shape and position of each. Describe the nectar-sac in the nectar-horn. Can you find the two petals? Can you see that each petal has a lobe near where it joins the stem? Find the little knob hanging down above the entrance of the nectar-sac; of what is it composed? Look at it with a lens, and tell how many stamens unite to make the knob? Where is the pollen and what is its color? What insect do you think could reach the nectar at the bottom of the spurred sac? Could any insect get at the nectar without rubbing its back against the flat surface of the pollen boxes? What remains after the stamens fall off? Describe how the bees do the work of pollenation of the jewelweeds. Write or tell as a story your own observations on the actions of the different bees visiting these flowers.

7. Carefully observe a seed-capsule without touching it; can you see the lines of separation between its sections? How many are there? What happens when the pod is touched? Are the loosened sections attached at the stem, or at the apex of the pod? Hold a pod at arm's length when discharging its contents and measure the distance to which the seeds are thrown. Of what use is this habit of seed-throwing to the plant?

8. Describe the differences in shape and color between the pale yellow and the orange jewelweeds. Watch to see if the same insects visit both. Which species do you think is best suited to the bumblebees?

MULLEIN

Teacher's Story

"I like the plants that you call weeds,—
Sedge, hardhack, mullein, yarrow,—
Which knit their leaves and sift their seeds
Where any grassy wheel-track leads
Through country by-ways narrow."
—LUCY LARCOM.

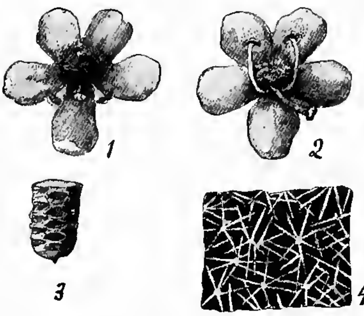
We take much pride unto ourselves because we belong to the chosen few of the "fittest," which have survived in the struggle for existence. But, if we look around upon other members of this select band, we shall find many lowly beings which we do not ordinarily recognize as our peers. Mullein is one of them, and after we study its many ways of "winning out" then may we bow to it and call it "brother."

I was wandering one day in a sheep pasture and looking curiously at the few plants left uneaten. There was a great thistle with its sharp spines and the pearly everlasting—too woolly and anæmic to be appetizing even to a sheep; and besides these, there was an army of mullein stalks—tall, slim, and stiff-necked, or branching like great candelabra, their upper leaves adhering alternately to the stalks for half their length. I stopped before one of them and mentally asked, "Why do

Mullein.
Photo by Verne Morton

the sheep not relish you? Are you bitter?" I took a bite, Nebuchadnezzar-like, and to my untrained taste it seemed as good fodder as any; but my tongue smarted and burned for some time after, from being pricked by the felt which covered the leaf. I recalled the practical joke of which my grandmother once made me the victim; she told me that to be beautiful, I needed only to rub my cheeks with mullein leaves, an experience which convinced me that there were other things far more desirable than beauty —comfort, for instance. This felt on the mullein is beautiful, when looked at through a microscope; it consists of a fretwork of little, white, sharp spikes. No wonder my cheeks were red one day and purple the next, and no wonder the sheep will not eat it unless starved! This frostlike felt covering not only keeps the mullein safe from grazing animals but it also keeps the water from evaporating from the leaf and this enables the plant to withstand drought. I soon discovered another means devised by the mullein for this same purpose, when I tried to dig up the plant with a stick; I followed its taproot down far enough to understand that it was a subsoiler and reached below most other plants for moisture and food. Although it was late autumn, the mullein was still in blossom; there were flowers near the tip and also one here and there on the seed-crowded stem. I estimated there were hundreds of seed-capsules on that one plant; I opened one, still covered with the calyx-lobes, and found that the mullein was still battling for survival; for I found this capsule and many others inhabited by little brown-headed white grubs, which gave an exhibition of St. Vitus dance as I laid open their home. They were the young of a snout beetle, which is a far more dangerous enemy of the mullein than is the sheep.

The mullein plant is like the old woman who lived in a shoe in the matter of blossom-children; she has so many that they are unkempt and irregular, but there are normally four yellow or white petals and a five-lobed calyx. I have never been able to solve the problem of the five stamens which, when the flower opens, are folded together in a knock-kneed fashion. The upper three are bearded below the anthers, the middle being the shortest. The lower two are much longer and have no fuzz on their filaments; they at first stand straight out, with the stigma between them; but after the upper anthers have shed their pollen, these stamens curve up like boars' teeth and splash their pollen on the upper petals, the stigma protruding desolately and one-sidedly below. Later the corolla, stamens and all, falls off, leaving the stigma and style attached to the seed-capsule.



1, 2. Mullein flowers in different stages. 3. Mullein seed enlarged. 4. A bit of Mullein leaf enlarged.

The color of the mullein flowers varies from lemon-yellow to white. The filaments are pale yellow; the anthers and pollen, orange. The seed-capsule is encased in the long calyx-lobes, and is shaped like a blunt egg. Cutting it in two crosswise, the central core, tough and flattened and almost filling the capsule, is revealed and, growing upon its surface, are numberless tiny, brown seeds, as fine as gunpowder. Later the capsule divides partially in quarters, opening wide enough to shake out the tiny seeds with every wandering blast. The seed, when seen through a lens, is very pretty; it looks like a section of a corncob, pitted and ribbed. A nice point of investigation for some junior naturalist is to work out the fertilization of the mullein flower, and note what insects assist. The mullein has another spoke in the wheel of its success. The seed, scattered from the sere and dried plants, settles comfortably in any place where it can reach the soil, and during the first season grows a beautiful velvety rosette of frosted leaves. No wonder Europeans grow it in gardens under the name of the "American velvet plant." These rosettes lie flat under the snow, with their tap-roots strong and already deep in the soil, and are ready to begin their work of food-making as soon as the spring sun gives them power.

LESSON CXLVI

MULLEIN

Leading thought—The mullein has its leaves covered with felt, which prevents evaporation during the dry weather and also prevents animals from grazing upon the plant. It has a deep root, and this gives moisture and food beyond the reach of most other plants. It blossoms all summer and until the snow comes in the autumn, and thus forms many, many seeds, which the wind plants for it; and here in our midst it lives and thrives despite us.

Method—The pupils should have a field trip to see what plants are left uneaten in pastures, and thus learn where mullein grows best. The flower or seed stalk, with basal leaves and root, may be brought to the schoolroom for the lesson.

Observations—1. Where does the mullein grow? Do you ever see it in swamps or woodlands? Do cattle or sheep eat it? Why? Does it flourish during the summer drought? How is it clothed to prevent the evaporation of its sap? Look at a mullein leaf with a lens and describe its appearance.

2. What sort of a root has the mullein? How is its root adapted to get moisture and plant food which other plants cannot reach? Describe the flowering stalk. How are the leaves arranged on it and attached to it? Are there several branching flower stalks or a single one?

3. Describe the flower bud. Do the mullein flowers nearest the base or the tip begin to blossom first? Is this invariable, or do flowers open here and there irregularly on the stem during the season?

4. Describe the mullein flower. How many lobes has the calyx? Are these covered with felt? How many petals? Are there always this number? Are the petals of the same size? Are they always regular in shape?

5. How many stamens? How do the upper three differ from the lower two? Describe the style and stigma. What are the colors of petals, anthers and stigma? What insects do you find visiting the flowers?

6. Describe the seed-capsule, its shape and covering. Cut it across and describe the inside. Where are the seeds borne? Are there many? Look at the seed with a lens, and describe it. How does the capsule open and by what means are the seeds scattered?

7. Does the mullein grow from the seed to maturity in one year? How does it look at the end of the first season? Describe the winter rosette, telling how it is fitted to live beneath the snows of winter. What is the advantage of this habit?

8. Write a theme telling all the ways the mullein has of flourishing and of combating other plants.

"The mullein's pillar, tipped with golden flowers,
Slim rises upward, and yon yellow bird
Shoots to its top."

—"The Hill Hollow," A. B. STREET.

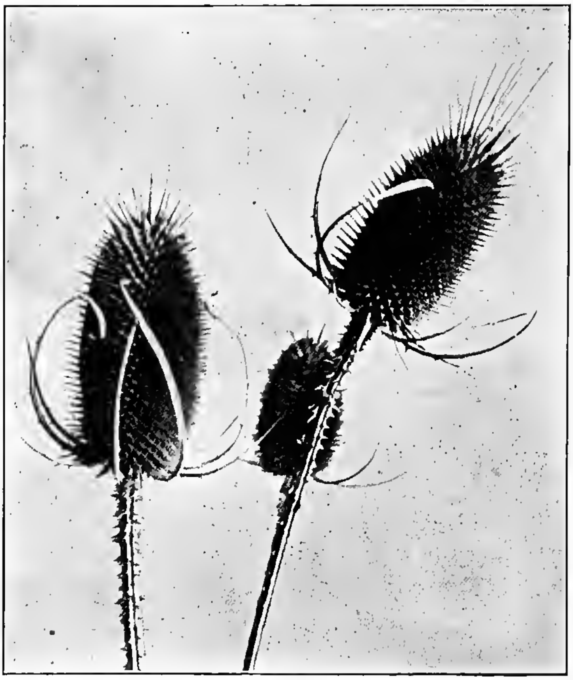
"Sober dress never yet made you sullen,
Style or size never brought you a blush;
You're the envy of weavers, O, Mullein,
For no shuttle can mimic your plush.
With your feet in the sand you were born,
Woolly monk of the thorn-field and fallow,
But your heart holds the milk of the mallow,
And your head wears the bloom of the corn."

—THERON BROWN

THE TEASEL

Teacher's Story

The old teasel stalks standing gaunt and gray in the fields, braving the blasts of winter, seem like old suits of armor, which elicit admiration from us for the strength and beauty of the protecting visor, breast-plate and gauntlets, and at the same time veer our thoughts to the knights of old who once wore them in the fray. Thus, with the teasel, we admire this panoply of spears, and they recall the purple flowers and the ribbed seeds which were once the treasure of every spear-guarded cavity and the proud reason of every lance at rest.



The teasel.

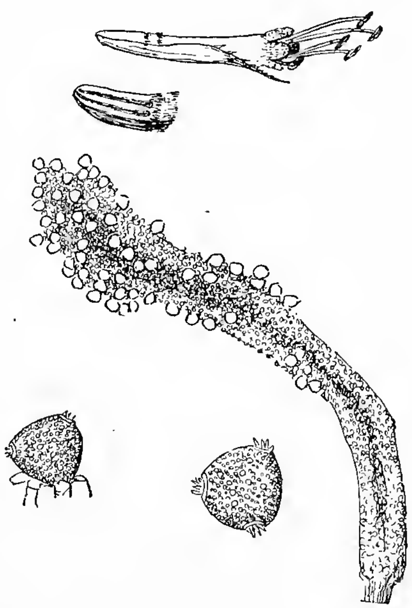
Let us study this plant in armor: First, its stem is tough, woody, hollow, with ridges extending its full length and each ridge armed with spines which are quite wide at the base and very sharp. It is impossible to take hold anywhere without being pricked by either large or small spines. The leaves are just fitted for such a stem. They are long, lanceolate, set opposite in pairs, rather coarse in texture, with a stiff, whitish midrib; the bases of the two leaves closely clasp the stem; the midrib is armed below with a row of long, white, recurved prickers, and woe unto the tongue of grazing beast that tries to lift this leaf into the mouth. If one pair of clasping leaves point east and west, the next pairs above and below point north and south.

The flower stems come off at the axils of the leaves and therefore each pair stands at right angles to the ones above and below. But if the teasel protects its stem and leaves with spikes, it does more for its flowers, which are set in dense heads armed with spines, and the head is set in an involucre of long, upcurving spiny prongs. If we look at it carefully, the teasel flower-head wins our admiration, because of the exquisite geometrical design made by the folded bases of the spines, set in diagonal rows. If we pull out a spine, we find that it enlarges toward the base to a triangular piece that is folded at right angles for holding the flower. Note that the spiny bracts at the tip of the flower-head are longer and more awesome than those at the sides; if we pass our hands down over the flower-head we feel how stiff the spines, or bracts are, and can hear them crackle as they spring back.

The teasel has a quite original method of blossoming. The goldenrod begins to blossom at the tip of the flowering branches and the blossom-tide runs inward and downward toward the base. The clover begins at the base and blossoms toward the tip, or the center. But the teasel begins at the middle and blossoms both ways, and how it knows just where to begin is more than we can tell. But some summer morning we will find its flower-head girt about its middle with a wide band of purple blossoms; after a few days, these fade and drop off, and then there are two bands, sometimes four rows of flowers in each, and sometimes only two. Below the lower band and above the upper band, the enfolding bracts are filled with little, round-headed lilac buds, while between the two rows of blossoms the protecting bracts hold the precious growing seed. Away from each other this double procession moves, until the lower band reaches the pronged involucre and the upper one forms a solid patch on the apex of the flower-head. Since the secondary blossom-heads starting from the leaf axils are younger, we may find all stages of this blossoming in the flower-heads of one plant.

No small flower pays better for close examination than does that of the teasel. If we do not pull the flower-head apart, what we see is a little purple flower consisting of a white tube with four purple lobes at the end, the lower lobe being a little longer than the others and turning up slightly at its tip; projecting from between each of the lobes, and fastened to the tube, are four stamens with long, white filaments and beautiful purple anthers filled with large, pearly white pollen grains; at the very heart of the flower, the white stigma may be seen far down the tube. But a little later, after the anthers have fallen or shriveled, the white stigma extends out of the blossom like a long, white tongue and is crowded with white pollen grains.

But to see the flower completely we need to break or cut a flower-head in two. Then we see that the long white tube is tipped at one end with purple lobes and a fringe of anthers, and at the other is set upon a little green, fluffy cushion which caps the ovary; the shape of the ovary in the flower tells us by its form how the seed will look later. Enfolding ovary and tube is the bract with its spiny edges, pushing its protecting spear outward, but not so far out as the opening of the flower, for that might



Teasel flower and seed enlarged. The stigma of a teasel floret much magnified to show the pollen adhering to it. Below, are pollen grains greatly magnified.

keep away the insects which carry the teasel's pollen. The pollen of the teasel is white and globular, with three little rosettes arranged at equal distances upon it like a bomb with three fuses. These little rosettes are the growing points of the pollen grains and from any of them may emerge the pollen tube to push down into the stigma. The teasel pollen is an excellent subject for the children to study, since it is so very large; and if examined with a microscope with a three-fourths objective, the tubes running from the pollen grains into the stigma may be easily seen.

In blossoming, the teasel does not always seem to count straight in the matter of rows of flowers. There may be more rows in the upper band than in the lower, or *vice versa;* this is especially true of the smaller secondary blossoms. But though the teasel flowers fade and the leaves fall off, still the spiny skeleton stands, the thorny stalks holding up the empty flower-heads like candelabra, from which the seeds are tossed far and wide, shaken out by the winds of autumn. But though battered by wintry blasts, the teasel staunchly stands; even until the ensuing summer, each bract on guard and its heart empty where once was cherished blossom and seed. Alas, because of this emptiness, it has been debased by practical New England housewives into a utensil for sprinkling clothes for ironing.

The spines of one species of teasel were, in earlier times, used for raising the nap on woolen cloth, and the plant was grown extensively for that purpose. The bees are fond of the teasel blossoms and teasel honey has an especially fine flavor.

The teasels are biennial, and during the first season, develop a rosette of crinkled leaves which have upon them short spines.

LESSON CXLVII

The Teasel

Leading thought—The teasel is a plant in armor, so protected that it can flourish and raise its seeds in pastures where cattle graze. It has a peculiar method of beginning to blossom in the middle of the flower-head and then blossoming upward and downward from this point.

A teasel winter rosette.
Photo by Verne Morton

Method—In September, bring in a teasel plant which shows all stages of blossoming, and let the pupils make observations in the schoolroom.

Observations— 1. Where does the teasel grow? Is it ever eaten by cattle? Why not? How is it protected?

2. What sort of stem has it? Is it

hollow or solid? Where upon it are the spines situated? Are the spines all of the same size? Can you take hold of the stem anywhere without being pricked?

3. What is the shape of the leaves? How do they join the stem? Are the leaves set opposite or alternate? If one pair points east and west in which direction will the pairs above and below point? How and where are the leaves armed? How does the cow or sheep draw the leaves into the mouth with the tongue? If either should try to do this with the teasel, how would the tongue be injured?

4. Where do the flower stems come off? Do they come off in pairs? How are the pairs set in relation to each other?

5. What is the general appearance of the teasel flower-head? Describe the long involucre prongs at the base. If the teasel is in blossom, where do you find the flowers? How many girdles of flowers are there around the flower-head? How many rows in one girdle? Where did the first flowers blossom in the teasel flower-head? Where on the head will the last blossoms appear? Where are the buds just ready to open? Where are the ripened seeds?

6. Examine a single flower. How is it protected? Cut out a flower and bract and see how the long-spined bract enfolds it. Is the bract spear long enough to keep the cattle from grazing on the blossom? Is it long enough to keep the bees and other insects from visiting the flowers? Where are the longest spines on the teasel head?

7. Study a single flower. What is the shape of its corolla? How is it colored? What color are the stamens? How many? Describe the pollen. If the pollen is being shed where is the stigma? After the pollen is shed, what happens to the stigma?

8. What do you find at the base of the flower? How does the young seed look? Later in the season take a teasel head and describe how it scatters its seed. How do the ripe seeds look? How long will the old teasel plants stand?

9. For what were teasels once used? How many years does a teasel plant live? How does it look at the end of its first season? How is this an advantage as a method of passing the winter?

QUEEN ANNE'S LACE, OR WILD CARROT

Teacher's Story

Queen Anne was apparently given to wearing lace made in medallion patterns; and even though we grant that her lace is most exquisite in design as well as in execution, we wish most sincerely that there had been established in America such a high tariff on this royal fabric as to have prohibited its importation. It has for decades held us and our lands prisoners in its delicate meshes, it being one of the most stubborn and persistent weeds that ever came to us from over the seas.

But for those people who admire lace of intricate pattern, and beautiful blossoms whether they grow on scalawag plants or not, this medallion flower attributed to Queen Anne is well worth studying. It belongs to the family *Umbelliferae*, which one of my small pupils always

Queen Anne's lace, or wild carrot
Photo by Verne Morton.

called umbrelliferae because, he averred, they have umbrella blossoms. In the case of Queen Anne's lace the flower-cluster, or umbel, is made up of many smaller umbels, each a most perfect flower-cluster in itself. Each tiny white floret has five petals and should have five stamens with creamy anthers, but often has only two. However, it has always at its center two fat little pistils set snugly together, and it rests in a solid, bristly, green, cup-like calyx. Twenty or thirty of these little blossoms are set in a rosette, the stems of graded length; and where the bases of the stems meet are some long, pointed, narrow bracts, which protectingly brood the flowers in the bud and the seeds as they ripen. Each of these little flower-clusters, or umbels, has a long stem, its length being just fit to bring it to its right place in the medallion pattern of this royal lace. And these stems also have set at their bases some bracts with long, thread-like lobes, which make a delicate, green background for the opening blossoms; these bracts curl up protectingly about the buds and the seeds. If we look straight into the large flower-cluster, we can see that each component cluster, or umbelicel, seems to have its own share in making the larger pattern; the outside blossoms of the outside clusters have the outside petals larger, thus forming a beautiful border and calling to mind the beautiful flowers of the Composites. At the very center of this flower medallion, there is often a larger floret with delicate wine-colored petals; this striking floret is not a part of a smaller flower-cluster, but stands in stately solitude upon its own isolated stem. The reason for this giant floret at the center of the wide, circular flower-cluster is a mystery; and so far as I know, the botanists have not yet explained the reason for its presence. May we not, then, be at liberty to explain its origin on the supposition that her Royal Highness, Queen Anne, was wont to fasten her lace medallions upon her royal person with garnet-headed pins?

When the flowers wither and the seeds begin to form, the flower-cluster then becomes very secretive; every one of the little umbels turns toward the center, its stem curving over so that the outside umbels reach over and "tuck in" the whole family; and the threadlike bracts at the base reach up as if they, too, were in the family councils, and must do their slender duty in helping to make the fading flowers into a little, tightfisted clump; and all of this is done so that the precious seeds may be safe while they are ripening. Such little porcupines as these seeds are! Each seed is clothed with long spines set in bristling rows, and is a most forbidding-looking youngster when examined through a lens; and yet there is method in its spininess, and we must grudgingly grant that it is not only beautiful in its ornamentation but is also well fitted to take hold with a will when wandering winds sift it down to the soil.

An inner and a border floret and a bract of Queen Anne's lace, enlarged.

The wild carrot is known in some localities as the "bird's-nest weed," because the maturing seed-clusters, their edges curving inward, look like little birds' nests. But no bird's nest ever contained so many eggs as does this imitation one. In one we counted 34 tiny umbels on which ripened 782 seeds; and the plant, from which this "bird's nest" was taken, developed nine more quite as large.

Altogether the wild carrot is well fitted to maintain itself in the struggle for existence, and is most successful in crowding out its betters in pasture and meadow. Birds do not like its spiny seeds; the stem of the plant is tough and its leaves are rough and have an unpleasant odor and acrid taste, which render it unpalatable to grazing animals. Winter's cold cannot harm it, for it is a biennial; its seeds often germinate in the fall, sending down long, slender taproots crowned with tufts of inconspicuous leaves; it thus stores up a supply of starchy food which enables it to start early the next season with great vigor. The root, when the plant is fully grown, is six or eight inches long, as thick as a finger and yellowish white in color; it is very acrid and somewhat poisonous.

The surest way of exterminating the Queen Anne's lace is to prevent its prolific seed production by cutting or uprooting the plants as soon as the first blossoms open.

"'Tis Eden everywhere to hearts that listen
And watch the woods and meadows grow."

—Theron Brown.

Seed-cluster, or "bird's nest," of wild carrot.
Photo by Charles F. Fudge.

LESSON CXLVIII

Queen Anne's Lace, or Wild Carrot

Leading thought—Queen Anne's lace is a weed which came to us from Europe and flourishes better here than on its native soil. It has beautiful blossoms set in clusters, and it matures many seeds which it manages to plant successfully.

Method—The object of this lesson should be to show the pupils how this weed survives the winter and how it is able to grow where it is not wanted, maintaining itself successfully, despite man's enmity. The weed is very common along most country roadsides, and in many pastures and meadows. It blossoms very late in the autumn, and is available for lessons often as late as November. Its seed-clusters may be used for a lesson at almost any time during the winter.

Observations—1. Look at a wild carrot plant; how are its blossoms arranged? Take a flower-cluster, what is its shape? How many small flower-clusters make the large one? How are these arranged to make the large cluster symmetrical?

2. Take one of the little flower-clusters from near the center, and one from the outside, of the large cluster; how many little flowers, or florets make up the smaller cluster? Look at one of the florets through a lens;

can you see the cup-shaped calyx? How many petals has it? Can you see its five anthers and its two white pistils?

3. Take one of the outer florets of the outside cluster; are all its flowers the same shape? How do they differ? Where are the florets with the large petals placed in the big flower-cluster? How does this help to make "the pattern?"

4. Do the outside or the central flowers of the large clusters open first? Can you find a cluster with an almost black or very dark red floret at its center? Is this dark flower a part of one of the little clusters or does it stand alone, its stem reaching directly to the main stalk? Do you think it makes the flowers of the Queen Anne's lace prettier to have this dark red floret at the center?

5. Take a flower-cluster with the flowers not yet open. Can you see the threadlike green bracts that close up around each bud? Can you see finely divided, threadlike bracts that stand out around the whole cluster? What position do these bracts assume when the flowers are open? What do they do after the flowers fade and the seeds are being matured?

6. What is the general shape of the seed-cluster of the wild carrot? Have you ever found such a cluster broken off and blowing across the snow? Do you think this is one way the seed is planted?

7. Examine a single seed of the wild carrot with a lens. Is it round or oblong? Thin or flat? Is it ridged or grooved? Has it any hooks or spines by which it might cling to the clothing of passers-by, or to the hair or fleece of animals, and thus be scattered more widely? Does the seed cling to its stem or break away readily when it is touched?

8. Take one seed-cluster and count the number of seeds within it. How many seed-clusters do you find on a single plant? How many seeds do you, therefore, think a single plant produces?

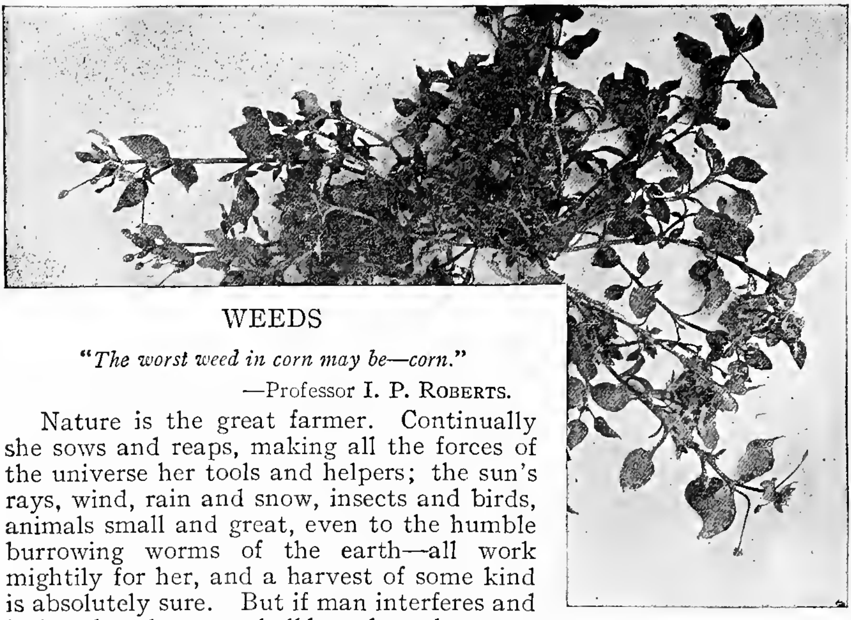
9. What should you consider the best means of destroying this prolific weed?

10. What do you think is the reason that the wild carrot remains untouched, so that it grows vigorously and matures its seeds in lanes and pastures where cattle graze?

11. Have you noticed any birds feeding on the seeds of the wild carrot?

I do not want change: I want the same old and loved things, the same wild flowers, the same trees and soft ash-green; the turtle-doves, the blackbirds, the coloured yellow-hammer sing, sing, singing so long as there is light to cast a shadow on the dial, for such is the measure of his song, and I want them in the same place. Let me find them morning after morning, the starry-white petals radiating, striving upwards to their ideal. Let me see the idle shadows resting on the white dust; let me hear the humble-bees, and stay to look down on the rich dandelion disc. Let me see the very thistles opening their great crowns—I should miss the thistles; the reed-grasses hiding the moor-hen; the bryony bine, at first crudely ambitious and lifted by force of youthful sap straight above the hedgerow to sink of its own weight presently and progress with crafty tendrils; swifts shot through the air with outstretched wings like crescent-headed shaftless arrows darted from the clouds; the chaffinch with a feather in her bill; all the living staircase of the spring, step by step, upwards to the great gallery of the summer—let me watch the same succession year by year.

—"The Pageant of Summer," by Richard Jefferies.



Chickweed.
Photo by Cyrus Crosby.

WEEDS

"The worst weed in corn may be—corn."

—Professor I. P. ROBERTS.

Nature is the great farmer. Continually she sows and reaps, making all the forces of the universe her tools and helpers; the sun's rays, wind, rain and snow, insects and birds, animals small and great, even to the humble burrowing worms of the earth—all work mightily for her, and a harvest of some kind is absolutely sure. But if man interferes and insists that the crops shall be only such as may benefit and enrich himself, she seems to yield a willing obedience, and under his control does immensely better work than when unguided. But Dame Nature is an "eye-servant." Let the master relax his vigilance for ever so short a time, and among the crops of his desire will come stealing in the hardy, aggressive, and to him, useless plants that seem to be her favorites.

A weed is a plant growing where we wish something else to grow, and a plant may, therefore, be a weed in some locations and not in others. The mullein is grown in greenhouses in England as the American velvet-plant. Our grandmothers considered "butter-and-eggs," a pretty posy, and planted it in their gardens, wherefrom it escaped, and is now a bad weed wherever it grows. A weed may crowd out our cultivated plants, by stealing the moisture and nourishment in the soil which they should have; or it may shade them out by putting out broad leaves and shutting off their sunlight. When harvested with a crop, weeds may be unpalatable to the stock which feed upon it; or in some cases, as in the wild parsnip, the plant may be poisonous.

Each weed has its own way of winning in the struggle with our crops, and it behooves us to find that way as soon as possible in order to circumvent it. This we can only do by a careful study of the peculiarities of the species. To do this we must know the plant's life history; whether it is an annual, surviving the winter only in its seeds; or a biennial, storing in fleshy root or in broad, green leafy rosette the food drawn from the soil and air during the first season, to perfect its fruitage in the second year; or a perennial, surviving and springing up to spread its kind and pester the farmer year after year, unless he can destroy it "root and branch." Purslane is an example of the first class, burdock or mullein of the second, and the field sorrel or Canada thistle of the third. According to their nature the farmer must use different means of extermination: he must strive to hinder the annuals and biennials from forming any seed whatever; and where perennials have made themselves a pest, he must put in a "hoed crop," requiring such constant and thorough tillage that the weed roots will be deprived of all starchy food manufactured by green leaves and be starved out. Especially every one who plants a garden should know how the weeds look when young, for seedlings of all kinds are delicate and easy to kill before their roots are well established.

LESSON CXLIX

Outline for the Study of a Weed

1. Why do we call a plant a weed? Is a weed a weed wherever it grows? How about "butter and eggs" when it grew in Grandmother's garden? Why do we call that a weed now? What did Grandmother call it?

2. In how many ways may a weed injure our cultivated crops?

3. Why must we study the habits of a weed before we know how to fight it?

We should ask of every weed in our garden or on our land the following questions, and let it answer them through our observations in order to know why the weed grows where it chooses, despite our efforts.

4. How did this weed plant itself where I find it growing? By what agency was its seed brought and dropped?

5. What kind of root has it? If it has a tap-root like the mullein, what advantage does it derive from it? If it has a spreading shallow-growing root like the purslane what advantage does it gain? If it has a creeping rootstock with underground buds like the Canada thistle, how is it thereby helped?

6. Is the stem woody or fleshy? Is it erect or reclining or climbing? Does it gain any advantage through the character of its stem?

7. Note carefully the leaves. Are they eaten by grazing animals? If not, why? Are they covered with prickles like the teazel or fuzz like the mullein, or are they bitter and acrid like the wild carrot?

8. Study the blossoms. How early does the weed bloom? How long does it remain in bloom? Do insects carry pollen for the flowers? If so, what insects? What do the insects get in return? How are the flower buds and the ripening seeds protected?

9. Does it ripen many seeds? Are these ripened at the same time or are they ripened during a long period? Of what advantage is this? How are the seeds scattered, carried and planted? Compute how many seeds one plant of this weed matures in one year.

"That which ye sow ye reap. See yonder fields!
The sesamum was sesamum, the corn
Was corn. The Silence and the Darkness know!"

—Edwin Arnold.

Courtesy of Doubleday, Page & Co.

CULTIVATED-PLANT STUDY

THE CROCUS

Teacher's Story

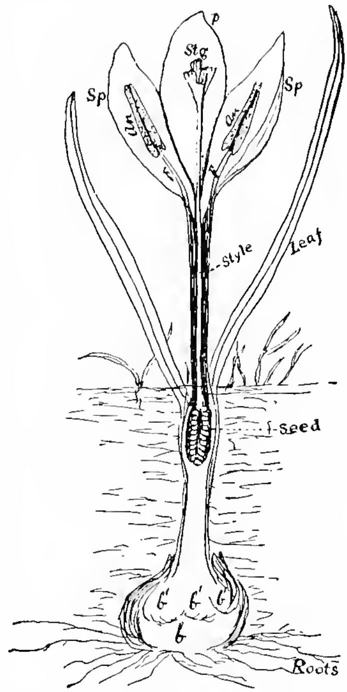
The crocus, like the snowdrop, cannot wait for the snow to be off the ground before it pushes up its gay blossoms, and it has thus earned the gratitude of those who are winter weary.

The old and young corms of the crocus.

The crocus has a corm instead of a bulb like the snowdrop or daffodil. A corm is a solid, thickened, underground stem, and is not in layers, like the onion. The roots come off the lower side of the corm. The corm of the crocus is well wrapped in several, usually five, white coats with papery tips. When the plant begins to grow the leaves push up through the coats. The leaves are grasslike and may be in number from two to eight, depending on the variety. Each leaf has its edge folded, and the white midrib has a plait on either side, giving it the appearance of being box-plaited on the under side. The bases of the leaves enclosed in the corm coats are yellow, since they have had no sunlight to start their starch factories and the green within their cells. At the center of the leaves appear the blossom buds, each enclosed in a sheath.

The petals and sepals are similar in color, but the three sepals are on the outside, and their texture, especially on the outer side, is coarser than that of the three protected petals. But sepals and petals unite into a long tube at the base. At the very base of this corolla tube, away down out of sight, even below the surface of the ground, is the seed-box, or ovary. From the tip of the ovary the style extends up through the corolla-tube and is tipped with a ruffled three-lobed stigma.

The three stamens are set at the throat of the corolla tube. The anthers are very long and open along the sides. The anthers mature first, and shed their pollen in the cup of the blossom where any insect, seeking the nectar in the tube of the corolla, must become dusted with it. However, if the stigma lobes fail to get pollen from other flowers, they later spread apart and curl over until they reach some of the pollen of their own flower.



The crocus.
p, petal; sp, sepal; an, anther; f, filament; stg. stigma; b, mother corm; b¹ b¹ b¹ young corms.

Crocus blossoms have varied colors: white, yellow, orange, purple, the latter often striped or feather-veined. And, while many seeds like tiny pearls, are developed in the oblong capsule, yet it is chiefly by its corms that the crocus multiplies. On top of the mother corm of this year develop several small corms, each capable of growing a plant next year. But after two years of this second-story sort of multiplication the young crocuses are pushed above the surface of the ground. Thus, they need to be replanted every two or three years. Crocuses may be planted from the first of October until the ground freezes. They make pretty borders to garden beds and paths. Or they may be planted in lawns without disturbing the grass, by punching a hole with a stick or dibble and dropping in a corm and then pressing back the soil in place above it. The plants will mature before the grass needs to be mowed.

LESSON CL

The Crocus

Leading thought—The crocuses appear so early in the spring, because they have food stored in underground storehouses. They multiply by seeds and by corms.

Method—If it is possible to have crocuses in boxes in the schoolroom windows, the flowers may thus best be studied. Otherwise, when crocuses are in bloom bring them into the schoolroom, bulbs and all, and place them where the children may study them at leisure.

Observations—1. At what date in the spring have you found crocuses in blossom? Why are they able to blossom so much earlier than other flowers?

2. Take a crocus just pushing up out of its bulb. How many overcoats protect its leaves? What is at the very center of the bulb? Has the flower bud a special overcoat?

3. Describe the leaves. How are they folded in their overcoats? What color are they where they have pushed out above their overcoats? What color are they within the overcoats? Why?

4. Do the flowers or the leaves have stems, or do they arise directly from the bulb?

5. What is the shape of the open crocus flower? Can you tell the difference between sepals and petals in color? Can you tell the difference by their position? Or by their texture above or below? As you look into the flower, which make the points of the triangle, the sepals or the petals?

6. Describe the anthers. How long are they? How many are there? How do they open? What is the color of the pollen? Describe how a bee becomes dusted with pollen? Why does the bee visit the crocus blossom? If she finds nectar there, where is it?

7. Describe the stigma. Open a flower and see how long the style is? How do the sepals and petals unite to protect the style? Where is the seed-box? Is it so far down that it is below ground? How many seeds are developed from a single blossom?

8. How many colors do you find in the crocus flowers? Which are the prettiest in the lawn? Which, in the flower beds?

9. How do the crocus blossoms act in dark and stormy weather? When do they open? How does this benefit them?

10. How do the crocus bulbs multiply? Why do they lift themselves out of the ground and thus need resetting.

11. Describe how to raise crocuses best; the kind of soil, the time of planting, and the best situations.

Out of the frozen earth below,
Out of the melting of the snow,
No flower, but a film, I push to light;
No stem, no bud—yet I have burst
The bars of winter, I am the first
O Sun, to greet thee out of the night!

Deep in the warm sleep underground
Life is still, and the peace profound:
Yet a beam that pierced, and a thrill that smote
Call'd me and drew me from far away;
I rose, I came, to the open day
I have won, unshelter'd, alone, remote.

—"The Crocus," by Harriet E. H. King.

When first the crocus thrusts its point of gold,
Up through the still snow-drifted garden-mould,
And folded green things in dim woods unclose
Their crinkled spears, a sudden tremor goes
Into my veins and makes me kith and kin
To every wild-born thing that thrills and blows.

—"A Touch of Nature," by T. B. Aldrich.

THE DAFFODILS AND THEIR RELATIVES

Teacher's Story

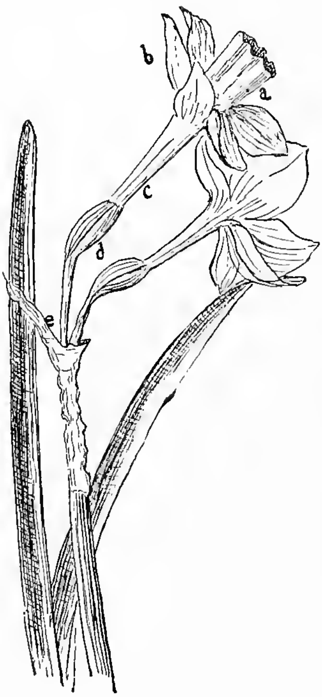
"Daffydown Dilly came up in the cold from the brown mold,
Although the March breezes blew keen in her face,
Although the white snow lay on many a place."

Thus, it is that Miss Warner's stanzas tell us the special reason we so love the daffodils. They bring the sunshine color to the sodden earth, when the sun is chary of his favors in our northern latitude; and the sight of the daffodils floods the spirit with a sense of sunlight.

Daffodil.

The daffodils and their relatives, the jonquils and narcissus, are interesting when we stop to read their story in their form. The six segments of the perianth, or, as we would say, the three bright-colored sepals and the three inner petals of the flower, are different in shape; but they all look like petals and stand out in star-shape around the flaring end of the flower tube, which, because of its shape, is called the corona, or crown; however, it looks more like a stiff little petticoat extending out in the middle of the flower than it does like a crown. The crown is simply the widened end of the tube of the flower, as may be seen by opening a flower lengthwise; the six seeming petals will peel off the tube, showing that they are fastened to the outside of it. When we look down into the crown of one of these flowers, we see the long style with its three-lobed stigma pushing out beyond the anthers, which are pressed close about it at the throat of the tube; between each two anthers may be seen a little deep passage, through which the tongues of the moth or butterfly can be thrust to reach the nectar. In a tube, slit open, we can see the nectar at the very bottom of it, and it is sweet to the taste and has a decided flavor. In this open tube we may see that the filaments of the stamens are grown fast to the sides of the tube for much of their length, enough remaining free to press the anthers close to the style. The ovary of the pistil is a green swelling at the base of the tube; by cutting it across we can see it is triangular in outline, and has a little cavity in each angle large enough to hold two rows of the little, white, shining, unripe seeds. Each of these cavities is partitioned from the others by a green wall; the partition is marked by a suture on the outside of the seed-pod.

When the flower stalk first appears, it comes up like a sheathed sword, pointing toward the zenith, green, veined lengthwise, and with a noticeable thickening at each edge. As the petals grow, the sheath begins to round out; and then as if to confuse those people who are so stupid as to believe that plants do not really do things, the stiff stem at the base of the sheath bends at right angles. This brings a strain upon the sheath which bursts it, usually along the upper side, although sometimes it tears it off completely at the base. The slitted sheath, or spathe, hangs around the stem, wrinkled and parchment-like, very like the loose wrist of a suede glove. The stalk is a strong green tube; the leaves are fleshy and are grooved on the inner side, the groove being deep enough to clasp part way around the flower stem. The number of leaves varies with the variety, and they are usually as tall as the flower stalk. There is one flower on a stalk in the daffodils and the poet's narcissus, but the jonquils and paper-white narcissus have two or more flowers on the same stalk.



Daffodil showing detail of flower.

a, corona or crown; b, sepals and petals forming perianth; c, corolla tube; d, ovary or seed-case; e, sheath or spathe.

A bed should be prepared by digging deep and fertilizing with stable manure. The bulbs should be planted in September or early October, and should be from four to six inches apart, the upper end of the bulbs at least four inches below the surface of the soil. They should not be disturbed but allowed to occupy the bed for a number of years, or as long as they give plenty of flowers. As soon as the surface of the ground is frozen in the winter, the beds should be covered from four to six inches in depth with straw-mixed stable manure, which can be raked off very early in the spring.

The new bulbs are formed at the sides of the old one; for this reason the daffodils will remain permanently planted, and do not lift themselves out of the ground like the crocuses. The leaves of the plant should be allowed to stand as long as they will after the flowers have disappeared, so that they may furnish the bulbs with plenty of food for storing. The seeds should not be allowed to ripen, as it costs the plant too much energy and thus robs the bulbs. The flowers should be cut just as they are opening. Of the white varieties, the poet's narcissus is the most satisfactory, as it is very hardy and very pretty, its corona being a shallow, flaring, greenish yellow rosette with orange-red border, the anthers of its three longest stamens making a pretty center. No wonder Narcissus bent over the pool in joy at viewing himself, if he was as beautiful a man as the poet's narcissus is as a flower.

LESSON CLI

Daffodils, Jonquils and Narcissus

Paper-white narcissus.

Leading thought— The daffodil, jonquil and narcissus are very closely related, and quite similar. They all come from bulbs which should be planted in September; but after the first planting, they will flower on year after year, bringing much brightness to the gardens in the early spring.

Method—The flowers brought to school may be studied for form, and there should be a special study of the way the flower develops its seed, and how it is propagated by bulbs. The work should lead directly to an interest in the cultivation of the plants. In seedsmen's catalogues or other books, the children will find methods of planting and cultivating these flowers in cities. Daffodils are especially adapted for both window gardens and school gardens.

Observations—1. Note the snape of the flower. Has it any sepals? What do we call the flowers that have their sepals colored like petals, thus forming a part of the beauty of the flower? Can you see any difference in color, position and texture between the petals and sepals?

2. How do the petal-like parts of these flowers look? How many of them are there? Do they make the most showy part of the flower?

3. What does the central part of the flower look like? Why is it called the corona, or crown? Is it a part of the tube which joins the flower to the stem? Do the petals and sepals peel off this tube? Peel them off one flower, and see that the tube is shaped like a trumpet.

4. Look down into the crown of the flower and tell what you see. Can you see where the insect's tongue must go to reach the nectar?

5. Cut open a trumpet lengthwise to find where the nectar is. How far is it from the mouth of the tube? How long would the insect's tongue have to be to reach it? What insects have tongues as long as this?

6. In order to reach the nectar how would an insect become dusted with pollen? Are the stamens loose in the flower-tube? Is the pistil longer than the stamens? How many parts to the stigma? Can you see

how the flowers are arranged so that insects can carry pollen from flower to flower?

7. What is the green swelling in the stem at the base of the trumpet? Is it connected with the style? Cut it across and describe what you see. How do the young seeds look and how are they arranged?

8. Where the flower stem joins the stalk, what do you see? What is this dry spathe there for? Are there one or more flower stems coming from this spathe?

9. Describe the flower stalk? Are the leaves wide or narrow? Are they as long as the flower stalk, are they flat, or are they grooved to fit around the flower stalk?

10. What are the differences between daffodils, jonquils and poet's narcissus? When should the bulbs for these flowers be planted? Will there be more bulbs formed around the one you plant? Will the same bulb ever send up flowers and leaves again? How do the bulbs divide to make new bulbs?

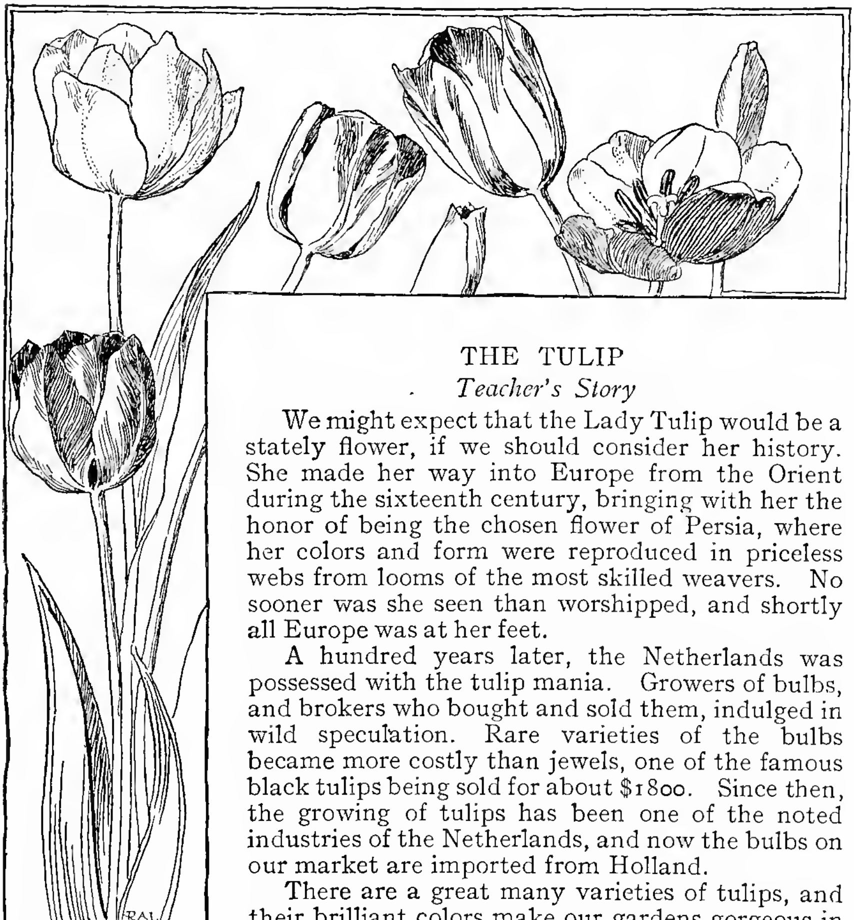
11. How should the bed for the bulbs be prepared? How near together should the bulbs be planted? How deep in the earth? How protect them in the North during the winter?

12. Why should you not cut the leaves off after the flowers have died? Why should you not let the seeds ripen? When should the flowers be cut for bouquets? Who was Narcissus, and why should these early spring flowers be named after him?

Supplementary reading—Green Things Growing, Mulock; The Daffodils, Wordsworth; The Story of Narcissus, Child's Study of the Classics; Mary's Garden, Duncan, Chapters XXVI and XXVII.

"I emphatically deny the common notion that the farm boy's life is drudgery. Much of the work is laborious, and this it shares with all work that is productive; for the easier the job the less it is worth doing. But every piece of farm work is also an attempt to solve a problem, and therefore it should have its intellectual interest; and the problems are as many as the hours of the day and as varied as the face of nature. It needs but the informing of the mind and the quickening of the imagination to raise any constructive work above the level of drudgery. It is not mere dull work to follow the plow—I have followed it day after day—if one is conscious of all the myriad forces that are set at work by the breaking of the furrow; and there is always the landscape, the free fields, the clean soil, the rain, the promise of the crops. Of all men's labor, the farmer's is the most creative. I cannot help wondering why it is that men will eagerly seek work in the grease and grime of a noisy factory, but will recoil at what they call the dirty work of the farm. So much are we yet bound by tradition!"

—L. H. Bailey.



THE TULIP

Teacher's Story

We might expect that the Lady Tulip would be a stately flower, if we should consider her history. She made her way into Europe from the Orient during the sixteenth century, bringing with her the honor of being the chosen flower of Persia, where her colors and form were reproduced in priceless webs from looms of the most skilled weavers. No sooner was she seen than worshipped, and shortly all Europe was at her feet.

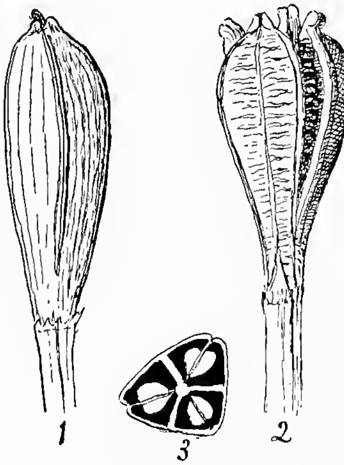
A hundred years later, the Netherlands was possessed with the tulip mania. Growers of bulbs, and brokers who bought and sold them, indulged in wild speculation. Rare varieties of the bulbs became more costly than jewels, one of the famous black tulips being sold for about $1800. Since then, the growing of tulips has been one of the noted industries of the Netherlands, and now the bulbs on our market are imported from Holland.

There are a great many varieties of tulips, and their brilliant colors make our gardens gorgeous in early spring. Although this flower is so prim, yet it bears well close observation. The three petals, or inner segments of the perianth, are more exquisite in texture and in satiny gloss on their inner surface than are the three outer segments or sepals; each petal is like grosgrain silk, the fine ridges uniting at the central thicker portion. In the red varieties, there is a six pointed star at the heart of the flower, usually yellow or yellow-margined, each point of the star being at the middle of a petal or sepal; the three points on the petals are longer than those on the sepals.

When the flower's bud first appears, it is nestled down in the center of the plant, scarcely above the ground. It is protected by three green sepals. As it stretches up, the bud becomes larger and the green of the sepals takes on the color of the tulip flower, until when it opens there is little on the outside of the sepals to indicate that they once were green. But they still show that they are sepals, for they surround the petals, each standing out and making the flower triangular in shape as we look into it. During storms and dark days, the sepals again partially close about the flower.

The seed-vessel stands up, a stout, three-sided, pale green column at the center of the flower, in some varieties, its three-lobed yellowish stigma making a Doric capital; in others, the divisions are so curled as to make the capital almost Ionian. The six stout, paddle-shaped stamens have their bases expanded so as to encircle completely the base of the pistil column; these wide filaments are narrower just below the point where the large anthers join. The anther opens along each side to discharge the pollen; however, the anthers flare out around the seed vessel and do not reach half way to the stigma, which is probably the tulips' way of inducing the insects to carry their pollen, since the bees cannot reach the nectar at the base of the pistil without dusting themselves with pollen.

The flower stem is stout, pale green, covered with a whitish bloom. The leaves are long, trough-shaped and narrow with parallel veins; the bases of the lower ones encircle the flower stem and have their edges more or less ruffled and their tips recurved; the upper leaves do not completely encircle the flower stem at their bases. The texture of the leaves is somewhat softer on the inside than on the outside, and both sides are grayish green.



Tulip seed-capsule.

1, Tulip seed-capsule; 2, the same opened; 3, cross section of same.

After the petals and stamens are dropped the seed-vessel looks like an ornamental tip to the flower stem; it is three-sided, and has within double rows of seeds along each angle. The seeds should not be allowed to ripen as they thus take too much strength from the bulbs.

The bulb is formed of several coats, or layers, each of which extends upwards and may grow into a leaf; this shows that the bulb is made up of leaves which are thickened with the food which is stored up in them during one season, so as to start the plant growing early the next spring. In the heart of each bulb is a flower bud, sheltered and cuddled by the fleshy leaf-layers around it, which protect it during the winter and furnish it food in the spring. This structure of the bulb explains why the leaves clasp the flower stem at their bases. The true roots are below the bulb, making a thick tassel of white rootlets, which reach deep into the soil for food and water.

Tulips are very accommodating; they will grow in almost any soil if it is well drained, so that excessive moisture may not rot the bulbs. In preparing a bed, it should be rounded up so as to shed water; it should also be worked deep and made rich. If the soil is stiff and clayey, set bulbs only three inches deep, with a handful of sand beneath each. If the soil is mellow loam, set the bulbs four inches deep and from four to six inches apart each way, depending on the size of the bulbs. They should be near enough so that when they blossom the bed will be covered and show no gaps. Take care that the pointed tip of the bulb is upward and that it does not fall to one side as it is covered. October is the usual time for planting as the beds are often used for other flowers during the summer.

However, September is not too early for the planting, as the more root growth made before the ground freezes, the better; moreover, the early buyers have best choice of bulbs. The beds should be protected by a mulch of straw or leaves during the winter, which should be raked off as soon as the ground is thawed in the spring. The blossoms should be cut as soon as they wither, in order that the new bulbs which form within and at the sides of the parent bulb may have all of the plant food, which would otherwise go to form seed. Tulips may be grown from seed, but it takes from five to seven years to obtain blossoms, which may be quite unlike the parent and worthless. The bulblets grow to a size for blooming in two or three years; the large one which forms in the center of the plant will bloom the next season.

Tulips
Courtesy Doubleday, Page & Co.

LESSON CLII

The Tulips

Leading thought—The tulips blossom early, because they have food stored in the bulbs the year before, ready to use early in the spring. There are many varieties; each is worth studying carefully, and we should all know how to grow these beautiful flowers.

Methods—These observations may be made upon tulips in school gardens or bouquets. The best methods of cultivating should be a part of the garden training. For this, consult the seed catalogues; also let the pupils form some idea of the number of varieties from the seed catalogues. Water-color drawings should be a large factor in studying the tulip. The red varieties are best for beginning the study, and then follow with the other colors; note differences.

Observations—1. What is the color of your tulip? Is it all the same color? Is the bottom of the flower different in color? What is the pretty shape of these different colors at the heart of the flower?

2. Look at a tulip just opening. What causes it to appear so triangular? Can you see that the three sepals are placed outside the petals? Is there any difference in color between the sepals and petals on the inside On the outside? Are the sepals and petals the same in length and shape? Do you know the name given to this arrangement when sepals and petals look alike in color? Are the three petals more satiny on the inside than the sepals? Is the center part of the petal as soft as the edges?

3. When the tulip flower bud first begins to show, where is it? What color are the sepals which cover it? Describe the opening of the flower? Do the green sepals fall off? What becomes of them?

4. In the open flower, where is the seed-pod, and how does it look? How do the anthers surround the seed-pod, or ovary? Describe the anthers, or pollen-boxes? What color are they? What color is the pollen? Do the anthers reach up to the stigma, or tip of seed-pod? Where is the nectar in tulips? How do the insects become covered with the pollen in reaching it? Do the flowers remain open during dark and stormy days? Why?

5. Describe the tulip stem and the leaves. Do the leaves completely encircle the flower stem at the base? Are their edges ruffled? In the sprouting plant, do these outer basal leaves enfold the leaves which grow higher on the stem? Are the leaves the same color above and below? What shade of green are they?

6. After the petals have dropped, study the seed-pod. Cut it crosswise and note how many angles it has. How are these angles filled? Should tulips be allowed to ripen seeds? Why not?

7. Study a bulb of a tulip. There are outer and inner layers and a heart. What part of the plant do the outer layers make? What part does the center make? Where are the true roots of the tulip?

8. When should tulip bulbs be planted? How should you prepare the soil? How protect the bed during the winter? How long would it take to grow the flowers from the seed? Where are most of our bulbs grown? Do you know about the history of tulips?

Supplementary reading—Bulbs and Bulb-Culture, Peter Henderson; Plants and their Children, Dana, p. 216; Mary's Garden and How It Grew, Duncan, Ch. XXVI; Bulbs and How to Grow Them, Doubleday-Page Co.

Pansies.
Drawn by Anna C. Stryke.

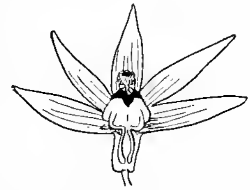
THE PANSY

Teacher's Story

SOME people are pansy-faced and some pansies are human-faced, and for some occult reason this puts people and pansies on a distinctly chummy basis. When we analyze the pansy face, we find that the dark spots at the bases of the side petals make the eyes, the lines radiating from them looking quite eyelashy. The opening to the nectar-tube makes the nose, while the spot near the base of the lower petal has to do for a mouth, the nectar guiding-lines being not unlike whiskers. Meanwhile, the two upper petals give a "high-browed" look to the pansy countenance, and make it a wise and knowing little face.

The pansy nectar is hidden in the spur made by the lower petal extending behind the flower. The guiding lines on the lower and side petals all converge, pointing directly to the opening which leads to this nectar-well, telling the secret to every bee that flies. Moreover, the broad lower petal is a platform for the lady bee to alight upon, while she probes the nectar-well with her tongue.

But at the door leading to the nectar-well sits a little man; his head is green, he wears a white cape with a scalloped, reddish brown collar, and he sits with his bandy legs pushed back into the spur as if he were taking a foot bath in nectar. This little pansy man has plenty of work to do; for his mouth, which is large and at the top of his green head, is the stigma. The cape is made of five overlapping stamens, the brown, scalloped collar being the anthers; his legs consist of prolongations of the two lower stamens. And when the bee probes the nectar-well with her tongue, she tickles the little man's feet so that his head and shoulders wriggle; and thus she brushes the pollen dust from his collar against her fuzzy face, and at the same time his mouth receives the pollen from her dusty coat.



The little pansy-man.

As the pansy matures, the little man grows still more manlike; after a time he sheds his anther cape, and we can see that his body is the ribbed seed-pod. He did not eat pollen for nothing, for he is full of growing seeds. Sometimes the plush brushes, which are above his head in the pansy flower, become filled with pollen, and perhaps he gets a mouthful of it, although these brushes are supposed to keep out intruders.

The pansy sepals, five in number, are fastened at about one-third of their length, their heart-shaped bases making a little green ruffle around the stem where it joins the flower. There is one sepal above and two at each side, but none below the nectar-spur. The flower stem is quite short and always bends politely so the pansy can look sidewise at us instead of staring straight upward. The plant stem is angled and crooked and stout. In form, the leaves are most capricious; some are long and pointed, others wide and rounded. The edges are slightly scalloped and the leaf may have at its base a pair of large, deeply lobed stipules. In a whole pansy bed it would be quite impossible to find two leaves just alike.

The pansy ripens many seeds. The ribbed seed-capsule, with its base set comfortably in the faithful sepals, finally opens in three valves and the many seeds are scattered. To send them as far afield as possible, the edges of each valve of the pod curl inward, and snap the seeds out as boys snap apple seeds from the thumb and finger.

Pansies like deep, rich and cool, moist soil. They are best suited to a northern climate, and prefer the shady side of a garden to the full sunshine. The choice varieties are perpetuated through cuttings. They may be stuck in the open ground in summer in a half-shady place and should be well-watered in dry weather. All sorts of pansies are readily raised from seed sown in spring or early summer, and seedlings, when well established, do not suffer, as a rule, from winter frosts.

The general sowing for the production of early spring bloom is made out of doors in August, while seeds sown indoors from February to June will produce plants to flower intermittently during the late summer and fall months. When sowing pansy seed in August, sow the seed broadcast in a seed-bed out of doors, cover very lightly with fine soil or well-rotted manure, and press the seed in with a small board; then mulch the seed-bed with long, strawy horse manure, from which the small particles have been shaken off, to the thickness of one inch, so as to have the soil well and evenly covered. At the end of two weeks the plants will be up. Then remove the straw gradually, a little at a time, selecting a dull day if possible. Keep the bed moist.

If the pansies are allowed to ripen seeds the season of bloom will be short, for when its seeds are scattered the object of the plant's life is accomplished. Besides, the plant has not vitality enough to perfect seeds and continue its bloom, and flowers borne with the forming seeds are smaller than the earlier ones. But if the flowers are kept plucked as they open, the plants persistently put forth new buds. The plucked flowers will remain in good condition longer if picked in the early morning before the bees begin paying calls, for a fertilized flower fades more quickly than one which has received no pollen.

Photo by Verne Morton

LESSON CLIII

The Pansy

Leading thought—The pansy is a member of the violet family. The flower often resembles a face; the colors, markings and fragrance all attract the bees, who visit it for the nectar hidden in the spur of the lower petal.

Method—The children naturally love pansies because of the resemblance of these flowers to quaint little faces. They become still more interested after they see the little man with the green head, which appears in the flower as it fades. A more practical interest may be cultivated by studying the great numbers of varieties in the seed catalogs and learning their names. This is one of the studies which leads directly to gardening. There are many beautiful pansy poems which should be read in connection with the lesson.

Observations—1. How does the pansy flower resemble a face? Where are the eyes? The nose? The mouth? How many petals make the pansy forehead? The cheeks? The chin?

2. Where is the nectar in the pansy? Which petal forms the nectar-tube?

3. Describe how a bee gets the nectar. Where does she stand while probing with her tongue?

4. Where is the pollen in the pansy? What is the peculiar shape of the anthers? How do the two lower stamens differ in form from the three upper ones?

5. Where is the stigma? Does the bee's tongue go over it or under it to reach the nectar? Describe the pansy arrangement for dusting the bee with pollen and for getting pollen from her tongue.

6. Observe the soft little brushes at the base of the two side petals. What do you think they are for?

7. Take a fading flower; remove the petals, and see the little man sitting with his crooked legs in the nectar-tube. What part of the flower makes the man's head? What parts form his cape? Of what is his pointed, scalloped collar formed?

8. How many sepals has the pansy? Describe them. How are they attached? When the flower fades and the petals fall, do the sepals also fall?

9. Where in the flower is the young seed-pod? Describe how this looks after the petals have fallen.

10. Describe how the seed-pod opens. How many seeds are there in it? How are they scattered?

11. Study the pansy stem. Is it solid? Is it smooth or rough? Is it curved? Does it stand up straight or partially recline on the ground?

12. Take a pansy leaf and sketch it with the stipules at its base. Can you find two pansy leaves exactly alike in shape, color and size?

13. At what time should the pansy seed be planted? How should the soil be prepared?

Supplementary reading—"April Fools" (p. 50), "Pansy Song" (p. 125), Nature in Verse, compiled by Mary J. Lovejoy; "Garden Folk" (p. 179), "Pansies" pp. 183–184, Among Flowers and Trees with the Poets, Wait & Leonard; "A Yellow Pansy" (p. 124), Nature Pictures by American Poets compiled by Annie Russell Marble.

I dropped a seed into the earth. It grew, and the plant was mine.

It was a wonderful thing, this plant of mine. I did not know its name, and the plant did not bloom. All I know is that I planted something apparently as lifeless as a grain of sand and there came forth a green and living thing unlike the seed, unlike the soil in which it stood, unlike the air into which it grew. No one could tell me why it grew, nor how. It had secrets all its own, secrets that baffle the wisest men; yet this plant was my friend. It faded when I withheld the light, it wilted when I neglected to give it water, it flourished when I supplied its simple needs. One week I went away on a vacation, and when I returned the plant was dead; and I missed it.

Although my little plant had died so soon, it had taught me a lesson; and the lesson is that it is worth while to have a plant.—The Nature-Study Idea, L. H. Bailey.

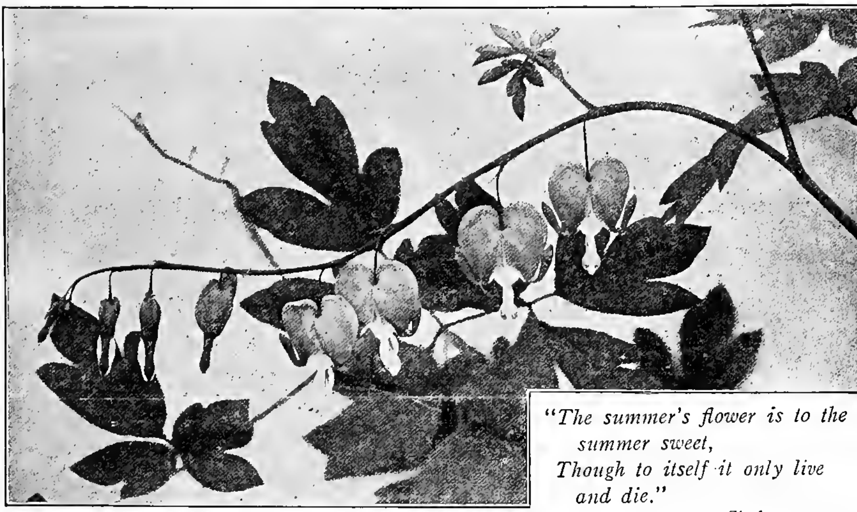


Photo by Verne Morton.

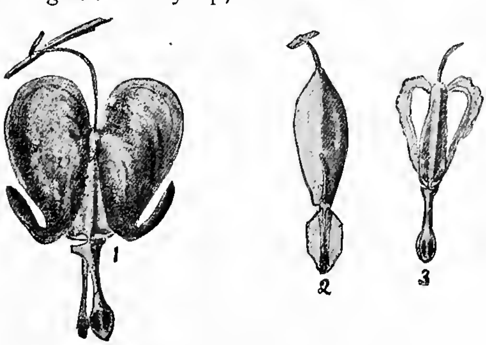
"The summer's flower is to the
summer sweet,
Though to itself it only live
and die."
—Shakespeare

THE BLEEDING HEART

Teacher's Story

For the intricate structure of this type of flower, the bleeding heart is much more easily studied than its smaller wild sisters, the Dutchman's breeches or squirrel corn; therefore it is well to study these flowers when we find them in profusion in our gardens, and the next spring we may study the wildwood species more understandingly.

The flowers of the bleeding heart are beautiful jewel-like pendants arranged along the stem according to their age; the mature flower, ready to shed its petals, is near the main stem, while the tiny unopened bud is hung at the very tip, where new buds are constantly being formed during a long season of bloom. This flower has a strange modification of its petals; the two pink outer ones, which make the heart, are really little pitchers with nectar at their bottoms, and although they hang mouth downwards the nectar does not flow out. When these outer petals are removed, we can see the inner pair placed opposite to them, the two of them close together and facing each other like two grooved ladles. Just at the mouth of the pitchers these inner petals are almost divided crosswise; and the parts that extend beyond are spoon-shaped, like the bowls of two spoons which have been pinched out so as to make a wide, flat



1, Flower of bleeding heart with swing-door ajar. 2, Side-view of flower showing the broad tips of the inner petals. 3, Flower with outer petals removed showing inner petals—and the heart-shaped bases of the stamens.

ridge along their centers. These spoon-bowls unite at the tip, and between them they clasp the anthers and stigma. Special attention should be given to the division between the two portions of these inner petals; for it is a hinge, the workings of which are of much importance to the flower. On removing the outer petals, we find a strange framework around which the heart-shaped part of the flower seems to be modeled. These are filaments of the stamens grouped in threes on each side; the two outer ones of each group are widened into frills on the outer edge, while the central one is stiffer and narrower. At the mouth of the pitchers all these filaments unite in a tube around the style; near the stigma they split apart into six short, white, threadlike filaments, each bearing a small, brilliant yellow anther. So close together are these anthers that they are completely covered by the spoon-bowls made by the inner petals, the pollen mass being flat and disklike. During the period when the pollen is produced, the stigma is flat and immature; but after the pollen is shed, it becomes rounded into lobes ready to receive pollen from other flowers.

Although the description of the plant of this flower is most complex and elaborate, the workings of the flower are most simple. As the nectar-pitchers hang mouth down, the bee must cling to the flower while probing upward. In doing this she invariably pushes against the outside of the spoon-bowls, and the hinge at their base allows her to push them back while the mass of pollen is thrust against her body; as this hinge works both ways, she receives the pollen first on one side and then on the other, as she probes the nectar-pitchers. And perhaps the next flower she visits may have shed its pollen, and the swing door will uncover the ripe stigma ready to receive the pollen she brings.

The sepals are two little scales opposite the bases of the outer petals. Before the flower opens, the "spouts of the nectar-pitchers" are clamped up on either side of the spoon-bowls, as if to keep everything safe until the right moment comes; at first they simply spread apart, but later curve backward. The seed-pod is long and narrow, and in cross-section is seen to contain two compartments with seeds growing on every side of the partition.

The bleeding heart is a native of China, and was introduced into Europe about the middle of the last century.

Reference—Our Garden Flowers, Keeler.

LESSON CLIV

The Bleeding Heart

Leading thought—The bleeding heart flower has its pollen and stigma covered by a double swing door, which the bees push back and forth when they gather the nectar.

Method—Bring a bouquet of the bleeding heart to the schoolroom, and let each pupil have a stem with its flowers in all stages. From this study, encourage them to watch these flowers when the insects are visiting them.

Observations—1. How are these flowers supported? Do they open upward or downward? Can you see the tiny sepals?

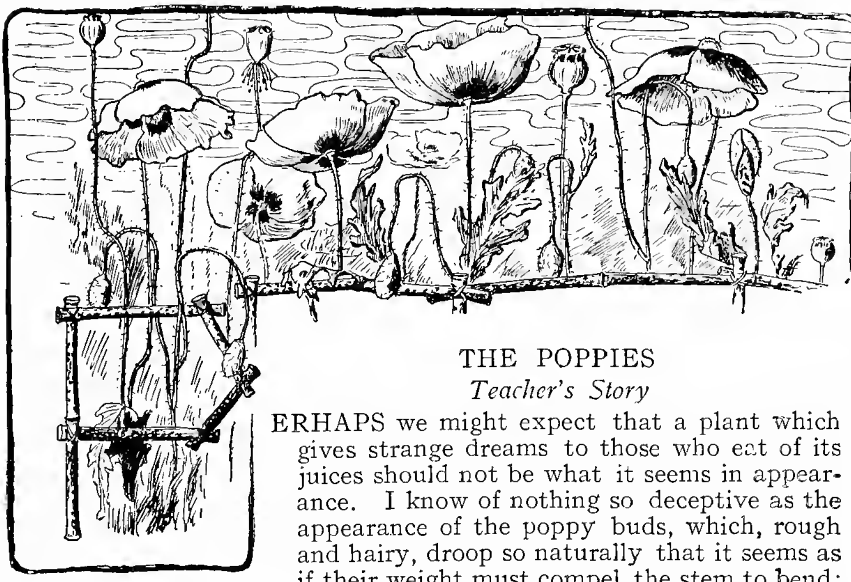
2. How many petals can you see in this flower? What is the shape of the two outer petals? How do they open? Where is the nectar developed in these petals?

3. Take off the two outer petals and study the two inner ones. What is their shape near the base? How are their parts shaped which project beyond the outer petals? What does the spoon-end of these petals cover? Can you find the hinge in these petals?

4. Where are the stamens? How many are there? Describe the shape of the stamens near the base. How are they united at the tip?

5. Where is the stigma? The style? The ovary?

6. Supposing a bee is after the nectar, where must she rest while probing for it? Can she get the nectar without pushing against the flat projecting portion of the inner petals? When she pushes these spoon-bowls back, what happens? Does she get dusted with pollen? After she leaves, does the door swing back? Suppose she visits another flower which has shed its pollen, will she carry pollen to its stigma? Does she have to work the hinged door to do this?



Poppies.
Drawn by Anna C. Stryke.

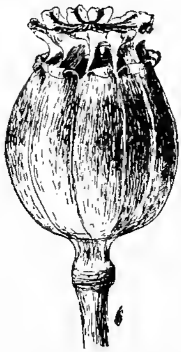
THE POPPIES

Teacher's Story

PERHAPS we might expect that a plant which gives strange dreams to those who eat of its juices should not be what it seems in appearance. I know of nothing so deceptive as the appearance of the poppy buds, which, rough and hairy, droop so naturally that it seems as if their weight must compel the stem to bend; and yet, if we test it, we find the stem is as stiff as if made of steel wire. Moreover, the flower and the ripened seed-capsule must be far heavier than the bud; and yet, as soon as the flower is ready to open, the stem straightens up, although it does not always remove the traces of the crook; and after the capsule is full of ripened seed, the stem holds it up particularly stiff, as if inviting the wind to shake out the seeds.

The rough covering of the bud consists of two sepals, as can be easily seen; but if we wish to see the poppy shed its sepals, we must get up in the morning, for the deed is usually done as soon as the first rays of the early sun bring their message of a fair day. The sepals break off at their base and fall to the ground. The two opposite outer petals unfold, leaving the two inner petals standing erect and on guard about the precious pollen, until the sunshine folds them back. An open poppy, when looked at below, shows two petals, each semicircular, and overlapping each other slightly; looked at from above, we see two petals, also half circles, set at right angles to the lower two, and divided from each other by the pistil.

The pistil of the poppy is, from the beginning, a fascinating box. At first, it is a vase with a round, circular cover, upon which are ridges, placed like the spokes of a wheel. If these ridges are looked at with a lens, particles of pollen may be seen adhering to them; this fact reveals the secret that each ridge is a stigma, and all of these radiating stigmas are joined so as better to catch the pollen. In a circle of fringe about the pistil are the stamens. In the study of the stamens, we should note whether their filaments expand or dilate near the anthers, and we should also note the color of the masses of pollen which crowd out from the anthers.



The poppy seed-shaker.
Drawn by Anna C. Stryke.

Despite the many varieties of poppies, there are only four species commonly cultivated. The opium poppy has upon its foliage a white bloom, the filaments of its stamens are dilated at the top, and its seed-capsule is smooth. The oriental poppy has all of these characters, except that its foliage is green and not covered with bloom. Its blossom is scarlet and very large and has a purple center in the petals and purple stamens; it has three sepals. Its flower stalks are stout and leafy. The corn poppy, which grows in the fields of Europe, is a weed we gladly cultivate. This, naturally, has red petals and is dark at the center of the flower; but it has been changed by breeding until now we have many varieties. Its foliage is finely cut and very bristly or hairy. Its seed-capsule is not bristly. To see this poppy at its best, we should visit northern Italy or southern France in late May, where it makes the grain fields gorgeous. This is the original parent of all the Shirley poppies. The Arctic, or Iceland poppy, has flowers of satiny texture and finely crumpled; its colors are yellow, orange or white, but never scarlet like the corn poppy; it has no leaves on its flower stem, and its seed-capsule is hairy. Of these four species, the opium poppy and the corn poppy are annuals, while the Arctic and the Oriental species are perennials.

The bees are over-fond of the poppy pollen and it is a delight to watch the fervor with which they simply wallow in it, brushing off all of the grains possible onto their hairy bodies. I have often seen a honey-bee seize a bunch of the anthers and rub them against the under side of her body, meanwhile standing on her head in an attitude of delirious joy. As showing the honey-bee's eye for color, I have several times seen a bee drop to the ground to examine a red petal which had fallen. This was plain evidence that she trusted to the color to guide her to the pollen.

But perhaps it is the development of the poppy seed-capsule which we find the most interesting of the poppy performances. After fertilization, the stigma-disk develops a scalloped edge, a stigma rounding out the point of each scallop; and a sharp ridge, which continues the length of the globular capsule, runs from the center of each scallop. If examined on the inside, it will be seen that the ridge on the capsule is the edge of a partition which extends only part way toward the center of the capsule. On these partitions, the little seeds are grown in great profusion, and when they ripen, they fall together in the hollow center of the seed-box. But how are they to get out? This is a point of interest for the children to observe, and they should watch the whole process. Just beneath the stigma-disk, and between each two of the sharp ridges, the point loosens; later, it turns outward and back, leaving a hole which leads directly into the central hollow portion of the capsule. The way these points open is as pretty a story as I know in flower history. This beautiful globular capsule, with its graceful pedestal where it joins the stem, is a seed-shaker instead of a salt or pepper-shaker. Passing people and animals push against it and the stiff stem bends and then springs back, sending a little shower of seeds this way and that; or a wind sways the stalk, and the seeds are sown, a few at a time, and in different conditions of season and weather. Thus, although the poppy puts all her eggs in one basket, she sends them to market a few at a time. The poppy seed is a pretty object, as seen through the lens. It is shaped like a round bean, and is covered with a honeycomb network.

LESSON CLV

The Poppy

Leading thought—The poppies shed their sepals when the flowers expand; they offer quantities of pollen to the bees, which are very fond of it. The seed-capsule develops holes around the top, through which the seeds are shaken, a few at a time.

Method—It is best to study these flowers in the garden, but the lesson may be given if some of the plants with the buds are brought to the schoolroom, care being taken that they do not droop. If the teacher thinks wise, the pupils might prepare an English theme on the subject of the opium poppy and the terrible effects of opium upon the eastern nations.

Observations—1. Look at the bud of the poppy; how is it covered? How many sepals? Can you see where they unite? Is the stem bent because the bud is heavy? What happens to this crook in the stem when the flower opens? Does the crook always straighten out completely?

2. Describe how the poppy sheds its sepals. At what time of day do the poppies usually open?

3. Look at the back of, or beneath, an open flower. How many petals do you see? How are they arranged? Look at the base of the flower. How many petals do you see? How are they arranged in relation to the lower petals and to the pistil?

4. Look at the globular pistil. Describe the disk which covers it. How many ridges on this disk? How are they arranged? Look at the ridges with a lens and tell what they are.

5. Look at the stamens. How are they arranged? Describe the anthers—their color, and the color of the pollen. Watch the bees working on the poppies, and note if they are after nectar or pollen.

6. Find all the varieties of poppies possible, and note the colors of the petals on the outside, the inside and at the base; of the stamens, including filaments, anthers and pollen; of the pistil-disk and ovary. Sketch the

poppy opened, and also in the bud. Sketch a petal, a stamen and the pistil, in separate studies.

7. Study the poppy seed-box as it ripens. How does the stigma-disk look? What is the shape of the capsule below the disk? Is it ridged? What relation do its ridges bear to the stigma ridges on the disk? Cut a capsule open, and note what these ridges on the outside have to do with the partitions inside. Where are the seeds borne?

8. Note the development of the holes beneath the edge of the disk of the poppy capsule. How are they made? What are they for? How are the seeds shaken from these holes? What shakes the poppy seed-box and helps sow the seeds? Look at a seed through a lens, and describe its form and decoration.

9. Notice the form of the poppy leaf, and note whether it is hairy or covered with bloom. What is there peculiar about the smell of the poppy plant? Where do poppies grow wild?

10. Is the slender stem smooth or grooved and hairy? Is it solid or hollow?

11. When a stem or leaf is pierced or broken off, what is the color of the juice which exudes? Does this juice taste sweet or bitter and unpleasant? Do you know what harmful drug is manufactured from the juice of one species of poppy? What countries cultivate and use it most extensively?

THE CALIFORNIA POPPY

Teacher's Story

ALTHOUGH this brilliant flower blossoms cheerfully for us in our Eastern gardens, we can never understand its beauty until we see it glowing in masses on the California foothills. We can easily understand why it was selected as the flower of that great State, since it burnished with gold the hills, above the gold buried below; and in that land that prides itself upon its sunshine, these poppies seem to shine up as the sun shines down. The literature of California, and it has a noble literature of its own, is rich in tributes to this favored flower. There is a peculiar beauty in the contrast between the shining flower and its pale blue-green, delicate masses of foliage. Although it is called a poppy and belongs to the poppy family, yet it is not a true poppy, but belongs to a genus named after a German who visited California early in the nineteenth century, accompanying a Russian scientific expedition; this German's name was Eschscholtz, and he, like all visitors, fell in love with this brilliant flower, and in his honor it was named Eschscholtzia (es-sholts-ia) californica. This is not nearly so pretty, nor so descriptive, as the name given to this poppy by the Spanish settlers on the Pacific Coast, for they called it *Copa-de-oro*, cups of gold.

The bud of the Eschscholtzia is a pretty thing; it stands erect on the slender. rather long stem, which flares near the bud to an urnlike pedestal with a slightly ruffled rim, on which the bud is set. This rim is often pink above, and remains as a pretty base for the seed-pod. But in some garden varieties, the rim is lacking. The bud itself is covered with a peaked cap, like a Brownie's toboggan cap stuffed full to the tip. It is the shape of an old-fashioned candle extinguisher; it is pale green, somewhat ribbed, and has a rosy tip; it consists of two sepals, which have been sewed together by Mother Nature so skillfully that we cannot see the seams. One of the most interesting performances to watch that I know, is the way this poppy takes off its cap before it bows to the world. Like magic the cap loosens around the base; it is then pushed off by the swelling expanding petals until completely loosened, and finally it drops.

California poppy.
Drawn by Anna C. Stryke.

The petals are folded under the cap in an interesting manner. The outer petal enfolds all the others as closely as it can, and its mate within it enfolds the other two, and the inner two enfold the stamens with their precious gold dust. When only partially opened, the petals cling protectingly about the many long stamens; but when completely opened, the four petals flare wide, making a flower with a golden rim and orange center, although among our cultivated varieties they range from orange to an anaemic white. To one who loves them in their glorious native hues, the white varieties seem almost repulsive. Compare one of these small, pale flowers with the great, rich, orange ones that glorify some favored regions in the Mojave Desert, and we feel the enervating and decadent influence of civilization.

The anthers are many and long, and are likely to have a black dot on the short filament; at first, the anthers stand in a close cluster at the center of the flower, but later they flare out in a many pointed star. Often, when the flowers first open, especially the earlier ones, the stigmas cannot be seen at all; but after a time the three, or even six stigmas, spread wide athwart the flower and above the stamen-star, where they may receive pollen from the visiting insects. The anthers give abundance of pollen, but there is said to be no nectary present. This flower is a good guardian of its pollen, for it closes during the nights and also on dark and rainy days, only exposing its riches when the sunshine insures insect visitors. It closes its petals in the same order in which they were opened in our Eastern gardens, although there are statements that in California, each petal folds singly around its own quota of anthers. The insects in California take advantage of the closing petals and often get a night's lodging within them, where they are cozily housed with plenty of pollen for supper and breakfast; and they pay their bill in a strange way by carrying off as much of the golden meal as adheres to them, just as the man who weighs gold-dust gets his pay from what adheres to the pan of his scales.

After the petals fall, the little pod is very small, but its growth is as astonishing as that of Jack's beanstalk; it finally attains a slim length of three inches, and often more. It is grooved, the groove running straight from its rimmed base to its rosy tip; but later a strange twisting takes place. If we open one of these capsules. lengthwise, we must admire the orderly way in which the little green seeds are fastened by delicate white threads, in two crowded rows, the whole length of the pod.

The leaf is delicately cut and makes the foliage a fine mass, but each leaf is quite regular in its form. It has a long, flattened petiole, which broadens and clasps the stem somewhat at its base. Its blade has five main divisions, each of which is deeply cut into fingerlike lobes. The color of this foliage and its form show adaptations to desert conditions.

This plant has a long, smooth tap root, especially adapted for storing food and moisture needed during the long, dry California summers; for it is perennial in its native state, although in the wintry East, we plant it as an annual.

LESSON CLVI

The California Poppy

Leading thought—The California poppy is a native of California. It blossoms during the months of February, March and April in greatest abundance. It is found in the desert as well as among the foothills.

Method—If possible, the students should study this in the garden. In the East, it flowers until frost comes, and affords a delightful subject for a September lesson. In California it should be studied in the spring, when the hills are covered with them. But the plant may be brought into the schoolroom, root and all, and placed in a jar, under which conditions it will continue to blossom.

Observations—1. Look at the California poppy as a whole and tell, if you can, why it is so beautiful when in blossom.

2. Look at the flower bud. What sort of a stem has it? What is the shape of the stem just below the bud? What is the color of the little rim on which the bud rests? What peculiarity has this bud? Describe the little cap.

3. Watch a flower unfold. What happens to the "toboggan cap?" How does the bud look after the cap is gone? What is its appearance when the petals first open? When they are completely open?

4. Describe the anthers. How do they stand when the flower first opens? How later? Can you see the stigmas at first? Describe them as they look later.

5. Does the poppy remain open at night? Does it remain open during cloudy or rainy weather? Why?

6. Do the petals have the same position that they did in the bud? As the flower matures, note how each petal curls. Do they all fall at once? Are there any anthers left after the petals fall?

7. How does the little pod look when the petals first fall? What happens to it later? Note the little rim at its base. Cut the seed-pod open lengthwise, examine the seeds with a lens, and describe how they are fastened to the sides of the pod. Are the ribs straight from end to end in the pod at first? Do they remain in this position? How does the pod open and scatter its seeds?

8. Study the leaf of this California poppy. Describe how it joins the stem. Sketch a leaf showing its chief divisions into leaflets and how each leaflet is divided. Note that the juice of the stem has the peculiar odor of muriatic acid.

9. Look at the root. Do you think it is fitted to sustain the plant through a long, dry summer? What kind of summers do they have in California? Where does the poppy grow wild?

10. Read all the accounts you can find of the California poppy, and write a little theme describing why it was chosen as the flower of that great State, and how it came by its name.

In a low brown meadow on a day
Down by the autumn sea,
I saw a flash of sudden light
In a sweep of lonely gray;
As if a star in a clouded night
One moment had looked on me
And then withdrawn; as if the spring
Had sent an oriole back to sing
A silent song in color, where
Other silence was too hard to bear.

I found it and left it in its place,
The sun-born flower in cloth of gold
That April owns, but cannot hold
From spending its glory and its grace
On months that always love it less,
But take its splendid alms in their distress.
Back I went through the gray and the brown,
Through the weed-woven trail to the distant town;
The flower went with me, fairly wrought
Into the finest fiber of my thought.

—A California Poppy in November, Irene Hardy.

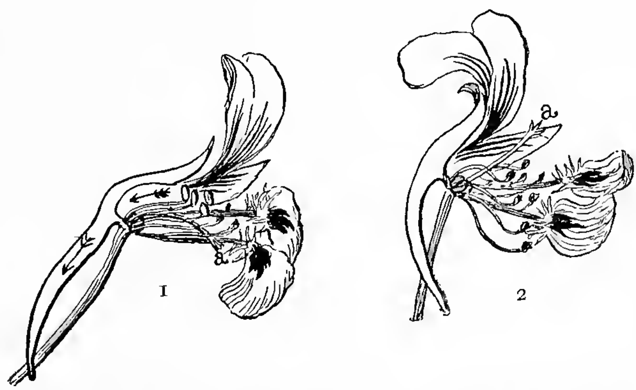
THE NASTURTIUM
Teacher's Story

"Little warriors, brave and fearless, with shields of emerald green,
Are climbing over fence rails, and everywhere are seen
Look:ng down on every side, while her brave Nasturtium army,
Queen Nature views with pride."

—Ray Laurance.

It is quite fitting that the nasturtium leaves should be shaped like shields, for that is one of their uses; they are shields to protect the young nasturtium seeds from the hot sun and from the view of devouring enemies. The nasturtiums are natives of Peru and Chili, and it is fitting that the leaves should develop in shield-shape, and the shields overlap until they form a tent to shade the tender developing fruit from the burning sun. But they were never meant to shield the flower, which thrusts its brilliant petals out between the shields, and calls loudly to the world to admire it. It would indeed be a pity for such a remarkable flower to remain hidden; its five sepals are united at their base, and the posterior one is extended into a long spur, a tube with a delectable nectar-well at its tip. The five petals are set around the mouth of this tube, the two upper ones differing in appearance and office from those below; these two stand up like a pair of fans, and on them are lines which converge; on the upper sepals are similar lines pointing toward the same interesting spot. And what do all these lines lead to, except a veritable treasure-cave filled with nectar! The lower petals tell another story; they stand out, making a platform, or doorstep, on which the visiting bee alights. But it requires a big insect to do the work of this flower, and what if some inefficient little bee or fly should alight on the petal-doorstep and steal into the cave surreptitiously! This contingency is guarded against thus: Each of these lower petals narrows to a mere insect footbridge at their inner end; and in order to render this footbridge quite impassable, it is beset with irregular little spikes and projecting fringes, sufficient to perplex or discourage any small insect from crawling that way.

But why all these guiding lines and guarded bridges? If you watch the same blossom for several successive days, it will reveal this secret. When a flower first opens, the stamens are all bent downward, but when an anther is ready to open its pollen doors, the filament lifts it up and places it like a sentinel blocking the doorway to the nectar treasure. Then when the robber comes, whether it be butterfly, bee or humming-bird, it gets a round of pollen ammunition for its daring. Perhaps there



1. *Nasturtium flower in early stage of blossoming. Note the anthers lifted in the path to the nectar which is indicated by the arrow. The closed stigma is shown deflected at* a.
2. *The same flower in later stage; the anthers are empty and deflected. The stigma is raised* (a) *in the nectar path.*

may be two or three anthers standing guard at the same time, but, as soon as their pollen is exhausted, they shrivel and give room for fresh anthers. Meanwhile, the stigma has its three lobes closed and lying idly behind and below the anthers; after all the pollen is shed, the style raises and takes its position at the cave entrance and opens up its stigmas, like a three-tined fork, to rake the pollen from any visiting insect, thus robbing the robber of precious gold-dust which shall fertilize the seeds in its three-lobed ovary. Although the flower needs to flare its colors wide to call the bees and hummingbirds, yet the growing seeds must be protected; therefore, the stem which held the flower up straight, now twists around in a spiral and draws the triplet seeds down behind the green shields.

Nasturtium leaves are very pretty, and are often used as subjects for decorative water-color drawings. The almost circular leaf has its stem attached below and a little at one side of the center; the leaves are brilliant green above but quite pale beneath, and are silvery when placed beneath the water. The succulent stems have a way of twisting half around the wires of the trellis and thus holding the plant secure to its support. But if there is no trellis, the main stem seems to awaken to the responsibility and grows quite stocky, often lifting the plant a foot or two in height, and from its summit sending out a fountain of leaf and flower stems.

The nasturtium is among the most interesting and beautiful of our garden flowers, and will thrive in any warm, sunny, fairly moist place. Its combinations of color are exceedingly rich and brilliant. H. H. says of it:

> *"How carelessly it wears the velvet of the same*
> *Unfathomed red, which ceased when Titian ceased*
> *To paint it in the robes of doge and priest."*

LESSON CLVII

The Nasturtium

Leading thought—The nasturtium has a special arrangement by which it sends its own pollen to other flowers and receives pollen from other flowers by insect messengers.

Method—The nasturtiums and their foliage should be brought into the schoolroom in sufficient quantity so that each child may have a leaf and a flower for study. The object of the lesson is to interest the pupils in studying, in their gardens, one flower from the bud until the petals wither, taking note of what happens each day and keeping a list of the insect visitors.

Observations—1. Look at the back of the flower. What is there peculiar about the sepals? How many sepals are there? How many join to make the spur? What is in this spur? Taste of the tip. Find where the nectar is.

2. Look the flower in the face. How do the two upper petals differ in shape from the three lower ones? What markings are there on the upper petals? Where do these lines point? Are there any markings on the sepals pointing in the same direction? If an insect visiting a flower should follow these lines, where would it go?

3. Describe the shape of the lower petals. Suppose a little ant were on one of these petals and she tried to pass over to the nectar-tube or spur, would the fringes hinder her?

4. Look down the throat of the spur, and tell what a bee or other insect would have to crawl over before it could get at the nectar.

5. In your garden, or in the bouquet in the window if you cannot visit a garden, select a nasturtium that is just opening and watch it every day, making the following notes: When the blossom first opens where are the eight stamens? Are the unripe, closed anthers lifted so as to be in the path of the bee which is gathering nectar? How do the anthers open? How is the pollen held up in the path to the nectar? Can you see the stigma of this flower? Where is it? *Note the same flower on successive days:* How many anthers are open and shedding pollen to-day? Are they all in the same position as yesterday? What happens to the anthers which have shed their pollen?

6. When the stigma rises in the nectar path, how does it look? Where are all the anthers when the stigma raises its three tines to rake the pollen off the visiting insect? Do you know why it is an advantage to the nasturtium to develop its seed by the aid of the pollen from another plant?

7. Can you see the beginning of the seed-case when the stigma arises to receive the pollen?

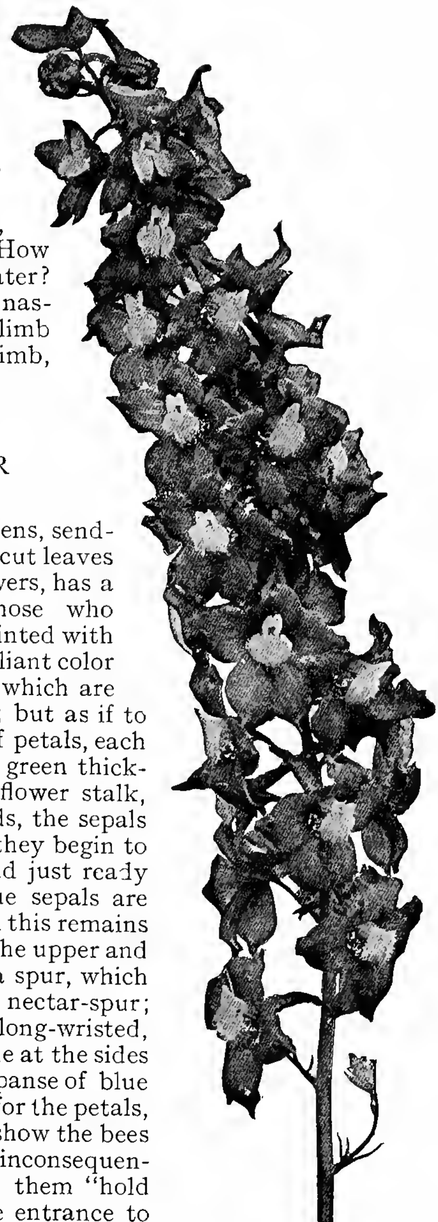
8. The flowers project beyond the leaves. Do the ripening seed-cases do this? What happens to their stems to withdraw them behind the leaf?

9. Sketch a nasturtium leaf, and explain why it is like a shield. How does the leaf look when under water?

10. What sort of stem has the nasturtium? How does it manage to climb the trellis? If it has no trellis to climb, does it lie flat upon the ground?

THE BEE-LARKSPUR

Teacher's Story

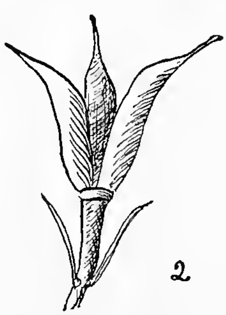


The bee-larkspur.
Photo by Cyrus Crosby.

This common flower of our gardens, sending up from a mass of dark, deeply-cut leaves tall racemes of purple or blue flowers, has a very interesting story to tell those who watch it day by day and get acquainted with it and its insects guests. The brilliant color of the flowers is due to the sepals, which are purple or blue, in varying shades; but as if to show that they are sepals instead of petals, each has on the back side near its tip, a green thickened spot. If we glance up the flower stalk, we can see that, in the upper buds, the sepals are green, but in the lower buds they begin to show the blue color; and in a bud just ready to open, we can see that the blue sepals are each tipped with a green knob, and this remains green after the sepals expand. The upper and rearmost sepal is prolonged into a spur, which forms the outside covering of the nectar-spur; it is greenish and wrinkled like a long-wristed, suede glove; two sepals spread wide at the sides and two more below. All this expanse of blue sepals is simply for a background for the petals, which, by their contrasting color, show the bees where to probe for nectar. Such inconsequential petals as they are! Two of them "hold hands" to make an arch over the entrance to the nectar tube; and just below these on each side are two more tiny, fuzzy, spreading petals, often notched at the tip and always hinged in a peculiar way about the upper petal; they stand guard at the door to the nectar storehouse. If we peel off the wrinkled sepal-covering of the spur, we can see the upper petals extending back into it, making a somewhat double-barreled nectary.

If we look into a larkspur flower just opened, we see below the petals a bunch of green anthers, hanging by white threadlike filaments to the center of the flower and looking like a bunch of lilliputian bananas. Behind these anthers is an undeveloped stigma, not visible as yet. After the flower has been open for a short time, three or four of the anthers rise up and stand within the lower petals; while in this position, their white pollen bursts from them, and no bee may then thrust her tongue into the nectar-spur without being powdered with pollen. As soon as the anthers have discharged their pollen, they shrivel and their places are taken by fresh ones. It may require two or three days for all the anthers to lift up and get rid of their pollen. After this has been accomplished, the three white, closely adhering pistils lift up their three stigmas in the self-same path to the nectar; and now they are ready to receive the pollen which the blundering bee brings from other flowers. Since we cannot always study the same flower for several consecutive days, we can read the whole story by studying the flowers freshly opened on the upper portion of the stalk, and those below them that are in more advanced stages.


1


2

1, Drawing of the bee-larkspur flower enlarged.
2, The seed capsule of the bee-larkspur.

The bees, especially the bumblebee, will tell the pollenation story to us in the garden. The contrasting color of the petals and sepals tells her where to alight; this she does accurately, and the inconsequential lower petals seem made for her to grasp; she presses them to her breast with her front and middle legs with a dramatic, almost ecstatic, gesture that is comical to witness, and holds them firmly while she thrusts her head into the opening between them; she probes the spur twice, evidently finding there the two nectar-wells. It is a fascinating pasttime to follow her as she goes from flower to flower like a Madam Pompadour, powdered with her white pollen. In order that a bee may work on these flowers, it is necessary that they hang vertically. The tips of the tall flower stalks are likely to bend or curl over; but no matter what the direction the broken or bent stem takes, the flowers will twist around on their pedicels until they face the world and the bee, exactly as if they were on a normally erect stem.

All the larkspurs have essentially the same pollen story, although some have only two petals; in every case the anthers at first hang down, and later rise up in the path to the nectar, in order to discharge their pollen; after they wither, the stigmas arise in a similar position.

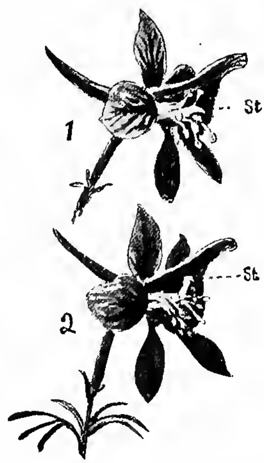
The bee-larkspur has a very beautiful fruit. It consists of three graceful capsules rising from the same base and flaring out into pointed tips. The seeds are fastened to the curved side of each capsule, which, when ripe, opens so that they may be shaken out by the winds. When studying the bud, we notice two little bracts set at its base and these remain with the fruit.

LESSON CLVIII

The Bee-larkspur

Leading thought—The bee-larkspur begins blossoming early in the season, the blossom stalk elongating and developing new buds at its tip until late in autumn. The flower has a very interesting way of making the bees carry its pollen.

Method—Bring to the schoolroom a flower stalk of the bee-larkspur, and there study the structure and mechanism of the flower. This lesson should inspire the pupils to observe for themselves the visiting bees and the maturing seeds. Ask them to write an account of a bumblebee making morning calls on the larkspurs.



The larkspur.
1, showing early stage with stigma deflected.
2, showing advanced stage with stigma raised.

Observations—1. Which flowers of the larkspur open first—those near the tip of the stem or those below?

2. Examine the buds toward the tip of the flower stalk. What color are the sepals in these buds? Do the sepals change color as the flower opens? Note the little green knobs which tip the closed sepals that clasp the bud. What color are the sepals on the open flower? Is there any green upon them when open?

3. Where is the nectar-spur? Which sepal forms this? How are the other sepals arranged?

4. Now that we know the flower gets its brilliant color from its sepals, let us find the petals. Look straight into the flower, and note what forms the contrasting color of the heart of the flower; these are the petals. Can you see that two are joined above the opening into the nectar-tube? How many guard the entrance from below? How are these lower petals hinged about the upper one? Peel a sepal-cover from the nectar-spur, and see if the upper petals extend back within the spur, forming nectar-tubes?

5. Take a flower just opened, and describe what you see below the petals. What is the color of the anthers? Of the filaments? Can you see the stigma?

6. Take a flower farther down the stalk, which has therefore been open longer, and describe the position of the anthers in this. Are there any of them standing upright? Are they discharging their pollen? What color is the pollen? Are these upright anthers in the way of the bee, when she thrusts her tongue into the nectar-tube?

7. Take the oldest flower you can find. What has happened to the anthers? Can you see the pistils in this? In what position now are the stigmas?

8. Push aside the anthers in a freshly opened flower and see if you can find the stigmas. What is their position? How do they change in form

and position after the pollen is shed? Do they arise in the path of the bee before all the pollen from the anthers of their own flower is shed? If so, how are they pollenated?

9. *Suggestions for Observation in the Garden*—Watch a bumblebee working on the larkspur and answer the following questions: How does she hold on to the flower? Where does she thrust her tongue? Can she get the nectar without brushing the pollen from the anthers which are lifting up at the opening of the nectar-tube? In probing the older flowers, how would she come in contact with the lifted stigmas? How do the petals contrast in color with the sepals? Does this tell the bees where to look for nectar? Compare the common larkspur with the bee-larkspur, and notice the likeness and difference. What kind of fruit capsules has the bee-larkspur? Describe the seeds, and how they are scattered.

THE BLUE FLAG, OR IRIS

Teacher's Story

Beautiful lily, dwelling by still rivers
Or solitary mere,
Or where the sluggish meadow brook delivers
Its waters to the weirl

The burnished dragon fly is thine attendant,
And tilts against the field,
And down the listed sunbeams rides resplendent
With steel-blue mail and shield.
—From "Flower-de-luce," HENRY W. LONGFELLOW.

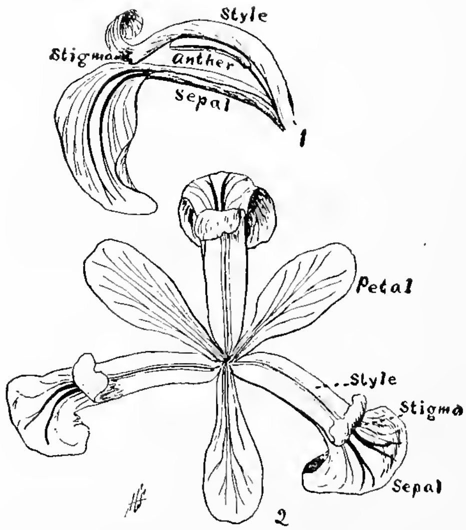
The iris blossom has a strange appearance, and this is because nothing in it is as it seems. The style of the pistil is divided into three broad branches and they look like petals; and they have formed a conspiracy with the sepals to make a tunnel for bees, leaving the petals out of the plan entirely and the sepals "rise to the occasion." The petals stand up lonely between the three strangely matched pairs, and all they accomplish by their purple guiding lines, is to basely deceive the butterflies and other insects which are in the habit of looking for nectar at the center of a flower. If we look directly down into the flower of the blue flag, there are ridges on the broad styles and purple veins on the petals, all pointing plainly to the center of the flower, and any insect alighting there would naturally seek for nectar-wells where all these lines so plainly lead. But there is an "April fool" for the insects which trust to these guides, for there is no nectar to be had there. Dr. Needham, in his admirable study of this flower and its visitors (American Naturalist, May, 1900), tells us that he has seen the little butterflies called "skippers," the flag weevils and the flower beetles all made victims of this deceptive appearance; this is evidence that the nectar guiding lines on flowers are noted and followed by insects.

The blue flag is made for bees; the butterflies and beetles are interlopers and thieves at best. The bees are never deceived into seeking the nectar in the wrong place. They know to a certainty that the sepal with

Iris in blossom.
Photo by Verne Morton.

its purple and yellow tip and many guiding lines although far from the center of the flower, is the sure path to the nectar. A bee alights on the lip of the sepal, presses forward scraping her back against the down-hanging stigma, then scrapes along the open anther which lies along the roof of the tunnel; and she here finds a pair of guiding lines each leading to a nectar-well at the very base of the sepal. The bees which Dr. Needham found doing the greatest work as pollen-carriers were small solitary bees (*Clisodon terminalis* and *Osmia destructa*); each of these alighted with precision on the threshhold of the side door, pushed its way in, got the nectar from both wells, came out and sought another side door speedily. One might ask why the bee in coming out did not deposit the pollen from its own anther upon the stigma; but the stigma avoids this by hanging down, like a flap to a tent, above the entrance, and its surface for receiving pollen is directed so that it gathers pollen from the entering bee and turns its back to the bee that is just making its exit.

The arrangement of the flower parts of the iris may be described briefly thus: three petals, three sepals, a style with three branches; the latter being broad and flat and covering the bases of the three sepals, making tubes which lead to the nectar; three anthers lie along the under side of the styles. The wild yellow iris is especially fitted for welcoming the bumblebee as a pollen-carrier, since the door between the style and the sepal is large enough to admit this larger insect. The bumblebees and the honey-bees work in the different varieties of iris in gardens.



Detail of the blossoms of the blue flag flower.

1, Side-view of the passage to the nectar.
2, Looking directly into the iris flowers. Note the deceiving guide-lines in the petals.

In some varieties of iris there is a plush rug along the vestibule floor over which the bee passes to get the nectar. Through a lens, this plush is exquisite—the nap of white filaments standing up and tipped with brilliant yellow. Various theories as to the use of this plush have been advanced, the most plausible being that it is to keep the ants out; but the ant could easily pass along either side of it. While holding an iris in my hand, one day in the garden, a bumblebee visited it eagerly, never noting me; after she had probed the nectar-wells, she probed or nibbled among the plush, working it thoroughly on her way out. Was she a foolish bee, or did she find something there to eat? What child will find if other bees do this?

LESSON CLIX

The Blue Flag or Iris

Leading thought—Each iris flower has three side doors leading to the nectar-wells; and the bees, in order to get the nectar, must brush off the pollen dust on their backs.

Method—While the blue flag is the most interesting of our wild species of iris, yet the flower-de-luce, or the garden iris, is quite as valuable for this lesson. The form of the flowers may be studied in the schoolroom, but the pupils should watch the visiting insects in the garden or field.

Observations—1. Look for the side doors of the iris blossom. Which part of the flower forms the doorstep? How is it marked to show the way in? Which part of the flower makes the arch above the door?

2. Find the anther, and describe how it is placed. Can you see two nectar-wells? Explain how a bee will become dusted with pollen while getting the nectar.

3. Where is the stigma? What is there very peculiar about the styles of the iris? Can a bee, when backing out from the side door, dust the stigma with the pollen she has just swept off? Why not? How does the stigma of the next flower that the bee visits get some of the pollen from her back?

4. Look straight down into an iris flower. Can you see the three petals? How are they marked? How would these lines on the petals mislead any insect that was searching for nectar?

5. Watch the insects visiting the iris. Do you know what they are? What do they do?

6. Describe the way the iris flower-bud is enfolded in bracts. What is there peculiar about the way the iris leaves join the stem?
7. How many kinds of flag, or iris, do you know?
8. Describe the seed-vessel and seeds of the iris.

Fleur-de-lis.
Photo by Cyrus Crosby.

The fleur-de-lis is the national flower of France.

"It is said that the Franks of old had a custom, at the proclamation of a king, of elevating him upon a shield or target, and placing in his hand a reed, or flag in blossom, instead of a sceptre."

—"Among the Flowers and Trees with the Poets", WAIT AND LEONARD.

The sunflower. Next to the ray-flowers are the florets in last stages of blossoming with stigmas protruding; next within are rows in the earlier stage with pollen bursting from anther-tubes, while at center are the unopened buds.

THE SUNFLOWER

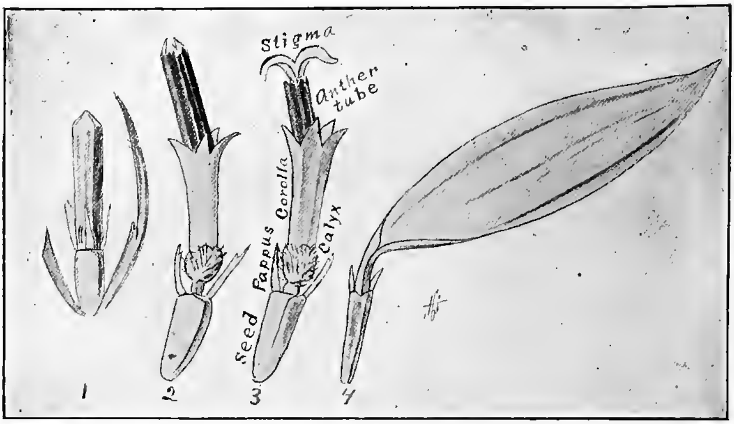
Teacher's Story

Many of the most beautiful of the autumn flowers belong to the *Compositae*, a family of such complicated flower arrangement that it is very difficult for the child or the beginner in botany to comprehend it; and yet, when once understood, the composite scheme is very simple and beautiful, and is repeated over and over in flowers of very different appearance. It is a plan of flower cooperation; there are many flowers associated to form a single flower-head. Some of these, the "ray," or "banner," flowers, hold out bright pennants to attract the attention of insects; while the disk-flowers, which they surround, attend to the matter of the pollenation and production of seed.

The large garden sunflower is the teacher's ally to illustrate to the children the story of the composites. Its florets are so large that it is like a great wax model. And what could be more interesting than to watch its beautiful inflorescence—that orderly march toward the center in double lines of anther columns, with phalanxes bearing the stigmas surrounding them; and outside all, the ranks of ray-flowers flaunting their flags to herald to the world this peaceful conquest of the sleeping, tented buds at the center?

Ordinarily, in nature-study we do not pull the flowers apart, as is necessary in botany; in nature-study, all that we care to know of the flower is what it does, and we can see that without dissection. But with the compositæ the situation is quite different. Here we have an assemblage of flowers, each individual doing its own work for the community; and in order to make the pupils understand this fact it is necessary to study the individual florets.

We begin with the study of one of the buds at the center of the flower-head; this shows the white, immature seed below, and the closed, yellow corolla-tube above. Within the corolla may be seen the brown anther-tube, and on the upper part of the seed are two little, white, earlike scales, to which especial notice should be directed, since in other composites there are many of these scales and they form the pappus—the balloon to carry the seed. The bud shows best the protecting chaffy scale which enfolds the seed, its pointed, spine-edged tip being folded over the young bud, as may be seen by examining carefully the center of a freshly opened sunflower. In this tubular bud (see Fig. p. 632), there is a telescopic arrangement of the organs, and one after another is pushed out. First, the corolla-tube opens, starlike, with five pointed lobes, very pretty and graceful, with a bulblike base; from this corolla pushes out the dark-brown tube, made up of five anthers grown together. By opening the corolla, we see the filaments of the stamens below the joined anthers. This anther tube, if examined through a lens, shows rows of tiny points above and below, two to each anther, as if they had been opened like a book to join edges with their neighbors. The anther-tube is closed at the tip, making a five-sided cone; and at the seams, the yellow pollen bulges out, in starlike rays. The pollen bulges out for good reason, for behind it is the stigma, like a ramrod, pushing all before it in the tube for it is its turn next to greet the outer world. The two stigma-lobes are pressed together like the halves of a sharpened pencil, and they protrude through the anther-tube as soon as all the pollen is safely pushed out; then the



The flower of the sunflower-head enlarged.

1. A floret of the sunflower in the bud-stage as it appears at the center of the sunflower. Note the protecting bract at the right.
2. A floret in earliest stage of blossoming.
3. A floret in the latest stage of bloom with the parts named
4. A ray or banner-flower.

stigma-lobes separate, each curling backwards so as to offer a receptive surface to welcome pollen grains from other florets, or even other sunflowers. In the process of curling back, they press the anther-tube down into the corolla, and thus make the floret shorter than when in the pollen stage. The banner-flower differs in many essentials from the perfect florets of the disk. If we remove one from the flower-head, we find at its base a seedlike portion, which is a mere pretense; it is shrunken, and never can be a seed because it has connected with it no stigma to bring to it the pollen. Nor does this flower have stamens nor a tubular corolla; instead it has one great, petallike banner, many times longer and wider than the corollas of the other flowers. All this flower has to do is to hold its banner aloft as a sign to the world, especially the insect world, that here is to be found pollen in plenty, and nectar for the probing.

But more wonderful than the perfection of each floret is their arrangement in the flower-head. Around the edge of the disk the banner-flowers, in double or treble rank, flare wide their long petals like the rays of the sun, making the sunflower a most striking object in the landscape. If the sunflower has been open for several days, next to the ray-flowers will be seen a circle of star-mouthed corollas from which both ripened pollen and stigmas have disappeared, and the fertilized seeds below them are attaining their growth. Next comes a two or three-ranked circle, where the split, coiled-back stigma-lobes protrude from the anther-tubes; within this circle may be two or three rows of florets, where pollen is being pushed out in starry radiance; and within this ring there may be a circle where the anther-tubes are still closed; while at the center lie the buds, arranged in exquisite pattern of circling radii, cut by radii circling in the opposite direction; and at the very center the buds are covered with the green spear-points of their bracts. I never look at the buds in the sunflower without wondering if the study of their arrangement is not the basis of much of the most exquisite decoration in Moorish architecture. To appreciate fully this procession of the bloom of the sunflower from its rim to its center, we need to watch it day by day—then only can its beauty become a part of us.

The great, green bracts, with their long pointed tips, which "shingle" the house of every sunflower family, should be noted with care, because these bracts have manifold forms in the great *Compositae* family; and the pupil should learn to recognize this part of the flower-head, merely from its position. In the burdocks, these bracts form the hooks which fasten to the passer-by; in the thistle, they form the prickly vase about the blossom; while in the pearly everlasting, they make the beautiful, white, shell-like mass of the flower which we treasure as immortal. In the sunflower, these bracts are very ornamental, being feltlike outside and very smooth inside, bordered with fringes of pretty hairs, which may be seen best through a lens. They overlap each other regularly in circular rows, and each bract is bent so as to fit around the disk.

In looking at a mass of garden sunflowers, we are convinced that the heavy heads bend the stems, and this is probably true, in a measure. But the stems are very solid and firm, and the bend is as stiff as the elbow of a stovepipe; and after examining it, we are sure that this bend is made with the connivance of the stem, rather than despite it. Probably most people, the world over, believe that sunflowers twist their stems so that their blossoms face the sun all day. This belief shows the utter contentment of most people with a pretty theory. If you believe it, you had best ask the first sunflower you see if it is true, and she will answer you if you will ask the question morning, noon and night. My own observations make me believe that the sunflower, during the later weeks of its bloom, is like the Mohammedan, keeping its face toward the east. True, I have found many exceptions to this rule, although I have seen whole fields of sunflowers facing eastward, when the setting sun was gilding the backs of their great heads. If they do turn with the sun, it must be in the period of earliest blossoming before they become heavy with ripening seeds.

The sunflower seed is eagerly sought by many birds, and it is raised extensively for chicken-feed. The inadequate little pappus falls off, and the seeds are set, large end up, in the very ornamental diamond-shaped sockets. They finally become loosened, and now we see a reason for the bending flower-head; for, as the great stem is assaulted by the winds of autumn, the bended heads shake out their seed and scatter them far afield.

LESSON CLX

The Sunflower

Leading thought—The sunflower is not a single flower, but is a large family of flowers living together; and each little flower, or floret, as it is called, has its own work to do for the family welfare.

Method—Early in September, when school first opens, is the time for this lesson. If sunflowers are growing near by, they should be studied where they stand; and their story may thus be more completely told. Otherwise, a sunflower should be brought to the schoolroom and placed in water. If one is selected which has just begun to blossom, it will show, day by day, the advance of the blossoming ranks. I have kept such a flower fourteen days, and it blossomed cheerfully from its rim to its very center A large sunflower that has only partially blossomed is also needed for taking apart to show the arrangement of this big flower-family. Take a bud from the center, a floret showing anther-tube and another showing the curled pair of stigmas, and a ray or banner-flower. (See Fig. p. 632). Each pupil should be furnished with these four florets; and after they have studied them, show them the other half of the sunflower, with each floret in place. After this preliminary study, let them observe the blossoming sunflower for several consecutive days.

Observations—1. A little flower which is part of a big flower-family is called a floret. You have before you three florets of a sunflower and a banner-flower. Study first the bud. Of how many parts is it composed? What will the lower, white part develop into? Can you see two little white points standing up from it on each side of the bud? Note the shape and color of the unopened floret. Note that there is a narrow, stiff, leaf-like bract, which at its base clasps the young seed, while its pointed tip bends protectingly over the top of the bud.

2. Take an open floret with the long, dark brown tube projecting from it. Note that the young seed is somewhat larger than in the bud, and that it still has its earlike projections at the top. Describe the shape of the open corolla. Look at the brown tube with a lens. How many sides has it? How many little points projecting at the top and bottom on each side of the tube? How does the tube look at the tip, through a lens? Can you see the pollen bursting out? If so, how does it look? Do you think that there is just one tubular anther, or do you think several anthers are joined together to make this tube? Open the corolla-tube carefully, and see if you can answer this last question. Open the anther-tube, and see if you can find the pistil with its stigmas.

3. Take a floret with the two yellow horns of the stigma projecting. Where is the brown anther-tube now? Is it as long as in the floret you have just studied? What has happened to it? What did the stigmas do to the pollen in the anther-tube? How do the two parts or lobes of the stigma look when they first project? How later?

4. Make a banner-flower. How many parts are there to it? How does the seedlike portion of the blossom look? Do you think it will ever be a good seed? Describe the corolla of this flower. How much larger is it than the corolla of the florets? Has the banner-flower any pistil or stamens? Of what use is the banner-flower to the sunflower family? Do you think that we would plant sunflowers in our gardens for their beauty if they had no banner-flowers?

5. After studying the separate flowers, study a sunflower in blossom, and note the following: Where are the banner-flowers placed? How many rows are there? How are they set so that their banners make the sunflower look like the sun? Do you see why the central portion of the sunflower is called the disk, and the banner-flowers are called the rays—in imitation of the sun?

6. Next to the banner-flowers, what sort of florets appear? How many rows are there? What kind form the next circle, and in how many rows? What stages of the florets do you find forming the inner circle, and how many rows? What do you find at the center of the flower-head? Note the beautiful pattern in which the buds are arranged. Can you see the separate buds at the very center of the sunflower? If not, why?

7. Make notes on a sunflower that has just opened, describing the stages of the florets that are in blossom; continue these notes every day for a week, describing, each day, what has happened. If the sunflower you are observing is in garden or field, note how many days elapse between the opening of the outer row of flowers and the opening of the central buds.

8. Look below or behind the sunflower, and note the way it is attached to the stem. What covers the disk? These green, overlapping, leaflike structures are called bracts. What is the shape of one of these bracts? What is its texture, outside and inside? Look at it, with a lens, along the edges, and note what you see. How are the bracts arranged? Do they not "shingle" the house in which the sunflower-family lives? This covering of the disk, or the house where the sunflower-family lives, is called the involucre.

9. Does the stem of the sunflower hold it upright? Some people declare that it twists its stem so as to face the sun all day. Do you think this is true?

10. Study a sunflower-head after the seeds are ripe. Do the little ears which you saw at the top of the seeds still remain? How does the sunflower scatter the seeds? Note how the disk looks after the seeds are all gone. What birds are especially fond of sunflower seeds? Of what use are the seeds commercially?

"Flowers have an expression of countenance as much as men or animals. Some seem to smile; some have a sad expression; some are pensive and diffident; others again are plain, honest, and upright, like the broad-faced Sunflower, and the hollyhock."

—HENRY WARD BEECHER.

"Eagle of flowers! I see thee stand,
And on the sun's noon-glory gaze;
With eye like his thy lids expand
And fringe their disk with golden rays;
Though fixed on earth, in darkness rooted there,
Light is thy element, thy dwelling air,
Thy prospect heaven."

—"The Sunflower", MONTGOMERY.

A bachelor's button. Note the trumpet-shape of the ray-flowers.
Photo by Cyrus Crosby.

THE BACHELOR'S BUTTON

Teacher's Story

This beautiful garden flower gives a variation in form from other composites when studied according to Lesson CXXXV. This valued garden flower came to us from Europe and it sometimes escapes cultivation and runs wild in a gentle way. We call it bachelor's button; but in Europe it is called the cornflower, and under this name it found its way into literature. None of the flowers that live in families repays close study better than does the bachelor's button. The ray-flowers are tubular but they do not have banners. Their tubes flare open like trumpets, and they are indeed color trumpets heralding to the insect world that there is nectar for the probing and pollen for exchange. Looked at from above, the ray-flowers do not seem tubular; from the sides, they show as uneven-mouthed trumpets with lobed edges; but though we search each trumpet to its slender depths we can find no pistils. These ray-flowers have no duty in the way of maturing seeds. In some varieties the ray-flowers are white, and in others they are blue and purple. They vary in number from 7 to 14, or more.

The disk-flowers have a long corolla-tube, which is white and delicately lobed and is enlarged toward the upper end to a purple bulb with five, long, slender lobes. The anther-tube is purplish black, and is bent into almost a hook, the tip opening toward the middle of the flower-head. The pollen is glistening white tinged with yellow, and looks very pretty as it bursts out from the dark tubes. The purple stigma first appears with its tips close together, but with a pollen brush just below it; later it opens into a short Y. The buds at the center of the flower are bent hook-shaped over the center of the flower-head. The involucral bracts or "shingles" are very pretty, each one ornamented with a scaly fringe; they form a long, elegantly shaped base to the flower-head. After the flowers have gone

Stigma open and showing pollen-brush below. Enlarged.

and the seeds have ripened, these bracts flare open, making a wide-mouthed urn from which the ripened seeds are shaken by the winds; and after the seeds are gone, the white fuzz of their empty cases remains at the bottom of the urn. The seed is plump and shining, with a short fringe of pappus around the top and a contracted place at one side near the base where it grew fast to the receptacle; for these seeds are not set on end, as are those of the sunflower. The short pappus is hardly sufficient to buoy up the seed, and yet undoubtedly aids it to make a flying jump with the passing breeze.

LESSON CLXI
The Bachelor's Button

Leading thought—Each bachelor's button is made up of many little flowers which may be studied by the outline given in Lesson CXXXV.

THE SALVIA, OR SCARLET SAGE
Teacher's Story

The flower story of the sage is so peculiar that Darwin has used it to illustrate the mechanisms present in some flowers which the visiting insects must work in order to get the nectar. The scarlet sage, which gladdens our flower beds during the summer and autumn with its brilliance, has as interesting

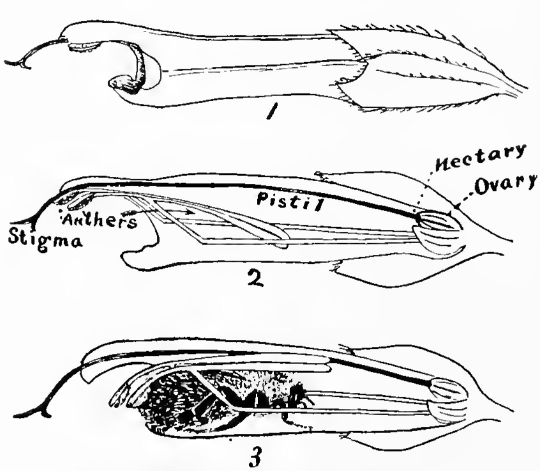
The salvia, or scarlet sage, showing the bracts still present above and falling as the flowers open.

a story as has any of its family. Looking at it from the outside, we should say that its nectar-wells lie too deep to be reached by any insect except a moth or butterfly, or a humming bird; there is no platform for a bee to alight upon, and the tube is too long to be fathomed by a bee's tongue; but the bees are very good business folk; they adapt themselves to flowers that are not adapted to them, and in autumn the glow of the salvia attracts the eye scarcely more than the hum of the visiting bees attracts the ear.

The calyx of the salvia is as red as the corolla, and is somewhat fuzzy while the corolla is smooth. The calyx is a three-lobed bulging tube held stiff by rather strong veins; there is one large lobe above and two small ones below the corolla. The corolla is a tube which is more than twice the length of the calyx; it is prolonged above into a projecting hood, which holds the anthers and the stigma; it has a short, cuplike lower lip and two little turned-back, earlike lobes at the side.

The special mechanism of the salvia is shown in the stamens; there are two of these lying flat along the floor of the corolla-tube and grown fast to it. Near the mouth of the tube, each of these lifts up at a broad angle to the roof, and is more or less T-shaped; at the tip of one of the arms of the T is an anther while the other arm is longer and slants down and inward to the floor of the tube, as shown at 2 in the figure.

The bee visiting the flower and entering the corolla-tube, pushes her head against the inner arms of the stamens, lifting them, and in so doing causes the anthers on the front arms of the T to lower and leave streaks of pollen along her fuzzy sides. The stigma is at first concealed in the hood; but, when ripe, it projects and hangs down in front of the opening of the corolla-tube, where it may be brushed along one side or the other by the visiting insect, which has been dusted with the pollen of some other flower. The stigma-lobes open in such a manner that they do not catch the pollen from the insect backing out of their own corolla. As the nectar is at the base of the corolla-tube, the bees, in order to get it, crawl in almost out of sight. Late in the season they seem to "go crazy" when gathering this nectar; I have often seen them searching the bases of the corolla-tubes which have fallen to the ground, in order to get what is left of the sweet treasure.



1. *Blossom of scarlet sage as seen from outside.*
2. *The same flower with side removed showing the arrangement of its parts.*
3. *A bee working the stamen's mechanism as she seeks the nectar.*

But the pollen story is not all that is of interest in the salvia. Some of the parts of the flower which are green in most blossoms, are scarlet as a cardinal's robe in this. If we glance at a flower stalk, we see that at its tip it looks like a braided, flattened cone; this appearance is caused by the scarlet, long-pointed bracts, each of which covers, with its bulging base, the scarlet calyx which in turn enfolds the scarlet flower bud. These bracts fall as the flowers are ready to open, making a brilliant carpet about the plant. Each flower stem continues to develop buds at its tip for a long season; and this, taken together with its scarlet bracts and flowers, renders the salvia a thing of beauty in our gardens, and makes it cry aloud to pollen-carriers that here, even in late autumn, there is plenty of nectar.

LESSON CLXII

Salvia, or Scarlet Sage

Leading thought—This flower has the bracts and calyx scarlet instead of green, and this makes it a brilliant mass of color to please our eyes and attract the pollen-carrying insects. Its anthers are arranged at the tip of two levers, which the insects push up and down as they enter the flower, thus becoming dusted with pollen.

Method—The structure of this flower may be studied in the schoolroom and its mechanism there understood; but the most important part of the lesson is the observation out-of-doors upon the way the bees work the stamen levers when seeking the nectar. This is best observed during late September or October, after other flowers are mostly gone, and when the bees are working with frantic haste to get all the honey possible.

Observations—1. How does the calyx of the salvia differ from that of other flowers in color? How does it differ from the corolla in texture? How many lobes has it? How are they placed about the corolla?

2. What is the shape of the corolla? How does it make a hood over the entrance to the tube? What does the hood hold? Is there any platform made by the lower lip of the corolla for a visiting insect to alight upon?

3. Cut open one side of the corolla and describe how the stamens are arranged. Thrust your pencil into an uninjured flower and see if the anthers in the hood are moved by it. How? Describe how a bee in visiting this flower moves the anthers so as to become dusted with pollen.

4. Where is the stigma? How does it receive pollen from visiting insects? Would it be likely to get the pollen which has just been scraped off from its own anthers by the bee? Why?

5. Experiment to find where the nectar is. Do you ever see bees getting the nectar from fallen flowers? Do they get it from the "front" or the "back door?"

6. What other parts of this flower are red, which in other flowers are green? How does this make the budding portions of the flower stem look? Why does this make the salvia a more beautiful plant for our gardens?

7. Compare the mechanism of the stamens of the scarlet sage with the mechanism of the stamens of the common garden sage.

Drawn by Anna C. Stryke.

PETUNIAS

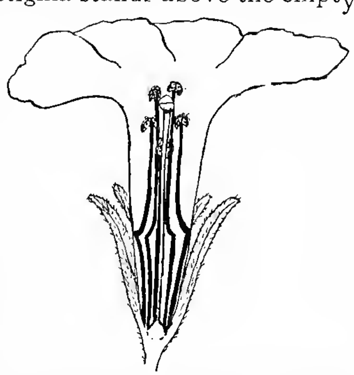
Teacher's Story

THESE red-purple and white flowers, which, massed in borders and beds, make gay our gardens and grounds in late summer and early autumn, have an interesting history. Professor L. H. Bailey uses it as an illustration in his thought-inspiring book, "The Survival of the Unlike;" he says that our modern petunias are a strange compound of two original species; the first one was found on the shores of the La Plata in South America and was introduced into Europe in 1823. "It is a plant of upright habit, thick sticky leaves and sticky stems, and very long-tubed white flowers which exhale a strong perfume at nightfall." The second species of petunia came from seeds sent from Argentina to the Glasgow Botanical Gardens in 1831. "This is a more compact plant than the other, with a decumbent base, narrower leaves and small, red-purple flowers which have a very broad or ventricose tube, scarcely twice longer than the slender calyx lobes." This plant was called *Petunia violacea* and it was easily hybridized with the white species; it is now, strangely enough, lost to cultivation, although the white species is found in some old gardens. The hybrids of these two species are the ancestors of our garden petunias, which show the purple-red and white of their progenitors. The petunias are of the Nightshade family and are kin to the potato, tomato, egg-plant, tobacco and Jimson-weed, and, like the latter, the flowers are especially adapted to give nectar to the long-tongued sphinx or humming bird moths.

The petunia corolla is tubular, and the five lobes open out in salver-shape; each lobe is slightly notched at its middle, from which point a marked midrib extends to the base of the tube. In some varieties the edges of the lobes are ruffled. Within the throat of the tube may be seen a network of darker veins, and in some varieties this network spreads out over the corolla-lobes. Although many colors have been developed in petunias, the red-purple and white still predominate; when the two colors combine in one flower, the pattern may be symmetrical, but is often broken and blotchy.

When a flower-bud is nearly ready to open the long, bristly tube of the corolla lies with its narrow base set in the calyx, the long, fuzzy lobes of which flare out in bell-shape; the tube is marked by lengthwise lines made by the five midribs; the lobes of the corolla are folded along the outer portions of these midribs, and these folded tips are twisted together much as if some one had given them a half turn with the thumb and finger. It is a pleasing experience to watch one of these flowers unfold. When a flower first opens, there lies near the bottom of the throat of the tube the green stigma, with two anthers snuggled up in front of it and two behind it, the latter being not quite so advanced in age as the former. As the filaments of the front pair of anthers are longer than those of the rear pair, the little group lies at a low angle offering a dusty doormat for entering insects. If we open a flower at this stage, we find another anther, as yet unopened, and which is on the shortest stamen of the five. This seems to be a little pollen-reserve, perhaps for its own use later in the season. There is an interesting mechanism connected with these stamens; each is attached to the corolla-tube at the base for about half its length, and at the point of attachment curves suddenly inward so as to "cuddle up" to the pistil, the base of which is set in the nectar-well at the bottom of the flower. If we introduce a slender pencil or a toothpick into the flower-tube along the path which the moth's tongue must follow to reach the nectar, we can see that the stamens, pressing against it at the point where they curve inward, cause the anthers to move about so as to discharge their pollen upon it; and as the toothpick is withdrawn they close upon it cogently so that it carries off all the pollen with which it is brought in contact.

If we look at the stigma at the center of its anther-guard, it has a certain close-fisted appearance, although its outer edges may be dusted with the pollen; as the flower grows older, the stigma stands above the empty anthers at the throat of the flower tube and opens out into two distinct lobes. Even though it may have accepted some of its own pollen, it apparently opens up a new stigmatic surface for the pollen brought from other flowers by visiting insects.



A petunia blossom cut open on the upper side, showing the pistil surrounded by the incurved stamens and the partially opened stigma surrounded by the anthers. Note the short stamen below the pistil.

Dr. James G. Needham says that at Lake Forest he has been attracted to the petunia beds in the twilight by the whirring of the wings of countless numbers of sphinx, or hummingbird moths which were visiting these flowers. We also may find these moths hovering over petunia beds in almost any region if we visit them on the warmer evenings. And it is a safe guess that the remote white ancestor of our petunias had some special species of sphinx moth which it depended upon for carrying its pollen; and the strong perfume it exhaled at nightfall was an odor signal to its moth friends to come and feast.

But even though the petunia flowers are especially adapted to the delectation of hummingbird moths, our bees which—like man—have claimed all the earth, will work industriously in the petunias, scrambling into the blossoms with much remonstrating, high-pitched buzzing because of the tight fit, and thus rifle the nectar-wells that were meant for insects of quite different build.

The leaves of the petunia are so broadly ovate as to be almost lozenge-shape, especially the lower ones; they are soft, and have prominent veins on the lower side; they are without stipules, and have short flat petioles. The stems are soft and fuzzy and are usually decumbent at the base, except the central stems of a stool or clump which, though surrounded by kneeling sisters, seem to prefer to stand up straight.

The flower stems come off at the axils of the leaves, the lower flowers open first. The blossoms remain open about two days; at the first sign of fading, the lobes of the corolla droop dejectedly like a frill that has lost its starch, and finally the corolla—tube and all—drops off, leaving a little conical seed-capsule nestled snugly in the heart of the bell-shaped calyx. At this time, if this peaked cap of the seed-capsule be removed, the many seeds look like tiny white pearls set upon the fleshy, conical placenta. As the capsule ripens, it grows brown and glossy like glazed manila paper and it is nearly as thin; then it cracks precisely down its middle, and the seeds are spilled out at any stirring of the stems. The ripe seeds are dark brown, almost as fine as dust, and yet, when examined with a lens, they are seen to be exquisitely netted and pitted.

References—The Survival of the Unlike, L. H. Bailey; The Encyclopedia of Horticulture, Bailey; Our Garden Flowers, Harriet Keeler.

LESSON CLXIII

The Petunia

Leading thought—The petunias have an interesting history being native to South America. Their flowers are fitted by form and mechanism to entice the hummingbird moths as visitors, and to use them for carrying pollen.

Method—The petunias are such determined bloomers that they give us flowers up to the time of killing frosts, and they are therefore good material for nature lessons. Each pupil should have a flower in hand to observe during the lesson, and should also have access to a petunia bed for observations on the habits of the plant.

Observations—1. What colors do you find in the petunia flowers? If striped or otherwise marked, what are the colors? Are the markings symmetrical and regular?

2. Sketch or describe a flower, looking into it. What is the shape of the corolla-lobes? How many lobes are there? How are they veined? What peculiar markings are at the throat of the flower?

3. What are the color and position of the stigma? How are the stamens arranged? How many anthers do you see? What is the color of the anthers? Of the pollen?

4. Sketch or describe the flower from the side. What is the shape of the corolla-tube? Is it smooth or fuzzy? How is it marked? What are the number and shape of the sepals, or lobes, of the calyx?

5. Study a freshly opened flower, and describe the position and appearance of the anthers and stigma. Do they remain in these relative positions after the flower is old?

6. Cut open a flower, slitting it along the upper side. Describe the stamens and how they are attached. Is the pistil attached in the same manner? Where is the nectar? Thrust a slender pencil or a toothpick into the tube of a fresh flower. Does this spread the anthers apart and move them around? When it is withdrawn, is there pollen on it? Can you see in your open flower the mechanism by which the pollen is dusted on the object thrust into the flower?

7. What insects have tongues sufficiently long to reach the nectar-well at the bottom of the petunia flower? At what time do these insects fly? At what time of day do most of the petunia flowers open? Visit the petunia beds in the twilight, and note whether there are any insects visiting them. What insects do you find visiting these flowers during the day?

8. Sketch or describe the leaves of the petunia. How do the leaves feel? Look at a leaf with a lens and note the fringe of hair along its edges. Describe the veining of the leaf.

9. Describe the petunia stems. Are they stout or slender? How do they feel? With what are they covered? Where do the flower stems come off the main stalk?

10. Describe or sketch a flower-bud just ready to open. How are the tips of the lobes folded? How long does the flower remain in bloom? What is the first sign of its fading?

11. Describe the seed-capsule. Where does it open? Are the seeds many or few, large or small? What is their color when ripe? When examined with a lens, have they any pits or markings?

THE HORSESHOE GERANIUM

Teacher's Story

The geraniums perhaps do more to brighten the world than almost any other cultivated flowers. They will grow for every one, whether for the gardener in the conservatory of the rich, or in a tin can on the windowsill of the crowded tenement of the poor. And it is interesting to know that this common plant has a cultivated ancestry of two hundred years' standing. These geraniums, which are really not geraniums botanically but are *pelargoniums*, originally came from southern Africa, and the two ancestors of our common bedding geraniums were introduced into England in 1710 and 1714.

The geranium is of special value to the teacher, since it is available for study at any season of the year, and has a most interesting blossom. The single-flowered varieties should be used for this lesson, since the blossoms that are double have lost their original form. Moreover, the geranium's blossom is so simple that it is of special value as a subject for a beginning lesson in teaching the parts of a flower; and its leaves and stems may likewise be used for the first lessons in plant structure.

The stem is thick and fleshy, and is downy on the new growth; there is much food stored in these stems, which accounts for the readiness with which cuttings from them will grow. Wherever a leaf comes off the stem, it is guarded by two stipules at the base; these stipules often remain after the leaves have fallen, thus giving the stem an unkempt look. The leaves are of various shapes, although of one general pattern; they are circular and beautifully scalloped and lobed, with veins for every lobe radiating from the petiole; they are velvety above and of quite different

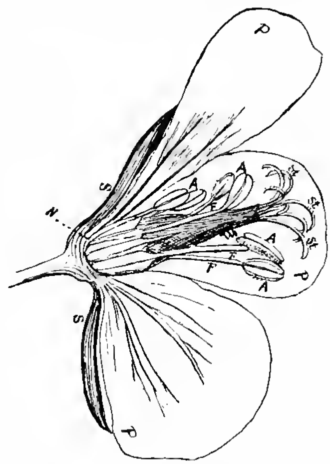
Horseshoe Geranium.

Photo by Sheldon.

Note the positions of the opened flowers and the buds. Note the shape of the two upper petals with their guide-lines, showing the position of the nectar-gland. The flower at the left, seen in profile, shows that these upper petals project farther forward than those below. Note the cluster of young buds set in a circlet of bracts just below this flower.

texture beneath, and many show the dark horseshoe which gives the name to this variety. The petiole is usually long and stiff and the leaves are set alternately upon the stem.

The flower has five petals, and at first glance they seem of much the same shape and position; but if we look at them carefully, we see that the upper two are much narrower at the base and project farther forward than do the lower three. Moreover, there are certain lines on these upper petals all pointing toward the center of the flower; these are the nectar guide-lines, and if we follow them we find a deep nectar-well just at the base of these upper petals and situated above the ovary of the flower. No other flower shows a prettier plan for guiding insects to the hidden sweets, and in none is there a more obvious and easily seen well of nectar. It extends almost the whole length of the flower stem, the nectar gland forming a hump near the base of the stem. If we thrust a needle down the whole length of this nectar tube we can see that this bright flower developed its nectar especially for some long-tongued insect, probably a butterfly. It is interesting to note that in the double geranium where the stamens have been all changed to petals and where, therefore, no seeds are formed, this nectar-well has been lost.



Diagram, flower of the horseshoe geranium.

S, sepals; P, petals; A, anther; F, filament; m, pistil; St., stigma; N, opening to nectar tube.

There are five sepals, the lower one being the largest. But the geranium is careless about the number of its stamens; most flowers are very good mathematicians, and if they have five sepals and five petals they are likely to have five or ten stamens. The geranium often shows seven anthers, but if we look carefully we may find ten stamens, three of them without anthers. But this is not always true; there are sometimes five anthers and two or three filaments without anthers. The color of the anthers differs with the variety of the flower. The stamens broaden below, and their bases are joined making a cup around the lower part of the ovary. The pistil is at the center of the flower and has no style, but at the summit divides into five long, curving stigmas; but again the geranium cannot be trusted to count, for sometimes there are seven or eight stigmas. Although many of our common varieties of geraniums have been bred so long that they have almost lost the habit of producing seed, yet we may often find in these single blossoms the ovary changed into the peculiar, long, beaklike pod, which shows the relationship of this plant to the cranesbill or wild geranium.

When the buds of the geranium first appear, all of them are nestled in a nest of protecting bracts, each bud being enclosed in its own protecting sepals. But soon each flower stem grows longer and droops and often the bracts at its base fall off; from this mass of drooping buds, the ones at the center of the cluster lift up and open their blossoms first. Often, when the outside flowers are in bloom, those at the center have withered petals but are hidden by their fresher sisters.

It would be well to say something to the pupils about those plants which have depended upon man so long for their planting that they do not develop any more seed for themselves. In connection with the geraniums, there should be a lesson on how to make cuttings and start their growth. The small side branches or the tips of the main stems may be used as cuttings. With a sharp knife make a cut straight across. Fill shallow boxes with sand, place them in a cool room and keep them constantly moist; plant the cuttings in these boxes, putting the stems for one-third of their length in the sand. After about a month the plants may be repotted in fertile soil. The fall is the best time to make cuttings.

LESSON CLXIV

The Horseshoe Geranium

Leading thought—The geraniums are very much prized as flowers for ornamental beds. Let us see why they are so valued.

Method—A variety of geranium with single flowers should be chosen for this purpose, and it may be studied in the schoolhouse window or in the garden. As the parts of this flower are of a very general type, it is an excellent one with which to teach the names and purposes of the flower parts. Each child can make a little drawing of the sepals, petals, stamens and pistil, and label them with the proper names.

Observations—1. What sort of a stem has the geranium. Is it smooth or downy? What makes the geranium stem look so rough and untidy?

2. Study the leaf. Show by description or drawing its shape, its wings, its veins. What are its colors and texture above? Beneath? Is the petiole long or short? What grows at the base of the petiole where it joins the stem? What marking is there on the leaf, which makes us call this a "horseshoe geranium?" Are there other geraniums with leaves of similar shape that have no horseshoe mark?

3. Study the flower. Are the petals all the same size and shape? How many of them are broad? How many narrow? Do the narrow

ones project in front of the others? Do these have guide-lines upon them? Where do these lines point? Find the nectar-well, how deep is it? Does it extend almost the entire length of the flower stem? For what insects must it have been developed? Are there nectar-tubes in the stems of the geraniums with double flowers? Why?

4. How many sepals are there? Are they all the same size? Where is the largest?

5. How many stamens can you see? What is the color of the filaments and of the anthers? How are the stamens joined at their bases? Can you find any stamens without anthers?

6. Where is the pistil situated? Can you see the ovary, or seed-box? How many stigmas? Describe their color and shape.

7. In what part of the flower will the seeds be developed? How does the geranium fruit look? Sketch the pod. Do the geraniums develop many seeds? Why not? Do you know the seed-pod of the wild geranium? If so, compare it with the pod of this plant.

8. Take a flower cluster when the flowers are all in the bud, and note the following: When the buds first appear, what protects them? What becomes of these bracts later? How do the sepals protect the bud? Are the bud stems upright and stiff or drooping? How many buds are there in a cluster?

9. Take notes on successive days as follows: What happens to the stem as the bud gets ready to bloom? Is it a central or an outside blossom that opens first? How many new blossoms are there each day? How long is it from the time that the first bud opens until the last bud of the cluster blossoms? What has this to do with making the geranium a valuable ornamental plant?

10. Make some geranium cuttings, and note how they develop into new plants. Place one of the cuttings in a bottle of water and describe how its roots appear and grow.

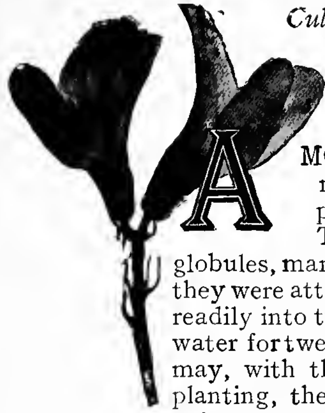
"God made the flowers to beautify
The earth, and cheer man's careful mood;
And he is happiest who hath power
To gather wisdom from a flower,
And wake his heart in every hour
To pleasant gratitude."

—WORDSWORTH.

Sweet Peas.

"Here are sweet peas on tip for a flight,
With wings of delicate flush o'er delicate white,
And taper fingers catching at all things,
To bind them all about with tiny rings."

—Keats.

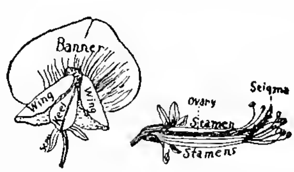


THE SWEET PEA

Teacher's Story

AMONG the most attractive of the seeds which make up the treasure of the children's seed packets, the sweet peas are of the prettiest. They are smooth, little white or brown globules, marked with a scar on the side, showing where they were attached to the pod. One of these peas divides readily into two sections; and after it has been soaked in water for twenty-four hours, the germ of the future plant may, with the aid of a lens, be seen within it. After planting, the sprout pushes through the seed-coat at a point very near the scar, and leaf shoots emerge from the same place; but the two act very differently. The leaf lifts upward toward the light, and the root plunges down into the soil. As the plant grows, it absorbs the food stored in the seed; but the seed remains below ground and does not lift itself into the air, as happens with the bean. The root forms many slender branches, near the tips of which may be seen the fringe of feeding roots, which take up the food and water from the soil. The first leaves of the pea seedling put forth no tendrils, but otherwise look like the later ones. The leaves grow alternately on the stalk, and they are compound, each having from three to seven leaflets. The petiole is winged, as is also the stem of the plant. There is a pair of large, clasping stipules at the base of each leaf. If we compare one of these leaves with a spray of tendrils, we can see that they resemble each other in the following points: The basal leaflets of the petiole are similar and the stipules are present in each case; but the leaflets nearest the tip are marvelously changed to little, stiff stems with a quirl at the tip of each ready to reach out and hook upon any object that offers surface to cling to. Sometimes we find a leaflet paired with a tendril. The sweet pea could not thrive without a support outside of itself.

Of course, the great upper petal of the sweet pea blossom is called the banner! It stands aloft and proclaims the sweet pea as open; but before this occurs, it tenderly enfolds all the inner part of the flower in the unopened bud, and when the flower fades it again performs this duty. The wings are also well named; for these two petals which hang like a peaked roof above the keel, seem like wings just ready to open in flight. The two lower petals are sewed together in one of Nature's invisible seams, making a long, curved treasure chest resembling the keel of a boat, and it has thus been called. Within the keel are hidden the pistil and stamens. The ovary is long, pod-shaped and downy; from its tip the style projects, as strong as a wire, curving upwards, and covered with a brush of fine, white hairs; at the very tip of the style, and often projecting slightly from the keel, is the stigma. Around the sides and below the ovary and style, are nine stamens, their filaments broadening and uniting to make a white, silken tube about the ovary, or young pod. From the tip of this stamen-tube, each of the nine



Blossom sweet pea with parts labelled.

filaments disengages itself, and lying close to the style thrusts its anther up into the point of the keel, below the stigma. But strange to say, one lone, lorn stamen "flocks by itself" above the pistil, curving its anther up stigma-ward. If we touch the point of the keel with the finger, up fly—like a jack-in-the-box—the anthers splashing the finger with pollen; and if a bee, in her search for nectar, alights on the wings at the very base of the petals, up flies the pollen brush and daubs her with the yellow dust, which she may deposit on the stigma of another flower. The interesting part of this mechanism is the brush near the tip of the style below the stigma—a veritable broom, with splints all directed upward. As the pollen is discharged around it, the brush lifts it up when the keel is pressed down, and the stiff petals forming the keel, in springing back to place, scrape off the pollen and plaster it upon the visitor. But for all this elaborate mechanism, sweet peas, of all flowers, are the most difficult to cross-pollenate, since they are so likely to receive some of their own pollen during this process.


Sweet pea pod bursting in spiral.

The sweet-pea bud droops, a tubular calyx with its five-pointed lobes forming a bell to protect it. Within the bud the banner petal clasps all in its protecting embrace.

After the petals fall, the young pod stands out from the calyx, the five lobes of which are recurved and remain until the pod is well grown. As the sweet pea ripens, all the moisture is lost and the pod becomes dry and hard; through the dampness of dews at night and the sun's heat which warps it by day, finally each side of the pod suddenly coils into a spiral, flinging the seed many feet distant in different directions.

LESSON CLXV
The Sweet Pea

Leading thought—The sweet pea has its leaflets changed to tendrils, which hold it to the trellis. Its flower is like that of the clover, the upper petal forming the banner, the two side petals the wings, and the two united lower petals the keel which protects the stamens and pistil.

Method—This should be a garden lesson. A study should be made of the peas before they are planted, and their germination carefully watched. Later, the method of climbing, the flower and the fruit should each be the subject of a lesson.

Observations on germination—1. Soak some sweet peas over night; split them the next morning. Can you see the little plant within?

2. Plant some of the soaked peas in cotton batting, which may be kept moist. At what point does the sprout break through the seed covering? Do the root and leaf-shoot emerge at the same place, or at different points? Which is the first to appear?

3. Plant some of the soaked peas in the garden. How do the young plants look when they first appear? Does the fleshy part of the seed remain a part of the plant and appear above the ground, as is the case with the bean? What becomes of the meat of the seed after growth has started?

4. Do the first leaves which unfold from the seed pea look like the later ones? Are the leaves simple or compound? Do they grow opposite each other or alternately?

5. Take a leaf and also a spray of the tendrils. How many leaflets are there in a compound leaf? Describe the petiole and the basal leaves. How far apart are the leaflets on the mid-stem? Compare the stem on which the tendrils grow with this leaf. Are the basal leaflets like those of the leaf? Is the petiole like that of the leaf? Do you think that the leaflets toward the tip of the stem often change to tendrils? Why do you think so? Why must the sweet pea have tendrils? Do you see the earlike stipules at the base of the leaf? Are there similar stipules at the base of the tendril stem?

Observations on the flower and fruit—1. Take the sweet pea in blossom. Why is the large upper petal called the banner? How does it compare in size with the other petals? What is its purpose when the flower is open? Why do you think the side petals are called wings? What is their position when the flower is open?

2. Describe that part of the flower below the wings. Do you think that it is made of two petals grown together? Why is it called the keel of the flower? Press down with your finger on the tip of the keel. What happens? Is your finger splashed with pollen? Where is the nectar in the sweet pea? Would an insect getting the nectar press down upon the keel and receive a splash of pollen?

3. Open the keel. How many stamens do you find within it? How many have their filaments joined together? Is there one separate from the others? Against what are the anthers pressed by the keel?

4. Remove the stamens and describe the pistil. Which part of this will make the pod in which the new peas will develop? Describe how the style is curved. How is the style covered near its tip? What is this brush for? Can you find the stigma with the help of the lens? When the bee is seeking for nectar and pushes down on the keel, does the stigma push out at the same point as the pollen? Does this enable the stigma sometimes to receive pollen which the bees bring from other flowers?

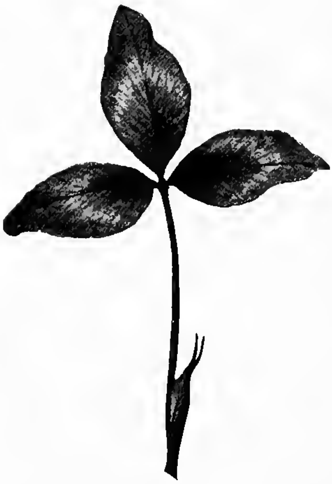
5. Describe an unopened flower bud. What is its position? How many lobes to the calyx? What is their shape, and how do they protect the bud? Which petal is folded over all the others? How does the position of the open flower differ from that of the bud?

6. How does the young pod look when the petals fall? How does it look when ripe? How does it open to scatter little, ripe sweet peas? Do the lobes of the sepals still remain with the pod?

THE CLOVERS

Teacher's Story

"Sweet by the roadside, sweet by the rills,
Sweet in the meadows, sweet on the hills,
Sweet in its wine, sweet in its red,
Oh, half of its sweetness cannot be said;
Sweet in its every living breath,
Sweetest, perhaps, at last, in death."
—"A Song of Clover", HELEN HUNT JACKSON.



Drawn by Ida Baker.

Clover has for centuries been a most valuable forage crop; and for eons it has been the special partner of the bees, giving them honey for their service in carrying its pollen; and in recent years it has been discovered that it has also formed a mysterious and undoubtedly an ancient partnership with bacteria below ground, which, moreover, brings fertility to the soil. The making of a collection of the clovers of a region is a sure way of enlisting the pupils' interest in these valuable plants. The species have some similarities and differences, which give opportunity for much observation in comparing them. There may be found in most localities the white and yellow sweet clovers, the black and spotted medics and their relative the alfalfa; while of the true clovers there are the red, the zigzag, the buffalo, the rabbit's foot, the white, the alsike, the crimson, and two yellow or hop clovers.

In all the clovers, those blossoms which are lowest, or on the outside of the head, blossom first, and all of them have

Crimson clover; just beginning to blossom at the left, more advanced at the middle, and at the end of its bloom at the right.
Photo by G. F. Morgan.

upon their roots the little swellings, or nodules, which are the houses in which the beneficent bacteria grow.

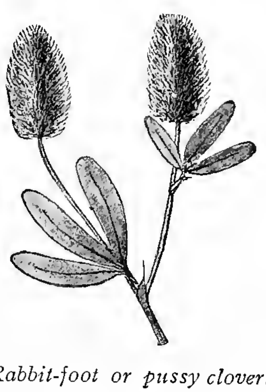
If we pull up or dig out the roots of alfalfa, or of the true clovers or vetches, we find upon the rootlets little swellings which are called nodules, or root-tubercles. Although these tubercles look so uninteresting, no fairy story was ever more wonderful than is theirs. They are, in fact, the home of the clover brownies, which help the plants to do their work. Each nodule is a nestful of living beings, so small that it would take twenty-five thousand of them end to end to reach an inch; therefore, even a little swelling can hold many of these minute organisms, which are called bacteria. For many years people thought that these swellings were injurious to the roots of the clover, but now we know that the bacteria which live in them are simply underground partners of these plants. The clover roots give the bacteria homes and place to grow, and in return these are able to extract a very valuable chemical fertilizer from the air, and to change its form so that the clovers can absorb it. The name of this substance is nitrogen, and it makes up more than three-fourths of the air we breathe. Other plants are unable to take the nitrogen from the air and use it for food, but these little bacteria extract it from the air which fills every little space between every two grains of soil and then change it to a form which the clovers can use. After the clover crop is harvested, the roots remain in the ground, their little storehouses filled with this precious substance, and the soil falls heir to it.

Alfalfa showing root-tubercles.

Nitrogen in the form of commercial fertilizer is the most expensive which the farmer has to buy. So when he plants clover or alfalfa on his land, he is bringing to the soil this expensive element of plant growth, and it costs him nothing. This is why a good farmer practices the rotation of crops and puts clover upon his land every three or four years.

Yellow or hop clover.

Buffalo clover.



Rabbit-foot or pussy clover.

Alfalfa is so dependent on its little underground partners, that it cannot grow without them; and so the farmer plants, with the alfalfa seed, some of the soil from an old alfalfa field, which is rich in these bacteria. On a farm I know, the bacterial soil gave out before all of the seed was planted; and when the crop was ready to cut it was easy to see just where the seed without the inoculated soil had been planted, for the plants that grew there were small and poor, while the remainder of the field showed a luxurious growth.

Alfalfa in leaf and blossom.

It is because of the great quantity of nitrogen absorbed from the air through the bacteria on its roots that the alfalfa is such a valuable fodder; for it contains the nitrogen which otherwise would have to be furnished to cattle in expensive grain or cotton-seed meal. The farmer who gives his stock alfalfa does not need to pay such large bills for grain. Other plants belonging to the same family as the clovers—like the vetches and cow-peas—also have bacteria on their roots. But each species of legume has its own species of bacteria; although in some cases soil inoculated with bacteria from one species of legume will grow it on roots of another species. Thus, the bacteria on the roots of sweet clover will grow on the roots of alfalfa and many farmers use the soil inoculated by sweet clover to start their alfalfa crops.

In addition to the enriching of the soil, clover roots, which penetrate very deeply, protect land from being washed away by freshets and heavy rains; and since clover foliage makes a thick carpet over the surface of the soil, it prevents evaporation and thus keeps the soil moist. Crimson clover is used extensively as a cover crop; it is sowed in the fall, especially where clean culture is practiced in orchards, and spreads its leaves above and its roots within the soil, keeping out weeds and protecting the land. In the spring it may be plowed under, and thus add again to the fertility. This is also an aesthetic crop, for a field of crimson clover in bloom is one of the most beautiful sights in our rural landscape.

Red clover blossom.

Red clover has such deep florets that, of all our bees, only the bumblebees have sufficiently long tongues to reach the nectar. It is, therefore, dependent upon this bee for developing its seed, and the enlightened farmer of to-day looks upon the bumblebees as his best friends. The export of clover seed from the United States has sometimes reached the value of two million dollars per year, and this great industry can only be carried on with the aid of the bumblebee. There are sections of New York State where the growing of clover seed was once a most profitable business, but where now, owing to the dearth of bumblebees, no clover seed whatever is produced.

Spotted medic.

LESSON CLXVI
The Clovers

Leading thought—The clovers enrich with nitrogen the soil in which they are planted. They are very valuable as food for stock; and their flowers are pollenated by bees.

Method—Each pupil should dig up a root of red clover or alfalfa to use for the lesson on the nodules. The flowers should be studied in the field, and also in detail in the schoolroom.

Observations—1. How many kinds of clover do you know? How many of the medics?

2. In all clovers, which flowers of the head blossom first, those on the lower or outside, or those on the upper or inside?

3. Take up a root of red clover or alfalfa, noting how deep it grows. Wash the root free from soil, and find the little swellings on it. Write the story of what these swellings do for the clover, and incidentally for the soil.

4. How must the soil be prepared so that afalfa may grow successfully? What does the farmer gain by feeding alfalfa, and why?

5. How do clover roots protect the land from being washed by heavy rains?

6. How do clovers keep the soil moist? How does this aid the farmer?

7. What is a cover crop, and what are its uses?

8. Upon what insects does the red clover depend for carrying pollen? Can it produce seed without the aid of these valuable bees? Why not?

SWEET CLOVER
Teacher's Story

In passing along the country roads, especially those which have suffered upheaval from the road machines, suddenly we are conscious of a perfume so sweet, so suggestive of honey and other delicate things, that we involuntarily stop to find its source. Close at hand we find this perfume laboratory in the blossoms of the sweet clover. It may be the species with white blossoms, or the one with yellow flowers, but the fragrance is the same. There stands the plant, lifting its beautiful

White sweet clover.

blue-green foliage and its spikes of flowers for the enjoyment of the passer-by, while its roots are feeling their way down deep in the poor, hard soil, taking air and drainage with them and building, with the aid of their underground partners, nitrogen factories which will enrich the poverty-stricken earth, so that other plants may find nourishment in it.

Never was there such another beneficent weed as the sweet clover—beneficent alike to man, bee and soil. Usually we see it growing on soil so poor that it can only attain a height of from two to four feet; but if it once gets foothold on a generous soil, it rises majestically ten feet tall.

Like the true clover, its leaf has three leaflets, the middle one being longer and larger than the other two and separated from them by a naked midrib; the leaflets are long, oval in shape, with narrow, toothed edges, and they are dull, velvety green; the two stipules at the base of the leaf are little and pointed.

The blossoming of the sweet clover is a pretty story. The blossom stem, which comes from the axil of the leaf, is at first an inch or so long, packed closely with little, green buds having pointed tips. But as soon as the blossoming begins, the stem elongates, bringing the flowers farther apart—just as if the buds had been fastened to a rubber cord which had been stretched. The buds lower down open first; each day some of the flowers bloom, while those of the day before linger, and thus the blossom tide rises, little by little up the stalk. But the growing tip develops more and more buds, and thus the blossom story continues until long after the frosts have killed most other plants; finally the tip is white with blossoms, while the seeds developed from the first flowers on the plant have been perfected and scattered.

Yellow sweet clover.

The blossom is very much like a diminutive sweet pea; the calyx is like a cup with five points to its rim, and is attached to the stalk by a short stem. The banner petal is larger than the wings and the keel. A lens shows the stamens united into two groups, with a thread-like pistil pushing out between; both stamens and pistil are covered by the keel, as in the pea blossom.

The flowers are beloved by bees and many other insects, which are attracted to them by their fragrance as well as by the white radiance of their blossoms. The ripened pod is well encased in the calyx at its base. The foliage of the sweet clover is fragrant, especially so when drying; it has been used for fodder. The sweet clovers came to us from Europe and are, in a measure, compensation for some of the other emigrant weeds which we wish had remained at home.

LESSON CLXVII

Sweet Clover

Leading thought—This beneficent plant grows in soil too poor for other plants to thrive in. It brings nitrogen and air into the soil, and thus makes it fertile so that other plants soon find in its vicinity nourishment for growth.

Method—Plants of the sweet clover with their roots may be brought to the schoolroom for study. The children should observe sweet clover in the field; its method of inflorescence, and the insects which visit it, should be noted.

Observations—1. What first makes you aware that you are near sweet clover? On what kinds of soil, and in what localities, does sweet clover abound?

2. Do you know how sweet clover growing in poor soils and waste places acts as a pioneer for other plants?

3. Dig up a sweet clover plant, and see how far its stems go into the soil?

4. How high does the plant grow? What is the color of its foliage?

5. Compare one of the leaves with the leaf of a red clover, and describe the likeness and the difference. Note especially the edges of the upper and the lower leaves, and also the stipules.

6. Describe the way the sweet clover blossoms. Do the lower or upper flowers open first? How does the flower stem look before it begins to blossom? What happens to it after the blossoming begins? How long will it continue to blossom?

7. Take a blossom and compare it with that of a sweet pea. Can you see the banner? The wings? The keel? Can you see if the stamens are united into two sets? Can you see the pistil? Note the shape of the calyx.

8. How many flowers are in blossom at a time? Does it make a mass of white to attract insects? In what other way does it attract insects? What insects do you find visiting it?

9. How do the ripened pods look?

"The blooming wilds His gardens are; some cheering
Earth's ugliest waste has felt that flowers bequeath,
And all the winds o'er summer hills careering
Sound softer for the sweetness that they breathe."

—Theron Brown.

THE WHITE CLOVER

Teacher's Story

THE sweet clover should be studied first, for after making this study it is easier to understand the blossoming of the white and the red clover. In the sweet clovers, the flowers are strung along the stalk but in the red, the white, and many others, it is as if the blossom stalk were telescoped, so that the flowers are all in one bunch, the tip of the stalk making the center of the clover head. We use the white clover in our lawns because of a peculiarity of its stem, which, instead of standing erect, lies flat on the ground, sending leaves and blossoms upward and thus making a thick carpet over the ground. The leaves are very pretty; and although they grow upon the stems alternately, they always manage to twist around so as to lift their three leaflets upward to the light. The three leaflets are nearly equal in size, with fine, even veins and toothed edges; and each has upon it, near the middle a pale, angular spot. The white clover, in common with other clovers, has the pretty habit of going to sleep at night. Botanists may object to this human term, but the great Linnæus first called it sleep, and we may be permitted to follow his example. Certainly the way the clover leaves fold at the middle, the three drawing near each other, looks like going to sleep, and is one of the things which even the little child will enjoy observing.

The clover head is made up of many little flowers; each one has a tubular calyx with five delicate points and a little stem to hold it up into the world. In shape, the corolla is much like that of the sweet pea, and each secretes nectar at its base. The outside blossoms open first; and as soon as open, the honey bees, which eagerly visit white clover wherever it is growing, begin at once their work of gathering nectar and carrying pollen; as soon as the florets are pollenated they wither and droop below the flower-head.

"Where I made One, turn down an empty Glass."

Sings old Omar, and I always think of it when I see the turned-down florets of the white-clover blossom. But in this case the glass is not empty, but holds the maturing seed. This habit of the white clover flowers saves the bees much time, since only those which need pollenating are lifted upward to receive their visits. The length of time the little clover head requires for the maturing of its blossoms depends much upon the weather and upon the insect visitors.

White clover honey is in the opinion of many the most delicious honey made from any flowers except, perhaps, from orange blossoms. So valuable is the white clover as a honey plant, that apiarists often grow acres of it for their bees.

LESSON CLXVIII

THE WHITE CLOVER

Leading thought—The white clover has creeping stems. Its flowers depend upon the bees for their pollination, and the bees depend upon the white clover blossoms for honey.

Method—The plant may be brought into the schoolroom while in blossom, and its form be studied there. Observations as to the fertilization of the flowers should be made out-of-doors.

Observations—1. Where does the white clover grow? Why is it so valuable in lawns?

2. Note carefully the clover leaf, the shape of the three leaflets, stems, and edges. Is part of the leaflet lighter colored than the rest? If so, describe the shape. Are the leaflets unequal or equal in size? Does each leaf come directly from the root? Are they alternately arranged? Why do they seem to come from the upper side of the stem?

3. Note the behavior of the clover leaves at night. How do the two side leaflets act? The central leaflet? Do you think that this is because the plant is sleepy?

4. Take a white clover head, and note that it is made up of many little flowers. How many? Study one of the little flowers with a lens. Can you see its calyx? Its petals? Its stem? In what way is it similar to the blossom of the sweet pea?

5. Take a head of white clover which has not yet blossomed. Tie a string about its stem so that you may be sure you are observing the same flower and make the following observations during several days: Which blossoms begin to open first—those outside or inside? How many buds open each day? What happens to the blossoms as they fade? Of what use is this to the plant? How many days pass from the time the flowers begin to blossom until the last flower at the center opens?

6. What insects do you see working on the white clover blossoms? How does the bee act when collecting nectar? Can you see where she thrusts her tongue? What does the bee do for the clover blossom? What sort of honey does the white clover give to the bee?

7. Tie little bags of cheesecloth over two or three heads of white clover and see if they produce any seed.

"*Little flower; but if I could understand*
What you are, root and all, and all in all,
I should know what God and man is."

—Tennyson.

"*To me the meanest flower that blows, can give*
Thoughts that do often lie too deep for tears."

—Wordsworth.

"*I know a place where the sun is like gold,*
And the cherry blooms burst with snow,
And down underneath is the loveliest nook
Where the four leaf clovers grow."

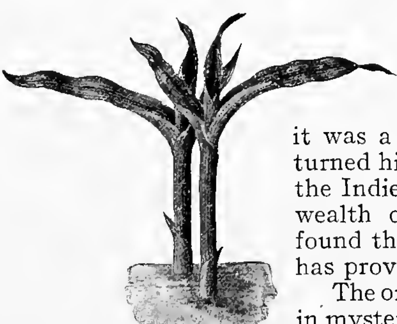
—Ella Higginson.

Seneca Indian women husking corn for braiding.
Photo by Arthur C. Parker. From Bulletin 144 of New York State Museum, "Iroquois uses of Maize and other Food Plants" by Arthur C. Parker.

THE MAIZE, OR INDIAN CORN

Teacher's Story

"Hail! Ha-wen-ni-yu! Listen with open ears to the words of thy people. Continue to listen. We thank our mother earth which sustains us. We thank the winds which have banished disease. We thank He-no for rain. We thank the moon and stars which give us light when the sun has gone to rest. We thank the sun for warmth and light by day. Keep us from evil ways that the sun may never hide his face from us for shame and leave us in darkness. We thank thee that thou hast made our corn to grow. Thou art our creator and our good ruler, thou canst do no evil. Everything thou doest is for our happiness."

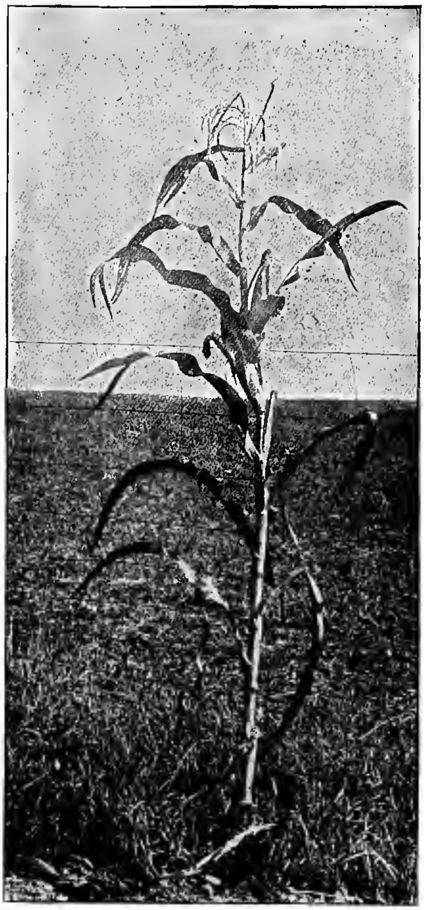


THUS prayed the Iroquois Indians when the corn had ripened on the hills and valleys of New York State long before it was a state, and even before Columbus had turned his ambitious prows westward in quest of the Indies. Had he found the Indies with their wealth of fabrics and spices, he would have found there nothing so valuable to the world as has proved this golden treasure of ripened corn.

The origin of Indian corn, or maize, is shrouded in mystery. There is a plant which grows on the table-lands of Mexico, which is possibly the original species; but so long had maize been cultivated by the American Indians that it was thoroughly domesticated when America was first discovered. In those early days of American colonization, it is doubtful, says Professor John Fiske, if our forefathers could have remained here had it not been for Indian corn. No plowing, nor even clearing, was necessary for the successful raising of this grain. The trees were girdled, thus killing their tops to let in the sunlight; the rich earth was scratched a little with a primitive tool, and the seed put in and covered; and the plants that grew therefrom took care of themselves. If the pioneers had been obliged to depend alone upon the wheat and rye of Europe, which only grows under good tilllage, they might have starved before they gained a foothold on our forest-covered shores.

The Corn Plant

In studying the maize it is well to keep in mind that a heavy wind is its worst enemy; such a wind will lay it low, and from such an injury it is difficult for the corn to recover and perfect its seed. Thus, the mechanism of the corn-stalk and leaf is adapted for prevention of this disaster. The corn-stalk is, practically, a strong cylinder with a pithy center; the fibres of the stalks are very strong, and at short intervals the stalk is strengthened by hard nodes, or joints, if the whole stalk were as hard as the nodes, it would be inelastic and break instead of bend; as it is, the stalk is very elastic and will bend far over before it breaks. The nodes are nearer each other at the bottom, thus giving strength to the base; they are farther apart at the top, where the wind strikes, and where the bending and bowing of the stalk is necessary.



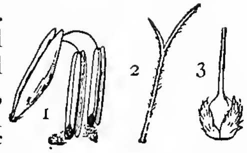
Stalk of corn with ear and tassel.

The leaf comes off at a node and clasps the stalk for a considerable distance, thus making it stronger, especially toward the base. Just where the leaf starts away from the stem there is a little growth called a rain-guard; if water should seep between the stalk and the clasping leaf, it would afford harbor for destructive fungi. The structure of the corn leaf is especially adapted to escape injury from the wind; the strong veins are parallel with a strong but flexible midrib at the center; often, after the wind has whipped the leaves severely, only the tips are split and injured. The edges of the corn leaf are ruffled and, where the leaf leaves the stalk, there is a wide fold in the edge at either side; this arrangement gives play for a sidewise movement without breaking the leaf margins. The leaf is thus protected from the wind, whether it is struck from above or horizontally. The true roots of the corn plant go quite deep into the soil, but are hardly adequate to the holding of such a tall, slender stalk upright in a wind storm; therefore, all about the base of the plant are brace-roots, which serve to hold the stalk erect—like the stay-ropes about a flagpole.

The pollen-bearing flowers of corn.

THE EAR OF CORN

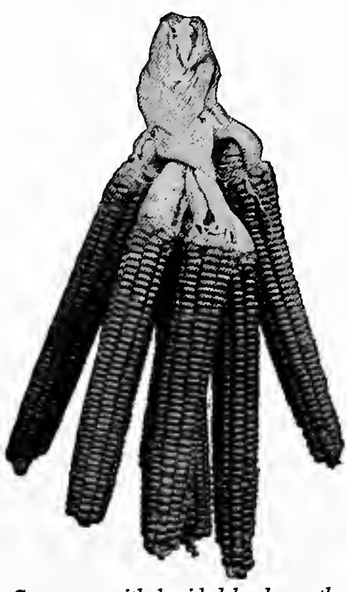
The ears of corn are borne at the joints or nodes; and the stalk, where the ear presses against it, is hollowed out so as to hold it snugly; this is very suggestive of a mother holding a baby in her arms. In the following ways, the husks show plainly that they are modified leaves: The husk has the same structure as the leaf, having parallel veins; it comes off the stem like a leaf; it is often green, and therefore does the work of a leaf; it changes to leaf shape at the tip of the ear, thus showing that the husk is really that part of the leaf which usually clasps the stem. If a husk tipped with a leaf is examined, the rain-guard will be found at the place where the two join. As a matter of fact, the ear of corn is on a branch stalk which has been very much shortened, so that the nodes are very close together, and therefore the leaves come off close together. By stripping the husks back one by one, the change from the outside, stiff, green leaf structure to the inner delicate, papery wrapping for the seed, may be seen in all its stages. This is a beautiful lesson in showing how the maize protects its seed, and the husk may well be compared to the clothing of a baby. The pistillate flowers of the corn, which finally develop into the kernels, grow in pairs along the sides of the end portion of the shortened stalk, which is what we call the "cob." Therefore, the ear will show an even number of rows, and the cob shows distinctly that the rows are paired. The corn-silk is the style of the pistillate flowers; and therefore, in order to secure pollen, it must extend from the ovule, which later develops into a kernel, to the tip of the ear, where it protrudes from the end of the husk. A computation of the number of kernels in a row and on the ear makes a very good arithmetic lesson for the primary pupils, especially as the kernels occur in pairs.



1, The anthers of corn; 2, The tip of the corn-silk showing the stigma; 3, The pistillate flower, which will develop into the kernel.

The Growth of the Corn

If we cut a kernel of corn crosswise we can see, near the point where it joins the cob, the little plant and the root. Corn should be germinated between wet blotters, in a seed-testing experiment, before observations are made on the growing corn of the fields. When the corn first appears, the corn leaves are in a pointed roll which pierces the soil. Soon they spread apart, but it may be some time before the corn-stalk proper appears. Then it stretches up rapidly, and very soon will be tipped with beautiful pale brown tassels. These tassels merit careful study for they are the staminate flowers. Each floret has two anthers hanging down from it, and each half of each anther is a little bag of pollen-grains; and in order that they shall be shaken down upon the waiting corn-silk below, the bottom of each bag opens wide when the pollen is ripe. The corn-silk, at this stage, is branched at the tip and clothed with fine hairs, so that it may catch a grain of the precious pollen. Then occurs one of the most wonderful pollen stories in all nature, for the pollen-tube must push down through the center of the corn-silk for its whole length, in order to reach the waiting ovule and thus enable it to become a kernel of corn. These young, unfertilized kernels are pretty objects, looking like seed-pearls, each wrapped in furry bracts. If the silk from one of these young flowers does not receive its grain of pollen, then the kernel will not develop and the ear will be imperfect. On the other hand if the pollen from another variety of corn falls upon the waiting stigmas of the silk, we shall find the ear will have upon it a mixture of the two varieties. This is best exemplified when we have the black and white varieties of sweet corn growing near each other.


Corn ears with braided husks as the Indians used to carry them.

One reason why corn is such a valuable plant to us is that its growth is so rapid. It is usually not planted until late spring, yet, with some varieties, by September the stalks are twenty feet high. The secret of this is that the corn, unlike many other plants, has many points of growth. While young, the lower part of the stalk lying between every two nodes is a growing center and the tip of the stalk also grows; in most plants, the tip of the stems is the only center of growth. The first two experiments suggested will demonstrate this. When blown down by the wind, the corn has a wonderful way of lifting itself, by inserting growing wedges in the lower sides of the nodes. A corn-stalk blown down by the wind will often show this wedge-shape at every joint, and the result will be an upward curve of the whole stalk. Of course, this cannot be seen unless the stalk is cut lengthwise through the center. Experiment 3 is suggested to demonstrate this.

During drought the corn leaves check the transpiration of water by rolling together lengthwise in tubes, thus offering less surface to the sun and air. The farmer calls this the curling of the corn, and it is always a sign of lack of moisture. If a corn plant with leaves thus curled, be given plenty of water, the leaves will soon straighten out again into their normal shape.

References: Corn Plants, Sargent; Cornell Nature-Study Leaflets, Vol. 1; Elements of Agriculture, Warren; The First Book of Farming, Goodrich; Agriculture, Jackson and Dougherty; Rural School Agriculture, Hays; Columbia's Emblem, Houghton, Mifflin and Co.

Corn in the shock.

LESSON CLXIX

The Maize

Leading thought—The Indian corn, or maize, is a plant of much beauty and dignity. It has wonderful adaptations for the development of its seed and for resisting its arch-enemy, the wind.

Method—The study may begin in spring when the corn is planted, giving the pupils the outline for observations to be filled out in their note-books during the summer, when they have opportunities for observing the plant; or it may be studied in the autumn as a matured plant. It may be studied in the school room or in the field, or both.

Observations on the corn plant—1. Describe the central stem. How many joints, or nodes, has it? Of what use to the plant are these nodes? Are the joints nearer each other at the bottom or the top of the plant?

2. Where do the leaves come off the stem? Describe the relation of the bases of the leaves to the stem. Of what use is this to the plant?

3. Note the little growth on the leaf where it leaves the stalk. Describe how this prevents the rain from seeping down between the stalk and the clasping leaf. What danger would there be to the plant if the water could get into this narrow space?

4. What is the shape of the leaf? Describe the veins. Does the leaf tear easily across? Does it tear easily lengthwise? Of what use to the leaf is this condition?

5. Are the edges of the corn leaf straight or ruffled? How does this ruffled edge permit the leaf to turn without breaking? Describe at length the benefit the corn plant derives from having leaves which cannot be broken across and that can bend readily sidewise as well as up and down.

6. Describe the roots of the corn plant. Describe the brace-roots. Explain their use.

7. Describe all the ways in which the corn plant is strengthened against its enemy, the wind.

Observation on the ear of corn—8. Where on the corn plant are the ears borne? Are two ears borne on the same side of the stalk? Remove an ear, and see how the stalk is changed to give it room.

9. Where do the ears come off the stalk in relation to the leaves?

10. Examine the outside husks, and compare them with the green leaves. What is there to suggest that the corn-husk is a leaf changed to protect the seed? Do you think that the husk represents that portion of the leaf which clasps the stalk? Why? Describe how the inner husk differs from the outer in color and texture. Describe how this is a special protection to the growing kernels.

11. After carefully removing the husk, examine the silk and see if there is a thread for every kernel. Is there an equal amount of silk lying between every two rows? Do you know what part of the corn flower is the cornsilk? What part is the kernel?

12. How many rows of kernels are there on an ear? How many kernels in a row? How many on the whole ear? Do any of the rows disappear toward the tip of the ear? If so, do they disappear in pairs? Do you know why? Are the kernels on the tip of the ear and near the base as perfect as those along the middle? Do you know whether they will germinate as quickly and vigorously as the middle ones?

13. Study a cob with no corn on it and note if the rows of kernel-sockets are in distinct pairs. This will, perhaps show best if you break the cob across.

14. Break an ear of corn in two, and sketch the broken end showing the relation of the cob to the kernels.

15. Are there any places on the ear you are studying, where the kernels did not grow or are blasted? What happened to cause this?

16. Describe the requisites for a perfect ear of seed-corn. Why should the plant from which the seed-ear is taken be vigorous and perfect?

Observations on the growth of corn—Work for the Summer Vacation—

17. How does the corn look when it first comes up? How many leaves are there in the pointed roll which first appears above the ground? How long before the central stalk appears?

18. When do the tassels first appear? What kind of flowers are the corn tassels? Describe the anthers. How many on each flower? Where do the anthers open to discharge their pollen?

19. How large are the ears when the pollen is being shed? Study an ear of corn at this period. Note that the kernel is the ovule, the silk is attached to it and is the long style extending out beyond the husks. Note that the tip, or stigma is branched.

20. What carries the pollen for the corn plant? If you have rows of popcorn and sweet corn or of sweet corn and field corn next to each other why is it that the ears will show a mixture of both kinds?

EXPERIMENT 1

Compare the growth of the corn plant with that of the pigweed. When the corn-stalk first appears above ground, tie two strings upon it, one just above a joint and one below it. Tie two strings the same distance apart on the stem of a pigweed. Measure carefully the distance between these two strings on the two plants. Two weeks later measure the distance between the strings again. What is the result?

EXPERIMENT 2

Measure the distance between two of the nodes or joints near the tip of a certain corn-stalk. Two weeks later measure this distance again and compare the two.

EXPERIMENT 3

When a stalk of corn is still green in August, bend it down and place a stick across it at about half its length. Describe how it tries to lift itself to an erect attitude after two or three weeks. Cut lengthwise across one of the nodes, beyond the point held down by the stick, and see the wedge-shaped growth within the joint which helps to raise the stalk to an upright position.

EXPERIMENT 4

During the August drought, note that the corn leaves are rolled. Give a corn plant with rolled leaves plenty of water and note what happens. Why?

THE COTTON PLANT

Teacher's Story

There are some plants which have made great chapters in the histories of nations, and cotton is one of them. The fibre of cotton was used for making clothing so long ago, that its discovery is shrouded in the myths of prehistoric times. But we believe it first came into use in India, for in this land we find certain laws concerning cotton which were codified 800 B. C.; and allusions to the fine, white raiment of the peoples of India are frequent in ancient history. Cotton was introduced into Egypt from India at an early date; it was in common use there 150 B. C. But not until our Civil War laid fallow the cotton fields of the United States, did Egypt realize the value of its crop; and although much money was lost there in agricultural speculation after our own product was again put on the market, yet cotton has remained since that time one of Egypt's most valuable exports.

When Columbus discovered America he found cotton growing in the West Indies, and the chief articles of clothing of the native Mexicans were made of cotton. Cloths of cotton were also found in ancient tombs of

The cotton in blossom.

Peru, proving it was used there long before the white man set his foot upon those shores. When Magellan made his famous voyage around the world in 1500, he found the cotton fibre in use in Brazil.

It is a strange fact that the only region of the world between the parallels of 40° north and 40° south latitude, where cotton did not grow as a native or cultivated plant when America was discovered, was the region of our Gulf States, which now produces more cotton than any other. The first mention of cotton as a crop in the American colonies is in the report published in 1666. At the time of the Revolutionary War the cotton industry was thoroughly established. It is one of the significant facts of history that the invention of the cotton gin by Eli Whitney in 1793, which revolutionized the cotton industry and brought it to a much more profitable basis, wrought great evil to the United States, since it revived the profits of slave-holding. The institution of slavery was sinking out of sight by its own weight; Washington showed that it was the most expensive way to work land, and Jefferson failed to liberate his own slaves simply because he believed that liberty would come to all slaves inevitably, since slave-holding was such an expense to the plantation owners. But the cotton gin, which removed the seeds rapidly—theretofore done by slow and laborious hand process—suddenly made the raising of cotton so profitable that slaves were again employed in its production with great financial benefits. And thus it came about that the cotton plant innocently wielded a great influence in the political, as well as the industrial life of our country.

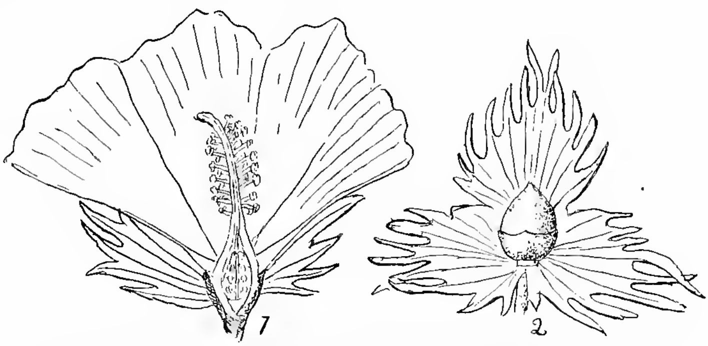
The cotton plant has a taproot, with branches which go deep into the soil. The stem is nearly cylindrical, the branches often spreading and sometimes irregular; the bark is dark and reddish; the wood is white. In Egypt, and probably in other arid countries, the stalks are gathered for fuel in winter.

The leaves are alternate, with long petioles. The upper leaves are deeply cut, some having five, some seven, some three, and some even nine lobes; strong veins extend from the petiole along the center of each lobe; the leaves near the ground may not be lobed at all. Where the petiole joins the stem, there is a pair of long, slender, pointed stipules, but they often fall off early. A strange characteristic of the cotton leaves is that they bear nectar-glands; these may be seen on the under side and along the main ribs of the leaf; they appear as little pits in the rib; some leaves may have none, while others may have from one to five. It has been thought that perhaps these glands might attract bees, wasps or ants, which would attack the caterpillars eating the leaves, but this has not been proved. However, many friendly insects get their nectar at these leaf-wells, and here is an opportunity for some young naturalist of the South to investigate this matter and discover what insects come to these glands at all times of day and what they do.

The flower bud is partially hidden beneath the clasping bracts of the involucre. These bracts are three or four in number, and they have the edges so deeply lobed that they seem branched. By pushing back the bracts we can find the calyx, which is a shallow cup with five shallow notches in its rim. The petals are rolled in the bud like a shut umbrella. The open flower has five broadly spreading petals; when the bud first opens in the morning, the petals are whitish or pale yellow with a purplish spot at the base, by noon they are pale pink, by the next day they are a deep purplish red and they fall at the end of the second day. There are nectar-glands also in the flower at the base of the calyx, and the insects are obliged to thrust their tongues between the bases of the petals to reach the nectar; only long-tongued bees, moths and butterflies are able to attain it.

There are many stamens which have their filaments united in a tube extending up into the middle of the flower and enlarging a little at the tip; below the enlarged base of this tube is the ovary which later develops into the cotton-boll; within the stamen-tube extends the long style, and from its tip are thrust out from three to five stigmas like little pennants from the top of a chimney; and sometimes they are more or less twisted together. The young boll is covered and protected by the fringed bracts;

which cover the bud and remain attached to the ripened boll. The calyx, looking like a little saucer, also remains at the base of the boll. The boll soon assumes an elongated, oval shape, with long, pointed tip; it is green outside and covered with little pits, as large as pin points. There are, extending back from the pointed tip, three to five creases or sutures, which show where the boll will open. If we open a nearly ripened boll, we find that half way between each two sutures where the boll will open, there is a partition extending into the boll dividing it into compartments. These are really carpels, as in the core of an apple, and their leaf origin may be plainly seen in the venation. The seeds are fastened by their pointed ends along each side of the central edge of the partition, from which they break away very easily. The number of seeds varies, usually two or three along each side; the young seeds are wrapped in the young cotton, which is a stringy, soft white mass. The cotton fibres are attached to the covering of the seed around the blunt end, and



1, The cotton flower cut in half, showing the stamen-tube at the center, up through which extends the style of the pistil. Note the bracts and calyx.
2, A young boll, with calyx at its base and set in the involucral bracts.

usually the pointed end is bare. When the boll opens, the cotton becomes very fluffy and if not picked will blow away; for this cotton fibre is a device of the wild cotton for disseminating its seeds by sending them off on the wings of the wind. Heavy winds at the cotton-picking time, are a menace to the crop and often occasion serious loss.

The mechanism of the opening of the cotton-boll is very interesting; along the central edge of each partition and extending up like beaks into the point of the boll, is a stiff ridge, about the basal portion of which the seeds are attached; as the boll becomes dry, this ridged margin becomes as stiff as wire and warps outward; at the same time, the outside of the boll is shriveling. This action tears the boll apart along the sutures and exposes the seeds with their fluffy balloons to the action of the wind. The ripe, open, empty boll is worth looking at; the sections are wide apart and each white, delicate, parchment-like partition, or carpel, has its wire edge curved back gracefully. The outside of the boll is brown and shriveled, but inside it is still white and shows that it had a soft lining for its "seed babies."

The amount of the cotton crop per acre varies with the soil and climate; the amount that can be picked per day also depends upon the cotton as well as the picker. Children have been known to pick one hundred pounds per day, and a first-class picker from five hundred to six hundred pounds, or even eight hundred; one man has made a record of picking sixty pounds in an hour. Cotton is one of the most important crops grown in America, and there are listed more than one hundred and thirty varieties which have originated in our country.

References—The various bulletins of the United States Department of Agriculture and of the experiment stations of the Southern States. The most complete of these is Bulletin No. 33, Office of Experiment Stations, U. S. Dept. of Agriculture, published in 1896.

LESSON CLXX

Cotton

Leading thought—Cotton has had a great influence upon our country politically as well as industrially. Its fibre was used by the ancients, and it is to-day one of the most important crops in the regions where it is grown.

A donkey laden with cotton stalks in Cairo, Egypt, the bundles to be sold for fuel.
Photo by J. H. Comstock.

Method—A cotton plant with blossoms and ripe bolls upon it may be brought into the schoolroom or studied in the field.

Observations—1. How many varieties of cotton do you know? Which kind is it you are studying?

2. What sort of root has the cotton plant? Does it go deep into the soil?

3. How high does the plant grow? Are the stems tough or brittle? What is the color of the bark? Of the wood? Do you know of a country where cotton stalks are used for fuel? Do the stem and branches grow erect or very spreading?

4. Are the leaves opposite or alternate? Are the petioles as long as the leaves? Are there any stipules where the petioles join the main stem? How many forms of leaves can you find on the same stem? How do the upper differ from the lower leaves? Describe or sketch one of the large upper leaves, paying especial attention to the veins and the shape of the lobes.

5. Look at the lower side of a leaf and find, if you can, a little pit on the midrib near its base. How many of these pits can you find on the veins of one leaf? What is the fluid in these pits? Taste it and see if it is sweet. Watch carefully a growing plant and describe what insects you find feeding on this nectar. Note if the wasps and ants, feeding on this nectar, attack the caterpillars of the cotton worm which destroy the leaf. Where are the nectar-glands of plants usually situated?

6. Study the flower bud; what covers it? How many of these bracts cover the flower bud? What is their shape and how do their edges look? Push back the bracts and find and describe the calyx. How are the petals folded in the bud?

7. Take the open flower; how many petals are there, and what is their shape? At what time of day do the flowers open? What color are the petals when the flowers first open? What is their color later in the day? What is their color the next day? When do the petals fall?

8. Describe the stamens; how are they joined? How are the anthers situated on the stamen-tube? Is the stamen-tube perfectly straight or does it bend at the tip?

9. Peel off carefully the stamen-tube and describe what you find within it. How many stigmas come out of the tip of the tube? Find the ovary below the stamen-tube. Which part of the flower grows into the cotton-boll?

10. Take a boll nearly ripe; what covers it? Push away the bracts; can you find the calyx still present? What is the shape of the boll? What is its color and texture? Can you see the creases where it will open? How many are there of these?

11. Open a nearly ripe boll very carefully. How many partitions are there in it? Where are they in relation to the openings? Gently push back the cotton from the seeds without loosening them, and describe how the seeds are connected with the partitions. Is the seed attached by its pointed or blunt end?

12. How many seeds in each chamber in the cotton boll? Where on the seed does the cotton grow? How does the cotton blanket wrap about the seed? If the cotton is not picked what happens to it? Of what use to the wild cotton plant are seeds covered with cotton?

13. What makes the cotton-boll open? Describe an open and empty boll outside and inside.

14. How much cotton is considered a good crop per acre in your vicinity? How much cotton can a good picker gather in a day?

15. Write English themes on the following topics: "The history of the cotton plant from ancient times until to-day," "How the cotton plant has affected American history."

"Queen-consort of the kingly maize,
The fair white cotton shares his throne,
And o'er the Southland's realm she claims
A just allegiance, all her own."

—Minnie Curtis Wait.

Photo by Verne Morton

THE STRAWBERRY

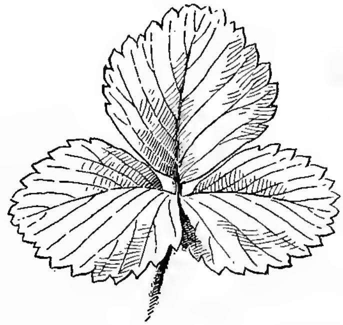
Teacher's Story

Of all the blossoms that clothe our open fields, one of the prettiest is that of the wild strawberry. And yet so influenced is man by his stomach that he seldom heeds this flower except as a promise of a crop of strawberries. It is comforting to know that the flowers of the field "do not care a rap" whether man notices them or not; insect attentions are what they covet, and they are surely as indifferent to our indifference as it is to them.

The field strawberry's five petals are little cups of white held up protectingly around a central treasure of anthers and pistils; each petal has its base narrowed into a little stem, which the botanists call a claw. When the blossom first opens, the anthers are little, flat, vividly lemon-yellow discs, each disc consisting of two clamped together sternly and determinedly as if they meant never to open and yield their gold dust. At the very center of the flower is a little, greenish yellow cone, which if we examine with a lens, we can see is made up of many pistils set together, each lifting up a little, circular, eager stigma high as ever it can reach. Whether all the stigmas receive pollen or not determines the formation of a good strawberry.

The sepals are slender and pointed and seem to be ten in number, every other one being smaller and shorter than its neighbors; but the five shorter ones are not sepals but are bracts below the calyx. The sepals unite at their bases so that the strawberry has really a lobed calyx instead of separate sepals. The blossom stem is soft, pinkish and silky and wilts easily. There are several blossoms borne upon one stem and the central one opens first.

The strawberry leaf is beautiful; each of its three leaflets is oval, deeply toothed, and has strong regular veins extending from the midrib to the tip of each tooth. In color it is rich, dark green and turns to wine-color in autumn. It has a very pretty way of coming out of its hairy bud scales, each leaflet folded lengthwise and the three pressed together. Its whole appearance then, is infantile in the extreme, it is so soft and helpless looking. But it soon opens out on its pink, downy stem and shows the world how beautiful a leaf can be.



Strawberry leaf.

Pistillate flower above. Perfect flower below.

If a comparison of the wild and cultivated strawberries is practicable, it makes this lesson more interesting. Much tillage an d food have caused the cultivated blossoms to double, and they may often have seven or eight petals. And while the wild flowers are usually perfect, many cultivated varieties have the pollen and pistils borne in different flowers, and they depend upon the bees to carry their pollen. The blossom stem of the garden strawberry is round, smooth and quite strong, holding its branching panicle of flowers erect, and it is usually shorter than the leaf stems among which it nestles. The flowers open in a series, so that ripe and green fruit, flowers and buds may often be found on the same stem. As the strawberry ripens, the petals and stamens wither and fall away; the green calyx remains as the hull, which holds in its cup the pyramid of pistils which swell and ripen into the juicy fruit. To the botanists the strawberry is not a berry, that definition being limited to fruits having a juicy pulp and containing many seeds, like the currant or grape. The strawberry is a fleshy fruit bearing its seed in shallow pits on its surface. These seeds are so small that we do not notice them when eating the fruit, but each one is a tiny nut, almond-shaped, and containing within its tough, little shell a starchy meat to sustain the future plant which may grow from it. It is by planting these seeds that growers obtain new varieties.

The root of the strawberry is fibrous and threadlike. When growers desire plants for setting new strawberry beds they are careful to take only such as have light colored and fresh-looking roots. On old plants the roots are rather black and woody and are not so vigorous.

The stem of the strawberry is partially underground and so short as to be unnoticeable. However, the leaves grow upon it alternately one above another, so that the crown rises as it grows. The base of each leaf has a broad, clasping sheath which partly encircles the plant and extends upward in a pair of earlike stipules.

The runners begin to grow after the fruiting season has closed; they originate from the upper part of the crown; they are strong, fibrous and hairy when young. Some are short between joints, others seem to reach far out as if seeking for the best location before striking root; a young plant will often have several leaves before putting forth roots. Each runner may start one or more new strawberry plants. After the young plant has root growth so as to be able to feed itself, the runner ceases to carry sap from the main stem and withers to a mere dry fiber. The parent plant continues to live and bear fruit, for the strawberry is a perennial, but the later crops are of less value. Gardeners usually renew their plots each year, but if intending to harvest a second year's crop, they cut off the runners as they form.

Strawberry fruit.

LESSON CLXXI

The Strawberry

Leading thought—The strawberry plant has two methods of perpetuating itself, one by the seeds which are grown on the outside of the strawberry fruits, and one by means of runners which start new plants wherever they find place to take root.

Method—It would be well to have a strawberry plant, with roots and runners attached, for an observation lesson by the class. Each pupil should have a leaf, including the clasping stipules and sheath at its base. Each one should also have a strawberry blossom and bud, and if possible a green or ripe fruit.

Observations—1. What kind of root has the strawberry? What is its color?

2. How are the leaves of the strawberry plant arranged? Describe the base of the leaf and the way it is attached to the stem. Has each leaflet a pedicel or stem of its own? How many leaflets are there? Sketch a strawberry leaf, showing the edges and form of the leaflets, and the veins.

3. From what part of the plant do the runners spring? When do the runners begin to grow? Does the runner strike root before forming a new plant or does the little plant grow on the runner and draw sustenance from the parent plant?

4. What happens to the runners after the new plants have become established? Does the parent plant survive or die after it sends out many runners?

5. Describe the strawberry blossom. How many parts are there to the hull or calyx? Can you see that five of these are set below the other five?

6. How many petals has it? Does the number differ in different flowers? Has the wild strawberry as many petals as the cultivated ones?

7. Study with a lens the small green button at the center of the flower. This is made up of pistils so closely set that only their stigmas may be seen. Do you find this button of pistils in the same blossom with the stamens? Does the wild blossom have both stamens and pistils in the same flower?

8. Describe the stamens. What insects carry pollen for the strawberry plants?

9. Are the blossoms arranged in clusters? Do the flowers all open at the same time? What parts of the blossom fall away and what parts remain when the fruit begins to form?

10. Are the fruits all of the same shape and color? Is the pulp of the same color within as on the surface? Has the fruit an outer coat or skin? What are the specks on its surface?

11. How many kinds of wild strawberries do you know? How many kinds of cultivated strawberries do you know?

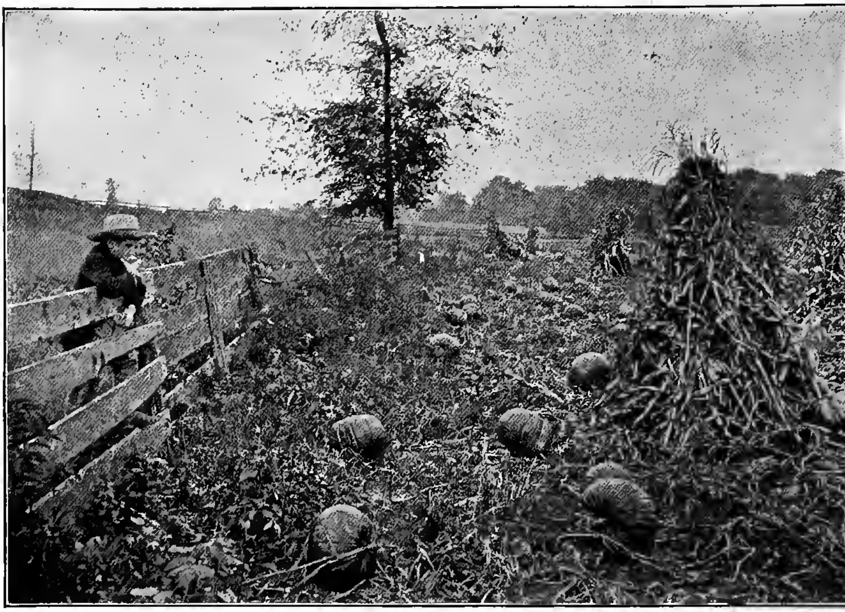
12. Describe how you should prepare, plant and care for a strawberry bed.

THE PUMPKIN

Teacher's Story

If the pumpkin were as rare as some orchids, people would make long pilgrimages to look upon so magnificent a plant. Although it trails along the ground, letting Mother Earth help it support its gigantic fruit, yet there is no sign of weakness in its appearance; the vine stem is strong, ridged, spiny and purposeful. And the spines upon it are surely a protection under some circumstances, for I remember distinctly when, as children, bare-footed and owning the world, we "played Indian" and found our ambush in the long rows of ripening corn, we skipped over the pumpkin vines, knowing well the punishment they inflicted on the unwary feet.

From the hollow, strongly angled stem arise in majesty the pumpkin leaves, of variously lobed patterns, but all formed on the same decorative plan. The pumpkin leaf is as worthy of the sculptor's chisel as is that of the classic *acanthus;* it is palmately veined, having from three to five lobes, and its broad base is supported for a distance on each side of the angled petiole by the two basal veins. The leaves are deep green above, paler below and are covered on both sides with minute bristles, and their edges are finely toothed. The bristly, angled stem which lifts it aloft is a

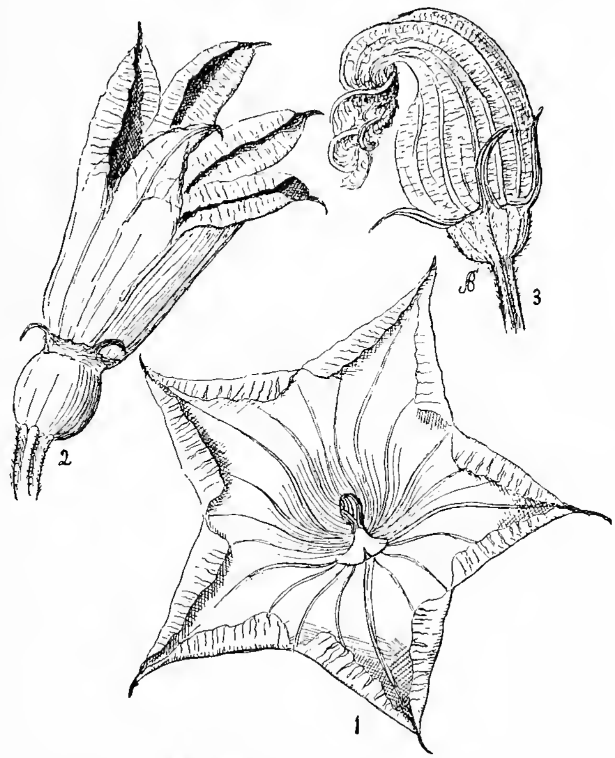


"When the frost is on the punkin and the fodder's in the shock."
Photo by Verne Morton.

quite worthy support for so beautiful a leaf. And, during our childhood, it was also highly esteemed as a trombone, for it added great richness of quality to our orchestral performances, balancing the shrillness of the basswood whistle and the sharp buzzing of the dandelion-stem pipe.

Growing from a point nearly opposite a leaf, may be seen the pumpkin's elaborate tendril. It has a stalk like that of the leaf, but instead of the leaf blade it seems to have the three to five naked ribs curled in long, small coils very even and exact. Perhaps, at some period in the past, the pumpkin vines lifted themselves by clinging to trees, as do the gourd vines of to-day. But the pumpkin was cultivated in fields with the maize by the North American Indians, long before the Pilgrim Fathers came to America, to make its fruit into pies. Since the pumpkin cannot sustain itself in our Northern climate without the help of man, it was evidently a native of a warmer land; and, by growing for so long a time as a companion of the corn, it has learned to send its long stems out for many feet, resting entirely upon the ground. But, like a conservative, elderly maiden lady, it still wears corkscrew curls in memory of a fashion, long since obsolete. Occasionally, we see the pumpkin vines at the edge of the field pushing out and clambering over stone piles, and often attempting to climb the rail fences, as if there still remained within them the old instinct to climb.

But though its foliage is beautiful, the glory of the pumpkin is its vivid yellow blossom and, later, its orange fruit. When the blossom first starts on its career as a bud, it is enfolded in a bristly, ribbed calyx with five stiff, narrow lobes, which close up protectingly about the green, cone-shaped bud, a rib of the cone appearing between each two lobes of the calyx. If we watch one of these buds day after day, we find that the green cone changes to a yellow color and a softer texture as the bud unfolds, and then we discover that it is the corolla itself; however, these ribs which extend out to the tip of the corolla-lobes remain greenish below, permanently. The expanding of the flower bud is a pretty process; each lobe, supported by a strong midrib, spreads out into a five-pointed star, each point being very sharp and angular because, folded in along these edges in one of the prettiest of Nature's hems, is the ruffled margin of the flower. Not until the sun has shone upon the star for some little time of a summer morning, do these turned-in margins open out; and, late in the afternoon or during a storm, they fold down again neatly before the lobes close up; if a bee is not lively in escaping she may, willy-nilly, get a night's lodging, for these folded edges literally hem her in.



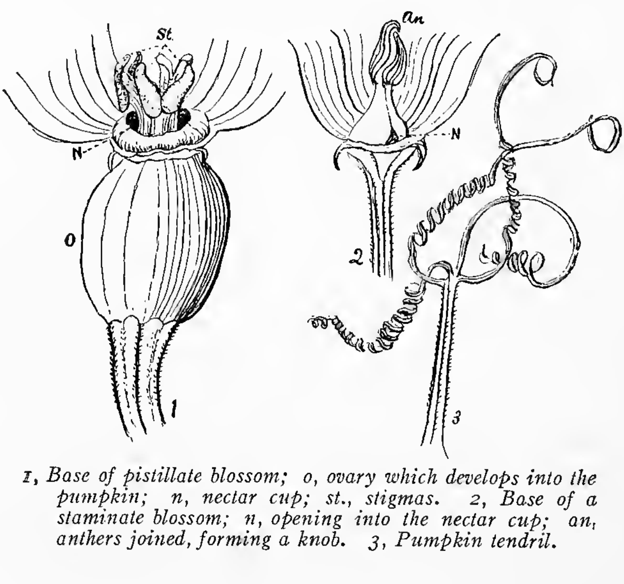
The closing of a pumpkin flower.
1, Staminate flower beginning to close; note the folded edges of the lobes 2, Pistillate flower nearly closed. 3, Staminate flower closed and in its last stage.

The story of the treasure at the heart of this starry, bell-shaped flower is a double one, and we had best begin it by selecting a flower that has below it a little green globe—the ovary—which will later develop into a pumpkin. At the heart of such a flower there stand three stigmas, that look like liliputian boxing-gloves; each is set on a stout, postlike style, which has its base in a great nectar-cup, the edges of which are slightly incurved over its welling sweetness. In order to reach this nectar, the lady bee must stand on her head and brush her pollen-dusted side against the greedy stigmas. Professor Duggar has noted that in dry weather the margins of this nectar-cup contract noticeably, and that in wet weather the stigmas close down as if the boxing-gloves were on closed fists.

The other half of the pumpkin-blossom story is to be found in the flowers which have no green globes below them, for these produce the pollen. Such a flower has at its center a graceful pedestal with a broad

The staminate blossom of the pumpkin, showing the anther knob at the center. A bud of the staminate flower; and a closed blossom at the right.
Photo by Verne Morton.

base and a slender stem, which upholds a curiously folded, elongate knob, that looks like some ancient or primitive jewel wrought in gold. The corrugations on its surface are the anther-cells, which are curiously joined and curved around a central oblong support; by cutting one across, we can see plainly the central core, bordered by cells filled with pollen. But where is the nectar well in the smooth cup of this flower? Some have

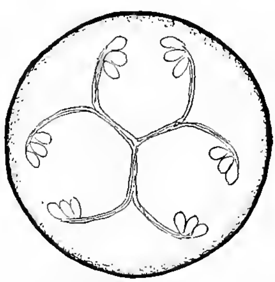


1, Base of pistillate blossom; o, ovary which develops into the pumpkin; n, nectar cup; st., stigmas. 2, Base of a staminate blossom; n, opening into the nectar cup; an, anthers joined, forming a knob. 3, Pumpkin tendril.

maintained that the bees visit this flower for the sake of the pollen, but I am convinced that this is not all of the story. In the base of the pedestal which supports the anther knob there appear, after a time, three inconspicuous openings; and if we watch a bee, we shall see that she knows these openings are there and eagerly thrusts her tongue down through them. If we remove the anthers and the pedestal, we shall find below the latter, a treasure cave; it is carpeted with the softest of buff velvet, and while it does not reek with nectar, as does the cup which encompasses the styles of the pistil, yet it secretes enough of the sweet fluid so that we can taste it distinctly. Thus, although the bees find pollen in this flower they also find there, nectar. The pumpkin is absolutely dependent upon the work of bees and other insects for carrying its pollen from the blossom that bears it to the one which needs it, as this is the only way that the fruit may be developed.

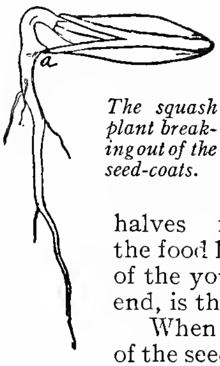
And after the pollen has been shed and delivered, the flower closes, this time with an air of finality. The fading corolla looks as if its lobes had been twisted about by the thumb and finger to secure tightness; and woe betide the bee caught in one of these prisons, unless she knows how to cut through its walls or can find within, sustenance to last until the withered flower falls. The young pumpkin is at first held up by its stiff stem but later rests upon the ground.

The ripe pumpkin is not only a colossal but also a beautiful fruit. The glossy rind is brilliant orange and makes a very efficient protection for the treasures within it. The stem is strong, five-angled and stubborn, and will not let go its hold until the fruit is over-ripe. It then leaves a star-shaped scar to match the one at the other end of the fruit, where once the blossom sat enthroned. The pumpkin in shape is like a little world flattened at the poles, and with the lines of longitude creased into its surface. But the number of these longitudinal creases varies with individual pumpkins, and seems to have no relation to the angles of the stem or the three chambers within.



Section of a pumpkin just after the blossom has fallen. Note how the seeds are borne.

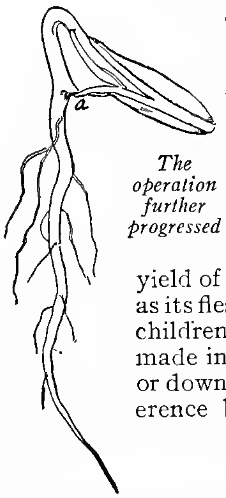
If we cut a small green pumpkin across, we find the entire inside solid There are three fibrous partitions extending from the center, dividing the pulp into thirds; at its outer end each partition divides, and the two ends curve in opposite directions. Within these curves the seeds are borne. A similar arrangement is seen in the sliced cucumber. As the pumpkin ripens, the partitions surrounding the seeds become stringy and very different from the "meat" next to the rind, which makes a thick, solid outer wall about the central chamber, where, within its "groined arches" are contained six rows of crowded seeds, attached by their pointed tips and supported by a network of yellow, coarse fibers—like babies supported in hammocks. All this network, making a loose and fibrous core, allows the seeds to fall out in a mass when the pumpkin is broken. If we observe where the cattle have been eating pumpkins we find these masses of seeds left and trampled into the mud, where, if our winter climate permitted, they could grow into plants next year.



The squash plant breaking out of the seed-coats.

The pumpkin seed is attached by its pointed end; it is flat, oblong and has a rounded ridge at its edge, within which is a delicate "beading." The outside is very mucilaginous; but when wiped dry, we can see that it has an outer, very thin, transparent coat; a thicker white, middle coat; while the meat of the seed is covered with a greenish, membranous coat. The meat falls apart lengthwise and flatwise, the two halves forming later the seed-leaves and containing the food laid up by the "pumpkin mother" for the nourishment of the young plant. Between these two halves, at the pointed end, is the germ, which will develop into a new plant.

When sprouting, the root pushes out through the pointed end of the seed and grows downward. The shell of the seed is forced open by a little wedge-shaped projection, while the seed-leaves are pulled from their snug quarters. In watching one of these seeds sprout, it is difficult not to attribute to it conscious effort, while it is sturdily pulling hard to release its seed-leaves. If it fails to do this, the seed shell clamps the seed-leaves together like a vise, and the little plant is crippled.



The operation further progressed

Both squashes and pumpkins figure in the spicy Thanksgiving pies, but the chief value of the pumpkin crop in America is as food for milch cows; it causes a yield of milk so rich, that the butter made from it is as golden as its flesh. But the Hallow-e'en jack o'lantern appeals to the children. In this connection, a study of expression might be made interesting; the turning of the corners of the mouth up or down, and the angles of the eyebrows, making all the difference between a jolly grin and an "awful face."

LESSON CLXXII
The Pumpkin

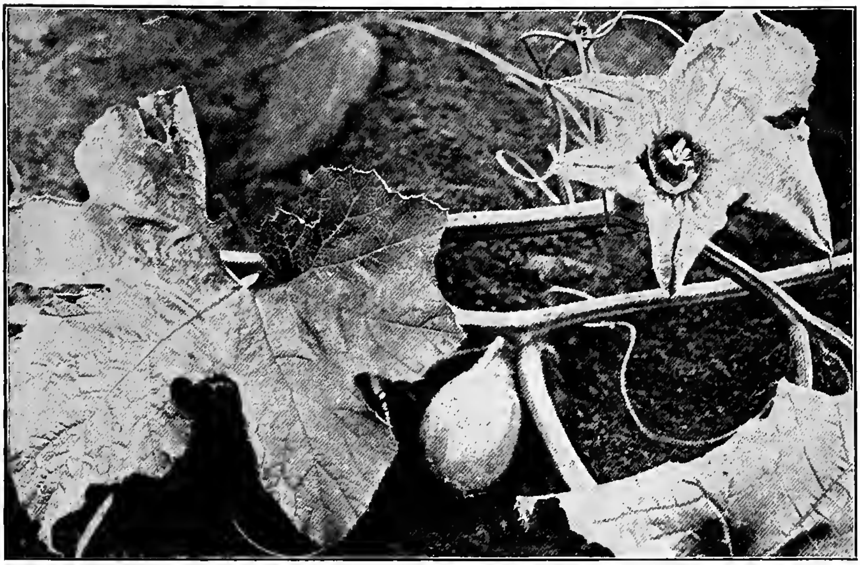
Leading thought—The pumpkin and squash were cultivated by the American Indians in their cornfields long before Columbus discovered the new world. The flowers of these plants depend entirely upon insects for carrying their pollen, and are unable to develop their fruit without this aid.

Method—This work may be done in the garden or field in September or early October; or a vine bearing both kinds of flowers, leaves and tendrils may be brought to the schoolroom for observation. The lesson on the pumpkin fruit may be given later. A small green pumpkin should be studied with the ripe one, and also with the blossoms, so as to show the position of the seeds during development. This lesson can be modified to fit the cucumber, the melon and the squash.

The Pumpkin Vine and Flowers

Observations—1. How many different forms of flowers do you find on a pumpkin vine? What are the chief differences in their shape?

2. Look first at the flowers with the long slender stems: What is the shape and color of the blossom? How many lobes has it? Is each lobe



Partially closed pistillate blossom at the right, showing the stigmas and the nectar-cup at the center. Note the young pumpkin and the beautiful leaf; note also the angular, spiny stems.

Photo by Verne Morton.

distinctly ribbed or veined? Is the flower smooth on the inner and the outer surface? Are the edges of the lobes scalloped or ruffled?

3. What do you see at the bottom of the golden vase of this flower? This yellow club, or knob, is formed by the joining of three anthers, one of which is smaller than the others. Do all the pumpkin flowers have this knob at the center? Look at the base of the standard which bears the anther-knob, and note if there are some openings; how many? Cut off the anther pedestal, and describe what is hidden beneath it. Note if the bees find the openings to the nectar-well and probe there for the nectar. Do they become dusted with pollen while seeking the nectar?

4. What color is the pollen which is clinging to the anther? Is it soft and light, or moist and sticky? Do you think that the wind would be able to lift it from its deep cup and carry it to the cup of another flower?

5. Describe the calyx behind this pollen-bearing flower. How many lobes has it? Are the lobes slender and pointed?

6. Find one of the flowers which has below it a little green globe, which will later develop into a pumpkin. How does this flower differ from the one that bears the pollen?

7. Describe or sketch the pistil which is at the bottom of this flower vase. Into how many lobes does it divide? Do these three stigmas face outward, or toward each other? Are the styles which uphold the stigmas short or long? Describe the cup in which they stand. Break away a bit of this little yellow cup and taste it. Why do you think the pumpkin flowers need such a large and well-filled nectary? Could insects get the nectar from the cup without rubbing against the stigmas, the pollen with

which they became so thoroughly dusted when they visited the staminate flowers?

8. Cut through the center of one of the small green pumpkins. Can you see into how many sections it is divided? Does the number of seed-clusters correspond with the number of stigmas in the flower? Make a sketch of a cross-section, showing where the seeds are placed.

9. What insects do you find visiting the pumpkin flowers?

10. Carefully unfold a flower bud which is nearly ready to open, and note how it is folded. Then notice late in the afternoon how the flower closes. What part is folded over first? What next? How does it look when closed?

11. Describe the stems of the pumpkin vine; how are they strengthened and protected? Sketch or describe a pumpkin leaf.

12. Describe one of the tendrils of the pumpkin vine. Do you think that these tendrils could help the vine in climbing? Have you ever found a pumpkin vine climbing up any object?

The Pumpkin Fruit

Observations—1. Do you think the pumpkin is a beautiful fruit? Why? Describe its shape and the way it is creased. Describe the rind, its color and its texture, and tell how it protects the fruit. Describe the stem; does it cling to the pumpkin? How many ridges in the stem where it joins the vine? How many where it joins the pumpkin? Which part of the stem is larger? Does this give it a firmer hold?

A closed pistillate flower of the pumpkin.
Photo by Verne Morton.

2. Cut in halves crosswise a small green pumpkin and a ripe one. Which is the most solid? Can you see how the seeds are borne in the green pumpkin? How do they look in the ripe pumpkin? What is next to the rind in the ripe fruit? What part of the pumpkin do we use for pies?

3. Can you see in the ripe pumpkin where the seeds are borne? How are they suspended? How many rows of seeds lengthwise of the pumpkin? Of what use could it be to the pumpkin to have the seeds thus suspended within it by these threads or fibers? What is left of a pumpkin after the cattle have eaten it? Might the seeds thus left plant themselves?

4. Is the pumpkin seed attached at the round, or the pointed, end? Describe the pumpkin seed its shape and its edges? How does it feel when first taken from the pumpkin? How many coats has the seed?

5. Describe the meat of the seed? Does it divide naturally into two parts? Can you see the little germ? Have you ever tried roasting and salting pumpkin and squash seeds, to prepare them for food as almonds and peanuts are prepared?

6. Plant a pumpkin seed in damp sand and give it warmth and light. From which end does it sprout? What comes first, the root or the leaves? What part of the seed forms the seed-leaves?

7. Describe how the pumpkin sprout pries open the shell to its seed, in order to get its seed-leaves out. What happens if it does not pull them out? Which part of the seedling pumpkin appears above ground first?

8. How do the true leaves differ in shape from the seed-leaves. What is the use of the seed-leaves to the plant?

Ah! on Thanksgiving day, when from East and from West,
From North and from South come the pilgrim and guest,
When the gray-haired New-Englander sees round his board
The old broken lines of affection restored,
When the care-wearied man seeks his mother once more,
And the worn matron smiles where the girl smiled before,
What moistens the lip and brightens the eye?
What calls back the past, like the rich Pumpkin pie?

Oh, fruit loved of boyhood! the old days recalling,
When wood-grapes were purpling and brown nuts were falling
When wild, ugly faces we carved in its skin,
Glaring out through the dark with a candle within!
When we laughed round the corn-heap, with hearts all in tune,
Our chair a broad pumpkin—our lantern the moon,
Telling tales of the fairy who travelled like steam,
In a pumpkin-shell coach, with two rats for her team!

—J. G. Whittier.

FLOWERLESS-PLANT STUDY

FERNS

MANY interesting things about ferns may be taught to the young child, but the more careful study of these plants is better adapted to the pupils in the higher grades, and is one of the wide-open doors that leads directly from nature-study to systematic science. While the pupils are studying the different forms in which ferns bear their fruit, they can make collections of all the ferns of the locality. Since ferns are easily pressed and are beautiful objects when mounted on white paper, the making of a fern herbarium is a delightful pastime; or leaf-prints may be made which give beautiful results (see page 734); but, better perhaps, than either collections or prints, are pencil or water-color drawings with details of the fruiting organs enlarged. Such a portfolio is not only a thing of beauty but the close observation needed for drawing brings much knowledge to the artist.

References.—Our Ferns in Their Haunts, W. N. Clute, (of greatest value to teachers because it gives much of fern literature); How to Know the Ferns, Parsons; Ferns, Waters; New England Ferns, Eastman.

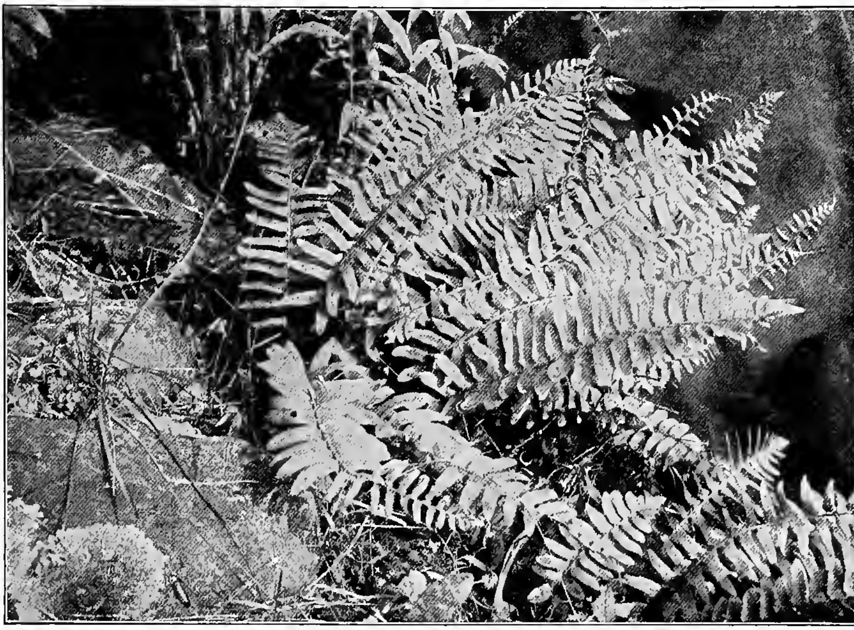
THE CHRISTMAS FERN

Teacher's Story

"No shivering frond that shuns the blast sways on its slender chaffy stem;
Full veined and lusty green it stands, of all the wintry woods the gem."

—W. N. Clute.

The rootstock of the fern is an humble example of "rising on stepping stones of our dead selves," this being almost literally true of the tree-ferns. The rootstock which is a stem and not a root—has, like other stems, a growing tip from which, each year, it sends up into the world several beautiful green fronds, and numerous rootlets down into the earth. These graceful fronds rejoice the world and our eyes for the summer, and make glad the one who, in winter, loves to wander often in the woods to inquire after the welfare of his many friends during their period of sleeping and waking. These fronds, after giving their message of winter cheer, and after the following summer has made the whole woodland green and the young fronds are growing thriftily from the tip of the rootstock, die down, and in midsummer we can find the old fronds lying sere and brown, with broken stipes, just back of the new fern clump; if we examine the rootstock we can detect behind them, remains of the stems of the fronds of year before last; and still farther behind we may trace all the stems of fronds which gladdened the world three years ago. Thus we learn that

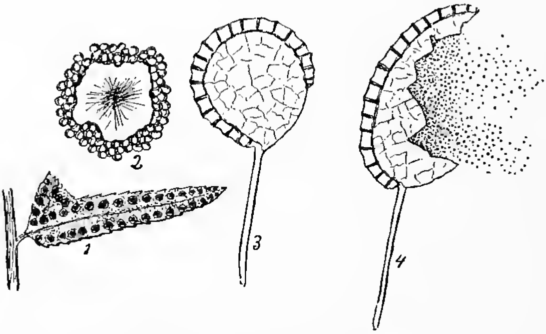


The Christmas fern. The contracted tips of some of the fronds consist of fruiting pinnæ.
Photo by Verne Morton.

this rootstock may have been creeping on an inch or so each season for many years, always busy with the present and giving no heed to its dead past. One of the chief differences between our ferns and the tree-ferns of the tropics, which we often see in greenhouses, is that in the tree-fern the rootstock rises in the air instead of creeping on, or below, the surface of the ground. This upright rootstock of the tree-fern also bears fronds at its tip, and its old fronds gradually die down, leaving it rough below its crown of green plumes.

The Christmas fern has its green stipe, or petiole, and its rachis, or midrib, more or less covered with ragged, brownish scales, which give it an unkempt appearance. Its pinnæ, or leaflets, are individually very pretty; in color they are dark, shining green, lance-shaped, with a pointed lobe or ear at the base projecting upward. The edges of the pinnæ are delicately toothed, each point armed with a little spine, and the veins are fine, straight and free to the margin; the lower pinnæ often have the earlike lobe completely severed.

In studying a fertile fern from above, we notice that about a dozen pairs of the pinnæ near the tip are narrowed and roughened and are more distinctly toothed on the margins. Examining them underneath, we find on each a double row of circular raised dots which are the fruit-dots, or sori; there is a row between the midrib and margin on each side, and also a double row extending up into the point at the base. Early in the season these spots look like pale blisters, later they turn pale brown, each blister having a depression at its center; by the middle of June, masses of tiny globules, not larger than pin points, push out from beneath the margin of these dots. The blisterlike membrane is simply a cover for the growing spores, and is called the *indusium;* by July it shrivels into an irregular scroll, still clinging to the pinnule by its depressed center; and by this time the profusion of tiny globules covers the entire under side of the pinna like a brown fuzz. If we scrape off some of this fuzz and examine it with a lens, we can see that it consists of numberless little globules, each with a stem to attach it to the leaf; these are the spore-cases, or sporangia, each globule being packed full of spores which, even through the lens, look like yellowish powder. But each particle of this dust has its own structure and contains in its heart the living fern-substance.



1. Fertile leaflet of Christmas fern showing indusia and spore-cases. 2. An indusium and spore-cases, enlarged. 3. A spore-case, enlarged. 4. A spore-case discharging spores, enlarged.

Not all the fronds of the fern clump bear these fruit-dots. The ones we select for decoration are usually the sterile fronds, for the fertile ones are not so graceful, and many ignorant people think the brown spore-cases are a fungus. The Christmas fern being evergreen and very firm in tex-

The common polypody often mistaken for the Christmas fern.
Photo by Verne Morton.

ture, is much used in holiday decoration, hence its common name, which is more easily remembered than *Polystichum acrostichoides*, which is its real name. It loves to grow in well-shaded woodlands, liking better the trees which shed their leaves than the evergreens; it is indeed well-adapted to thrive in damp, cold shade; it is rarely found on slopes which face the south, and sunshine kills it.

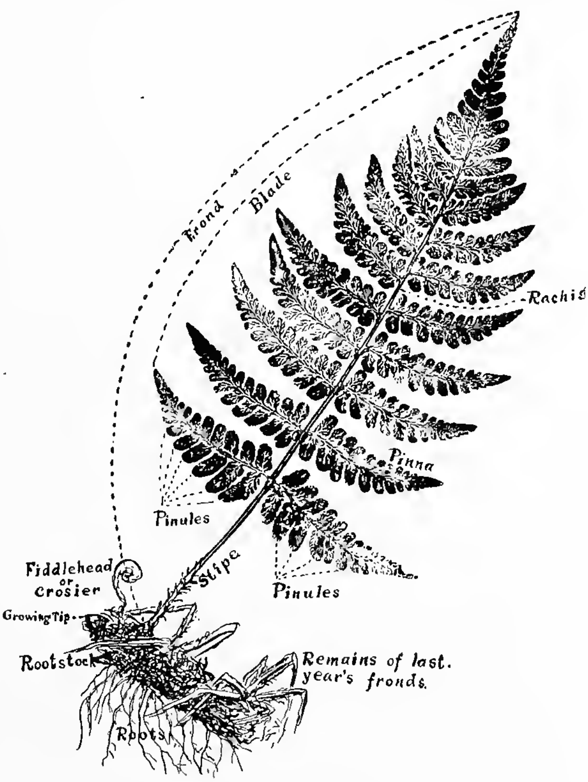
LESSON CLXXIII

The Christmas Fern

Leading thought—The fern has a creeping underground stem called the rootstock, which pushes forward and sends up fresh fronds each year. Some of the fronds of the Christmas fern bear spores on the lower surface of the terminal pinnæ.

Method—This lesson should be given during the latter part of May, when the fruit-dots are still green. Take up a fern and transplant it, in a dish of moss, in the schoolroom, and later plant it in some convenient shady place. The pupils should sketch the fertile frond from the upper side so as to fix in their minds the contracted pinnæ of the tip; one of the lower pinnæ should be drawn in detail, showing the serrate edge, the ear and the venation. The teacher should use the following terms constantly and insistently, so as to make the fern nomenclature a part of the school vocabulary, and thus fit the pupils for using fern manuals.

A *frond* is all of the fern which grows on one stem from the rootstock; the *blade* is that portion which bears leaflets; the *stipe* is the stem or petiole; the *rachis* is the midrib and is a continuation of the stipe; the *pinnule* is a leaflet of the last division; the *pinna* is a chief division of the midrib or rachis, when the fern is compound; the *sori* are the fruit dots; the *indusium* is the membrane covering the fruiting organs; the *sporangia* are the tiny brown globules, and are the spore-



Leaf-print of a fern with the parts named. This fern is twice pinnate.

cases; the *spores* make up the fine dust which comes from the spore-cases. It would be well to make a diagram on the blackboard of the fern with its parts named, so that the pupils may consult it while studying ferns.

Observations — 1. Study a stump of the Christmas ferns. Are there any withered fronds? Where do they join the rootstock? Do the green fronds come from the same place on the rootstock as the withered ones? Do the green ferns come from near the tip of the rootstock? Can you find the growing tip of the rootstock? Can you trace back and find where the fronds of last year and year before last grew? Does that part of the rootstock seem alive now? Can you find the true root of the fern?

2. Take a frond of the Christmas fern. Is the stem, or stipe, and the midrib, or rachis, smooth or rough? What color are the scales of the stalk? Do you think that these scales once wrapped the fern bud?

3. Does each frond of a clump have the same number of pinnæ on each side? Can you find fronds where the pinnæ near the tip are narrower than those below? Take a lower pinna and draw it carefully, showing its shape, its edges and its veins. Is there a point, or ear, at the base of every pinna? Is it a separate lobe or a mere point of the pinna?

4. Take one of the narrow pinnæ near the tip of the frond, and examine it beneath. Can you see some circular, roundish blisterlike dots? Are they dented at the center? How many of these dots on a pinna? Make a little sketch showing how they are arranged on the pinna and on the little earlike point. Look at the fruiting pinnæ of a fern during July, and describe how they look then.

5. Do all the fronds of a fern clump have these narrowed spore-bearing pinnæ? Do you know what those fronds are called that bear the fruit-dots?

6. Where do you find the Christmas fern growing? Do you ever find it in a sunny place? Why is it called the Christmas fern?

FERN SONG

Dance to the beat of the rain, little Fern
And spread out your palms again,
And say, "Tho' the sun
Hath my vesture spun,
He had labored, alas, in vain,
But for the shade
That the Cloud hath made,
And the gift of the Dew and the Rain."
Then laugh and upturn
All your fronds, little Fern,
And rejoice in the beat of the rain!

—John B. Tabb.

THE BRACKEN

Teacher's Story

It is well for the children to study the animals and plants which have a world-wide distribution. There is something comforting in finding a familiar plant in strange countries; and when I have found the bracken on the coast ranges of California, on the rugged sides of the Alps, and in many other far places, I have always experienced a thrill of delightful memories of the fence corners of the homestead farm. Since the bracken is so widespread, it is natural that it should find a place in literature and popular legend. As it clothes the mountains of Scotland, it is much sung of in Scottish poetry. Many superstitions cluster around it—its seed, if caught at midnight on a white napkin, is supposed to render the possessor invisible. Professor Clute, in Our Ferns in Their Haunts, gives a delightful chapter about the relation of the bracken to people.

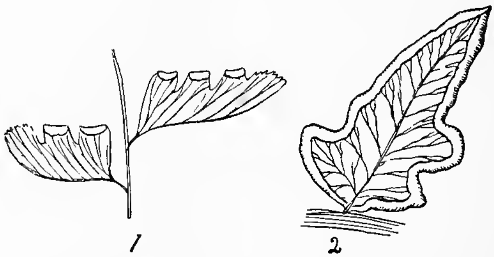
For nature-study purposes, the bracken is valuable as a lesson on the intricate patterns of the fern leaf; it is in fact a lesson in pinnateness. The two lower branches are large and spreading'

Bracken.
Photo by Verne Morton.

and are in themselves often three times pinnate; the branches higher up are twice pinnate; while the main branch near the tip is once pinnate, and at the tip is merely lobed. The lesson, as illustrated in the diagram of the fern, should be well learned for future study, because this nomenclature is used in all the fern manuals. The fact that a pinnule is merely the last division of a frond, whether it be twice or thrice pinnate, should also be understood.

The bracken does not love complete shade and establishes itself in waste places, living contentedly in not too shaded locations; it is especially fond of woodsides, and fence corners on high and cold land. As Professor Clute says, "It is found both in woodland and in the open field; its favorite haunt is neither, but is that half-way ground where man leaves off and nature begins, the copse or the thicket." With us it usually grows about three feet high, but varies much in this respect. The great triangular fronds often measure two or three feet across, and are supposed to bear a likeness to an eagle with spread wings. Its rootstock is usually too deeply embedded in earth for the study of any except the most energetic; it is about the size of a lead pencil and is black and smooth; in its way it is a great traveler, sending up fronds fifteen or twenty feet from its starting place. It also sends off branching rootstocks.

The fruiting pinnules look as if they were hemmed and the edges of the hems embroidered with brown wool; but the embroidery is simply the spore-cases pushing out from under the folded margin which protected them while developing.



1. Fruiting pinnules of the maiden-hair fern, enlarged. 2. Fruiting pinnule of the bracken, enlarged. In both these species the spores are borne under the recurved edges of the pinnules.

Much on which to base necromancy has been found in the figure shown in the cross-section of the stem or stipe. The letter C, supposed to stand for Christ, thus made is a potent protection from witches. But this figure has also been compared to the devil's hoof, an oak tree, or the initial of one's sweetheart, and all these imaginings have played their part in the lives of the people of past ages. It was believed in England that burning the bracken from the fields brought rain; the roots in time of scarcity have been ground and mixed with flour to make bread. The young ferns, or croziers, are sometimes cooked and eaten like asparagus. The fronds have been used extensively for tanning leather and for packing fish and fruit, and when burned their ashes are used instead of soap.

In Europe, bracken grows so rankly that it is used for roof-thatching and for the bedding of cattle. The name "brake," which is loosely used for all ferns, comes from the word "bracken;" some people think that brakes are different from ferns, whereas this is simply a name which has strayed from the bracken to other species. Its scientific name, *Pteris aquilina*, signifies eagle's wing.

LESSON CLXXIV

The Bracken

Leading thought—The bracken is a fern which has taken possession of the world. It is much branched and divided, and it covers the ground in masses where it grows. The edges of its pinnules are folded under to protect the spores.

Method—Bring to the schoolroom large and small specimens of the bracken, and after a study is made tell about the superstitions connected with this fern and as far as possible interest the pupils in its literature.

Observations—1. Do you find the bracken growing in the woods or open places? Do you find it in the cultivated fields? How high does it stand? Could you find the rootstock?

2. Take a bracken frond. What is its general shape? Does it remind you of an eagle with spread wings? Look at its very tip. Is it pinnate or merely lobed? Can you find a place farther down where the leaflets, or pinnules, are not joined at their bases? This is once pinnate. Look farther down and find a pinna that is lobed at the tip; at the base it has distinct pinnules. This is twice pinnate. Look at the lowest divisions of all. Can you find any part of this which is three times pinnate? Four times pinnate? Pinna means feather, pinnate therefore means feathered. If a thing is once pinnate, it means that it has divisions along each side similar to a feather; twice pinnate means that each feather has little feathers along each side; thrice pinnate means that the little feathers have similar feathers along each side, and so on.

3. Can you see if the edges of the pinnules are folded under? Lift up one of these edges and see if you can find what is growing beneath it. How do these folded margins look during August and September?

4. Cut the stem, or stipe, of a bracken across and see the figure in it. Does it look like the initial C? Or a hoof, or an oak tree, or another initial?

5. Discover, if you can, the different uses which people of other countries find for this fern.

HOW A FERN BUD UNFOLDS

Teacher's Story

Of all "plant babies," that of the fern is most cozily cuddled; one feels when looking at it, that not only are its eyes shut but its fists are tightly closed. But the first glance at one of these little woolly spirals gives us but small conception of its marvelous enfolding, all so systematic and perfect that it seems another evidence of the divine origin of mathematics. Every part of the frond is present in that bud, even to the fruiting organs; all the pinnæ and the pinnules are packed in the smallest compass—each division, even to the smallest pinnule, coiled in a spiral towards its base. These coiled fern buds are called crosiers; they are woolly, with scales instead of hairs, and are thus well blanketed. Some botanists object to the comparison of the woolly or fuzzy clothing of young plants with the blankets of human infants. It is true that the young plant is not kept at a higher temperature by this covering; but because of it, transpiration which is a cooling process is prevented, and thus the plant is kept warmer. When the fern commences to grow, it stretches up and seems to lean over backward in its effort to be bigger. First the main stem, or rachis, loosens its coil; but before this is completed, the pinnæ, which are coiled at right angles to the main stem, begin to unfold; a little later the pinnules, which are folded at right angles to the pinnæ, loosen and seem to stretch and yawn before taking a look at the world which they have just entered; it may be several days before all signs of the complex coiling disappear. The crosiers of the bracken are queer looking creatures, soon developing three claws which some people say look like the talons of an eagle; and so intricate is the action of their multitudinous spirals, that to watch them unfolding impresses one as in the presence of a miracle.


Fiddle heads, or crosiers. Young ferns unfolding.
Photo by Verne Morton.

LESSON CLXXV

How A Fern Bud Unfolds

Leading thought—All of the parts of the frond of a fern are tightly folded spirally within the bud, and every lobe of every leaflet is also folded in a spiral.

Method—The bracken crosier is a most illuminating object for this lesson, because it has so many divisions and is so large; it is also convenient, because it may be found in September. However, any fern bud will do. The lesson may be best given in May when the woodland ferns are starting. A fern root with its buds should be brought to the schoolroom, where the process of unfolding may be watched at leisure.

Observations—1. Take a very young bud. How does it look? Do you see any reason why ignorant people call these buds caterpillars? Can you see why they are popularly called "fiddle heads?" What is their true name? How many turns of the coil can you count? What is the covering of the crosier? Do you think this cover is a protection? How is the stem grooved to make the spiral compact?

2. Take a crosier a little further advanced. How are its pinnæ folded? How is each pinnule of each pinna folded? How is each lobe of a pinnule folded? Is each smaller part coiled toward each larger part?

3. Write in your note-book the story of the unfolding fern, and sketch its stages each day from the time it is cuddled down in a spiral until it is a fully expanded frond.

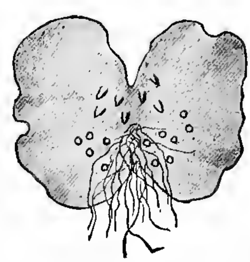
THE FRUITING OF THE FERN

Teacher's Story

"If we were required to know the position of the fruit-dots or the character of the indusium, nothing could be easier than to ascertain it; but if it is required that you be affected by ferns, that they amount to anything, signify anything to you, that they be another sacred scripture and revelation to you, help to redeem your life, this end is not so easily accomplished."—THOREAU.

The walking fern.

THE fern, like the butterfly, seems to have several this-world incarnations; and perhaps the most wonderful of these is the spore. Shake the dust out of the ripened fern and each particle, although too small for the naked eye to see, has within it the possibilities of developing a mass of graceful ferns. Each spore has an outside hard layer, and within this an atom of fern-substance; but it cannot be developed unless it falls into some warm, damp place favorable for its growth; it may have to wait many years before chance gives it this favorable condition, but it is strong and patient and retains its vital power for years. There are cases known where spores grew after twenty years of waiting. But what does this microscopic atom grow into? It develops into a tiny heart-shaped, leaflike structure which botanists call the prothallium; this has on its lower side little roots which reach down into the soil for nourishment; and on its upper surface are two kinds of pockets, one round and the other long. In the round pockets are developed bodies which may be compared to the pollen; and in the long pockets, bodies which may be compared to the ovules of flowering plants. In the case of ferns, water is necessary to float the pollen from the round pockets to the ovules in the long pockets. From a germ thus fertilized in one of the long pockets, a little green fern starts to grow, although it may be several years before it becomes a plant strong enough to send up fronds with spore-dots on them. To study the structure of the spore requires the highest powers of the microscope; and even the prothallium in most species is very small, varying from the size of a pin-head to that of a small pea, and it is therefore quite difficult to find. I found some once on a mossy log that bridged a stream, and I was never so triumphant over any other outdoor achievement. They may be found in damp

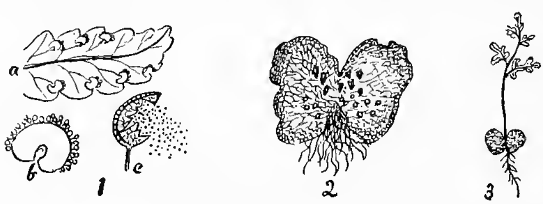


Prothallium, greatly enlarged, showing the two kinds of pockets and the rootlets.

places, in greenhouses, but the teacher will be very fortunate who is able to show her pupils this stage of the fern. The prothallium is a stage of

Christmas fern is below the others.
Photo by Verne Morton.

the fern to be compared to the flower and seed combined in the higher plants; but this is difficult for young minds to comprehend. I like to tell the children that the fern, like a butterfly, has several stages: Beginning with the spore-bearing fern, we next have the spores, next the prothallium stage, and then the young fern. While in the other case we have first the egg, then the caterpillar, then the chrysalis, and then the butterfly. Looking at the ripe fruit-dots on the lower side of the fern leaf, we can easily see with a lens a mass of tiny globules; each one of these is a spore-case, or sporangium, (plural *sporangia*), and is fastened to the leaf by a stalk and has, almost encircling it, a jointed ring. (See figure on page 686).



The life of a fern.

1. *a*, pinna bearing fruit: *b*, a fruit-dot, enlarged, showing spore-cases pushing out around the edges of the indusium, *c*, spore-case, enlarged, showing how it discharges the spores.
2. Prothallium, enlarged.
3. Young fern growing from the prothallium.

When the spores are ripe, this ring straightens out and ruptures the globule, and out fly the spores. By scraping a little of the brown fuzz from a fruiting pinna of the Christmas fern upon a glass slide and placing a cover glass upon it, we find it very easy to examine through the microscope, and we are able thus to find the spore-cases in all stages, and to see the spores distinctly. The spore-cases may also be seen with a hand lens, the spores seeming then to be mere dust.

The different ways the ferns blanket their spore-cases is a delightful study, and one which the pupils enjoy very much. All of our common ferns except the careless little polypody thus protect their spores. Whether this blanket be circular, or horse-shoe-shaped, or oblong, or in the form of pocket or cup, depends upon the genus to which the fern belongs. The little protecting blanket-membrane is called the *indusium*, and while its shape distinguishes the genus, the position in which it grows determines the species. I shall never forget my surprise and delight when, as a young girl, I visited the Philadelphia Centennial Expositon, and there in the great conservatories saw for the first time the tree-ferns of the tropics. One of these was labelled *Dicksonia*, and mystified, I asked the privilege of examining the fronds for fruiting organs. When lo! the indusium proved to be a little cup, borne at the base of the tooth of the pinnule, exactly like that of our boulder fern, which is also a Dicksonia. I had a sudden feeling that I must have fern friends all over the world.

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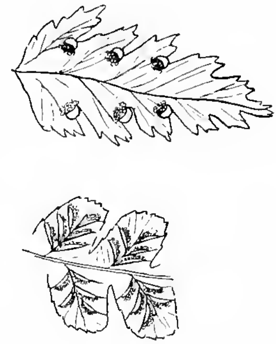
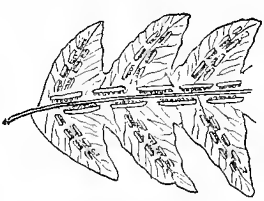


1. Fruiting pinnule of the boulder fern, enlarged. 2. Fruiting pinnules of spleenwort, enlarged.

Fruiting pinnules of evergreen wood fern.

The children are always interested in the way the maidenhair folds over the tips of her scallops to protect her spore nursery; and while many of our ferns have their fertile fronds very similar in form to the sterile ones, yet there are many common ferns with fertile fronds that look so different from the others, that one would not think they were originally of the same pattern; but although their pinnules are changed into cups, or spore-pockets, of various shapes, if they be examined carefully they will be seen to have the same general structure and the same divisions however much contracted, as have the large sterile fronds. The Osmundas, which include the interrupted, the cinnamon and the flowering ferns, are especially good for this part of the lesson. The sensitive fern, so common in damp places in open fields, is also an excellent illustration of this method of fruiting. While studying the ferns, the teacher should lay stress upon the fact that they represent the earliest and simplest forms of plants, that they reached the zenith of their growth in the Carboniferous age, and that, to a large extent, our coal is composed of them. It is interesting to think that the exquisite and intricate leaf patterns of the ferns should belong to a primitive type. Often when I have watched the forming by the frost, of the exquisite fernlike pictures on the window-pane, I have wondered if, after all, the first expression of the Creator did not



Fruiting pinnules of the chain fern.

find form in the most exquisite grace and beauty; and if perchance the first fishes, so fierce and terrible, did not mark the introduction of Satan.

A sensitive fern, showing sterile and fertile fronds.

LESSON CLXXVI

The Fruiting of the Fern

Leading thought—Ferns do not have flowers, but they produce spores. Spores are not seeds; but they grow into something which may be compared to a true seed, and this in turn develops into young ferns. Each genus of ferns has its own peculiar way of protecting its spores; and if we learn these different ways, we can recognize ferns without effort.

Method—July is the best time for this lesson, which is well adapted for summer schools or camping trips. However, if it is desired to use it as a school lesson, it should be begun in June, when the fruiting organs are green, and it may be finished in September after the spores are discharged. Begin with the Christmas fern, which ripens in June, and make the fruiting of this species a basis for comparison. Follow this with other wood ferns which bear fruit-dots on the back of the fronds. Then study the ferns which live in more open places, and which have fronds changed in form to bear the spores—like the sensitive, the ostrich, the royal and the flowering ferns. A study of the interrupted fern is a desirable preparation for the further study of those which have special fruiting fronds; the interrupted fern has, at about the middle of its frond, three pinnæ on each side, fitted for spore-bearing, the pinnules being changed into globular cups filled with spore-cases.

While not absolutely necessary, it is highly desirable that each member of the class should look at a fruit-dot of some fern through a three-quarters objective of a compound microscope, and then examine the spore-cases and the spores through a one-sixth objective. It must be remembered that this lesson is for advanced grades, and is a preparation for systematic scientific work. If a microscope is not available, the work may be done with a hand lens aided by pictures.

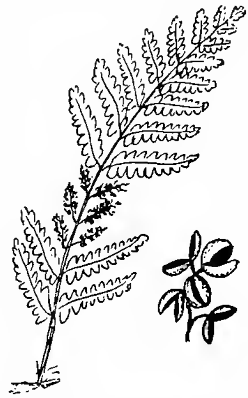


Diagram of the interrupted fern, showing the three pairs of fruiting pinnæ, and a part of one of these enlarged. This fern often has fronds four or five feet high.

Observations—1. Take a fern that is in fruit; lay it on a sheet of white paper and leave it thus for a day or two, where it will not be disturbed and where there is no draught; then take it up carefully; the form of the fern will be outlined in dust. What is this dust?

2. What conditions must the spores have in order to grow? What do they grow into? (See First Studies of Plant Life by Atkinson, p. 207).

3. Look at a ripe fruit-dot on the back of a fern leaf and see where the spores come from. Can you see with a lens many little, brown globules? Can you see that some of them are torn open? These are the spore-cases, called *sporangia*, each globule being packed with spores. Can you see how the sporangia are fastened to the leaf by little stems?

4. Almost all our common wood ferns have the spore-cases protected by a thin membrane, the spore-blanket, when very young; this little membrane is called the *indusium*, and it is of different shape in those ferns which do not have the same sirname, or generic name. Study as many kinds of wood ferns as you can find. If the blanket, or indusium, is circular with a dent at the center where it is fastened to the leaf, and the spore-cases push out around the margin, it is a *Christmas fern;* if horseshoe-shaped, it is one of the *wood ferns;* if oblong, in rows on each side of the midrib, it is a *chain fern;* but if oblong and at an angle to the midrib, it is a *spleenwort;* if it is ocket-shaped and opening at one side, it is a *bladder fern;* if it is cup-shaped, it is a *boulder fern;* if it breaks open and lays back in star shape, it is a *woodsia;* if the edge of the fern leaf is folded over all along its margin to protect the spore-cases, it is a *bracken;* if the tips of the scallops of the leaf be delicately folded over to make a spore blanket, it is the *maidenhair*.

5. If you know of swampy land where there are many tall brakes, look for a kind that has some of its pinnæ withered and brown. Examine these withered pinnæ, and you will see that they are not withered at all but are changed into little cups to hold spore-cases. This is the *interrupted fern*. The *flowering fern* has the pinnæ at its tip changed into cups for spore-cases. The *cinnamon fern*, which grows in swampy places, has whole fronds which are cinnamon-colored and look withered, but which bear the spores. The ostrich fern, which has fronds which look like mag-

nificent ostrich feathers, has stiff, little stalks of fruiting fronds very unlike the magnificent sterile fronds. The *sensitive fern*, which grows in damp meadows and along roadsides, also has contracted fruiting fronds. If you find any of these, compare carefully the fruiting with the sterile fronds, and note in each case the resemblance in branching and in pinnules and also the shape of the openings through which the spores are sifted out.

6. Gather and press specimens of as many ferns in the fruiting stage as you can find, taking both sterile and fruiting fronds in those species which have this specialization.

7. Read in the geologies about the ferns which helped to make our coal beds.

Supplementary reading.—The Story of a Fern; First Studies of Plant Life, Atkinson; The Petrified Fern, M. L. B. Branch.

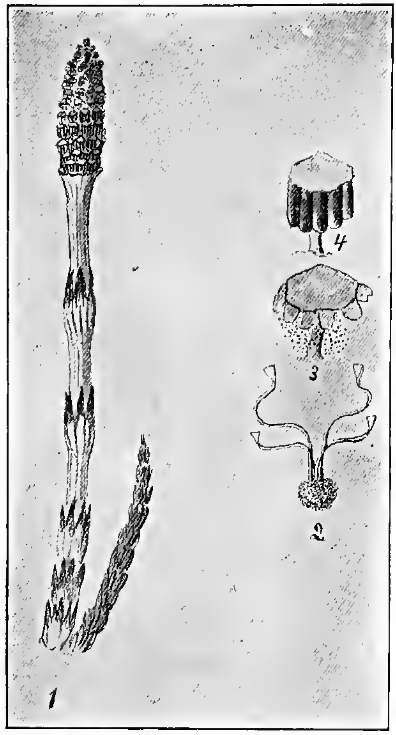
The bulb-bearing bladder fern. This beautiful fern clothes the banks of damp ravines. It has, in addition to fruiting organs, buds on the stem, which take root.

Photo by Verne Morton.

"*Nature made ferns for pure leaves to see what she could do in that line.*"—THOREAU

THE FIELD HORSETAIL

Teacher's Story

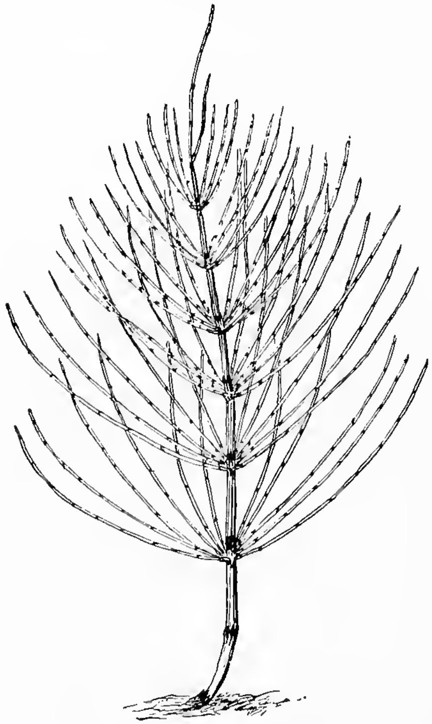


1, Fertile plant of the field horsetail; 2, spore; 3, disk discharging spores; 4, disk with spore-sacs.

These queer, pale plants grow in sandy or gravelly soil, and since they appear so early in the spring they are objects of curiosity to children. The stalk is pale and uncanny looking; the pinkish stem, all the same size from bottom to top, is ornamented at intervals with upward-pointing, slender, black, sharp-pointed scales, which unite at the bottom and encircle the stalk in a slightly bulging ring, a ring which shows a ridge for every scale, extending down the stem. These black scales are really leaves springing from a joint in the stem, but they forgot long ago how to do a leaf's work of getting food from the air. The "blossom" which is not a real blossom in the eye of the botanist, is made up of rows of tiny discs which are set like miniature toadstools around the central stalk. Before it is ripe, there extends back from the edge of each disc a row of little sacs stuffed so full of green spores that they look united like a row of tiny green ridges. The discs at the top of the fertile spike discharge their spores first, as can be seen by shaking the plant over white paper, the falling spores looking like pale green powder. The burst and empty sacs are whitish, and hang around the discs in torn scallops, after the spores are shed. The spores, when seen under the microscope, are wonderful objects, each a little green ball with four spiral bands wound about it. These spirals uncoil and throw the spore, giving it a movement as of something alive. The motor power in these living springs is the absorbing of moisture.

The beginning of the sterile shoot can be seen like a green bit of the blossom spike of the plantain; but later, after the fertile stalks have died down, these cover the ground with their strange fringes.

The person who first called these sterile plants "horsetails" had an overworked imagination, or none at all; for the only quality the two have in common is brushiness. A horse which had the hair of its tail set in whorls with the same precision as this plant has its branches would be one of the world's wonders. The *Equicetum* is one of the plants which give evidence of nature's resourcefulness; its remote ancestors probably had a whorl of leaves at each joint or node of the main stem and branches; but the plant now having so many green branches, does not really need the leaves, and thus they have been reduced to mere points, and look like nothing but "trimming," they are so purely ornamental. Each little cup or socket, of the joint or node, in branch or stem, has a row of points around its margin, and these points are terminals of the angles in the branch. If a branch is triangular in cross section, it will have three points at its socket, if quadrangular it will have four points, and the main stem may have six or a dozen, or even more points. The main stem and branches are made up entirely of these segments, each set at its lower end in the socket of the segment behind or below it. These green branches, rich in chlorophyl, manufacture for the plant all the food that it needs. Late in the season this food is stored in the rootstocks, so that early next spring the fertile plants, nourished by this stored material, are able to push forth before most other plants, and thus develop their spores early in the season. There is a prothallium stage as in the ferns.


The sterile plant of the field horsetail, one-half natural size.

Above where the whorl of stems comes from the main branch, may be seen a row of upward-standing points which are the remnants of leaves; each branch as it leaves the stem is set in a little dark cup with a toothed rim. There is a nice gradation from the stout lower part of the stem to the tip, which is as delicate as one of the side branches.

The rootstock dies out behind the plant and pushes on ahead like the rootstock of ferns. The true roots may be seen attached on the under side. The food made in the summer is stored in little tubers, which may be seen in the rootstocks.

LESSON CLXXVII

The Field Horsetail

The Fertile Plant

Leading thought—The horsetail is a plant that develops spores instead of seeds, and has green stems instead of leaves.

Method—In April and May, when the children are looking for flowers, they will find some of these weird looking plants. These should be brought to the schoolroom and the observation lesson given there.

Observations—1. Where are these plants found? On what kind of soil?

2. In what respect does this plant differ from other plants in appearance? Can you find any green part to it?

3. What color is the stem? Is it the same size its whole length? Is it smooth or rough?

4. Do you see any leaves on the stems? Do you see the black-pointed scales? In which direction do these scales point? Are they united at the bottom? What sort of a ring do they make around the stem? Split a stem lengthwise and see if there are joints, or nodes, where the ring joins the stalk.

5. How does the "blossom" look? What color are the little discs that make up the blossom? How are the discs set?

6. Take one of the plants which has the discs surrounded by green ridges. Shake it over a white paper. What comes from it? Where does it come from? Which discs on the stalk shed the green spores first?

The Sterile Plants

Leading thought—The horsetail or *Equicetum* is nourished by very different looking stems than those which bore the spores. It lacks leaves, but its branches are green and do the work of making food for the plant.

Method—The sterile plants of the horsetail do not appear for several weeks after the fertile ones; they are much more numerous, and do not resemble the fertile plants in form or color. These sterile plants may be used for a lesson in September or October. Some of these plants with their roots may be brought into the schoolroom for study.

Observations—1. Has this plant any leaves? How does it make and digest its food without leaves? What part of it is green? Wherever there is green in a plant, there is the chlorophyl-factory for making food. In the horsetail, then, what part of the plant does the work of leaves?

2. Take off one little branch and study with the lens. How does it look? Pull it apart? Where does it break easily? How many joints, or nodes, are there in the branch?

3. Study the socket from which one of the segments was pulled off. What do you see around its edge? How many of these points? Look at the branch in cross section. How many angles has it? What relation do the points bear to the angles? Do you think these points are all there are left of true leaves?

4. How do the little green branches come off the main stem? How many in a place? How many whorls of branches on the main stem?

5. Study the bases of the branches. What do you see? Look directly above where the whorl of branches comes off the main stem. What do you see? Cut the main stem in cross-section just below this place, and see if there are as many little points as there are angles, or ridges, in the stem. Do you suppose these little points are the remnants of leaves on the main stem?

6. What kind of root has the horsetail? Do you think this long running root is the true root or an underground stem? Where are the true roots? Do you think the rootstock dies off at the oldest end each year, like the fern? Can you find the little tubers in the rootstock, which contain nourishment for next year's spore-bearing stalks?

THE HAIR-CAP MOSS, OR PIGEON WHEAT

Teacher's Story

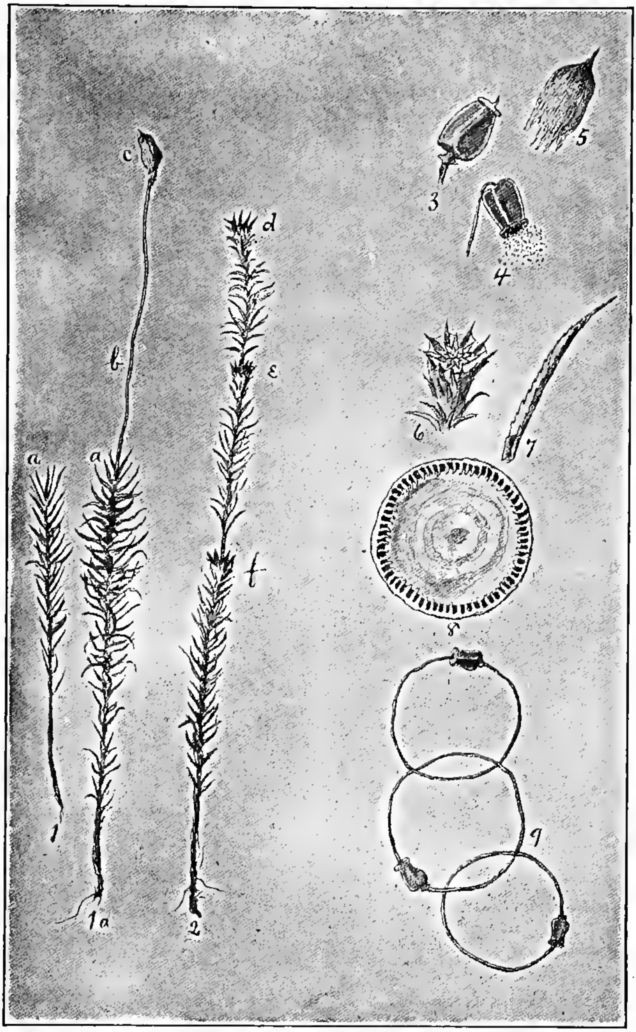
Photo by Verne Morton.

The hair-cap moss.

The mosses are a special delight to children because they are green and beautiful before other plants have gained their greenness in the spring and after they have lost it in the fall; to the discerning eye, a mossy bank or a mossy log is a thing of beauty always. When we were children we regarded moss as a forest for fairy folk, each moss stem being a tree, and we naturally concluded that fairy forests were evergreen. We also had other diversions with pigeon wheat, for we took the fruiting stem, pulled the cap off the spore-capsule, tucked the other end of the red stem into the middle of the capsule, making a beautiful coral ring with an emerald "set." To be sure these rings were rather too delicate to last long, but there were plenty more to be had for nothing; so we made these rings into long chains which we wore as necklaces for brief and happy moments, their evanescence being one of their charms.

Pigeon wheat is a rather large moss which grows on dry knolls, usually near the margins of damp woodlands in just those places where wintergreens love to grow. In fall or winter it forms a greenish brown mass of bristling stems; in the early summer the stems are tipped with the vivid green of the new growth. The bristling appearance comes from the long sharp leaves set thickly upon the ruddy brown stems; each leaf is pretty to look at with a lens, which reveals it as thick though narrow, grooved along the middle, the edges usually armed with sharp teeth and the base clasping the stem. These leaves, although so small, are wonderfully made; during the hot, dry weather they shut up lengthwise and twist into the merest threads, in order to keep their soft, green surfaces from losing their moisture by exposure to the air; more than this, they lift themselves and huddle close to the stem, and are thus as snug and safe as may be from the effect of drought; but as soon as the rains come, they straighten back at right angles to the stem, and curve their tips downward in a joyful expanding. Bring in some of this moss and let it dry, and then drop it into a glass of water and watch this miracle of leaf movement! And yet it is no miracle but a mechanism quite automatic—and therefore—like other miracles, when once they are understood.

In early June the mossy knoll shows us the origin of the name pigeon grass or pigeon wheat, for it is then covered with a forest of shining, ruddy, stiff, little stems, each stem bearing on its tip a woolly object about the



Hair-cap moss.

1, fruit-bearing moss stem before fertilization; 1*a*, the same stem after fruit is developed; *a*, where the ovule was before fertilization; *b*, fruit stem; *c*, spore-capsule with cap or veil upon it. 2, stem showing the star-like cups; *d*, the cup in which was developed the pollen which fertilized the ovule at *a*, this year; *e*, last year's cup; *f*, the cup of year before last; only the leaves from *e* to *d* are alive. 3, spore capsule with the cap removed, showing the lid. 5, the cap or veil removed. 4, spore capsule with lid off and shaking out the spores. 6, starlike cup in which the pollen is developed. 7, leaf of moss; 8, the top of the spore capsule showing the teeth around the edge between which the spores sift out. 9, a part of a necklace chain made of the spore capsules and their stems.

size of a grain of wheat. But it is safe to say that the pigeons and other birds enjoy our own kind of wheat better than this, which is attributed to them.

A study of one of these wheat grains reveals it as covered with a yellowish, mohair cap, ending in a golden brown peak at its tip, as if it were the original pattern of the toboggan cap; it closes loosely and downily around the stem below. This grain is the spore-capsule of the moss; the hairy cap pulls off easily when seized by its tip. This cap is present at the very beginning, even before the stem lengthens, to protect the delicate tissues of the growing spore-case; it is only through a lens that we can see it in all its silky softness. The capsule revealed by the removal of the cap is a beautiful green object, usually four-sided, set upon an elegant little pedestal where it joins the coral stem, and with a lid on its top like a sugar-bowl cover, with a point instead of a knob at its center. When the spores are ripe, this lid falls off, and then if we have a lens we may see another instance of moss mechanism. Looking at the uncovered end of the capsule, we see a row of tiny teeth around the margin, which seem to hold down an inner cover with a little raised rim. The botanists have counted these teeth and find there are 64. The teeth themselves are not important, but the openings between them are, since only through these openings can the spores escape. In fact, the capsule is a pepper-box with a grating around its upper edge instead of holes in its cover; and when it is fully ripe, instead of standing right side up, it tips over so as to shake out its spores more easily. These teeth are like the moss leaves; they swell with moisture, and thus in rainy weather they, with the inner cover, swell so that not a single spore can be shaken out. If spores should come out during the rain, they would fall among the parent plants where there is no room for growth. But when they emerge in dry weather, the wind scatters them far and wide where there is room for development.

When seen with the naked eye, the spores seem to be simply fine dust, but each dust grain is able to produce moss plants. However, the spore does not grow up into a plant like a seed, it grows into fine, green, branching threads which push along the surface of damp soil; on these threads little buds appear, each of which grows up into a moss stem.

The spore-capsule is hardly the fruit of the moss plant. If we examine the moss, we find that some stems end in yellowish cups which look almost like blossoms; on closer examination, we find that there are several of these cups, one below the other, with the stem extending up through the middle. The upper cup matured this year, the one below it last year, and so on. These cups are star-pointed, and inside, at the bottom, is a starlike cluster of leaves. Among the leaves of this star-rosette are borne the moss anthers called *antheridii*, too small for us to see without a high power microscope. The pollen from these anthers is blown over to other plants, some of which produce ovules at their very tips, although the ovule has no leaf-rosette to show where it is. This ovule, after receiving the pollen, grows into the spore-capsule supported on its coral stem. These—stem, capsule and all—grow up out of the mother plant, the red stem is enlarged at its base, and fits into the moss stem like a flagstaff in the socket. After the star-shaped cup has shed its pollen, the stem grows up from its center for an inch or so in height and bears new leaves, and next year will bear another starry cup.

The brown leaves on the lower part of the moss stem are dead, and only the green leaves on the upper part are living.

And this is the story of the moss cycle:

1. A plant with an ovule at its tip; another plant with a star-cup holding the moss pollen which is sifted by wind over to the waiting egg.
2. The egg or ovule as soon as fertilized develops into a spore-capsule, and is lifted up into the world on a beautiful shining stem and is protected by a silky cap.
3. The cap comes off; the lid of the spore-case falls off, the spores are shaken out and scattered by the wind.
4. Those spores that find fitting places grow into a net of green threads.
5. These green threads send up moss stems which repeat the story.

LESSON CLXXVIII

The Hair-Cap Moss

Leading thought—The mosses, like the butterfly and the fern, have several stages in their development. The butterfly stages are the egg, the caterpillar, the chrysalis, the butterfly. The moss stages are the egg (or ovule), the spores, the branching green threads, the moss plants with their green foliage. In June we can easily find all these stages, except perhaps the branching thread stage.

Method—The children should bring to the schoolroom a basin of moss in its fruiting stage; or still better, go with them to a knoll covered with moss. Incidentally tell them that this moss, when dried, is used by the Laplanders for stuffing their pillows, and that the bears use it for their beds. Once, a long time ago, people believed that a plant, by the shape of its leaf or flower, indicated its nature as a medicine, and as this moss looked like hair, the water in which it was steeped was used as a hair tonic.

Observation—1. Take a moss stem with a grain of pigeon wheat at the end. Examine the lower part of the stalk. How are the leaves arranged on it? Examine one of the little leaves through a lens and describe its shape, its edges, and the way it joins the stem. Are the lower leaves the same color as the upper ones? Why?

2. Describe the pretty shining stem of the fruit, which is called the pedicel. Is it the same color for its entire length? Can you pull it easily from the main plant? Describe how its base is embedded in the tip of the plant.

3. Note the silken cap on a grain of the pigeon wheat. This is called the veil. Is it all the same color? Is it grown fast to the plant at its lower margin? Take it by the tip, and pull it off. Is this done easily? Describe what it covers. This elegant little green vase is called a spore-capsule. How many sides has it? Describe its base which stands upon the stem. Describe the little lid. Pull off the lid; is there another lid below it? Can you see the tiny teeth around the edge which hold this lid in place? Ask your teacher, or read in the books, the purpose of this.

4. Do all the spore vases stand straight up, or do some bend over?

5. Do you think the silken cap falls off of itself after a while? Can you find any capsules where the cap or veil and the lid have fallen off? See if you can shake any dust out of such a spore vase. What do you

think this dust is? Ask your teacher, or read in the books, about moss spores and what happens if they find a damp place in which to grow.

6. Hunt among the moss for some stems that have pretty, yellowish, starlike cups at their tips. How does the inside of one of these cups look? Ask the teacher to tell you what grows in this cup. Look down the stem and see if you can find last year's cup. The cup of two years ago? Measured by these cups how old do you think this moss stem is?

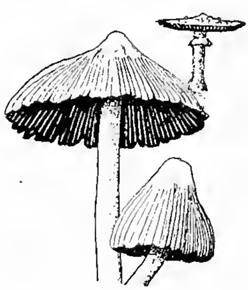
7. Select some stems of moss, both those that bear the fruit and those that bear the cups. After they are dried describe how the leaves look. Examine the plant with a lens and note how these leaves are folded and twisted. Do the leaves stand out from the stem or lie close to it? Is this action of the leaves of any use to the plant in keeping the water from evaporating? How do the star-cups look when dry?

8. Place these dried stems in a glass of water and describe what happens to the cup. Examine some of the dried moss and the wet moss with a lens, and describe the difference. Of what use to the moss is this power of changing form when damp?

Reference—First Lessons in Plant Life, Atkinson.

MUSHROOMS AND OTHER FUNGI

Teacher's Story



THERE is something uncanny about plants which have no green parts; they seem like people without blood. It is, therefore, no wonder that many superstitions cluster about toadstools. In times of old, not only did the toads sit on them, but fairies danced upon them and used them for umbrellas. The poisonous qualities of some species made them also a natural ingredient of the witch's cauldron. But science, in these days, brings revelations concerning these mysterious plants which are far more wonderful than the web which superstition wove about them in days of yore.

When we find plants with no green parts which grow and thrive, though unable to manufacture their own organic food through the alchemy of chlorophyl, sunlight and air, we may safely infer that in one way or another they gain the products of this alchemy at second hand. Such plants are either parasites or saprophytes; if parasites, they steal the food from the cells of living plants; if saprophytes, they live on such of this food material as remains in dead wood, withered leaves, or soils enriched by their remains.

Thus, we find mushrooms and other fungus fruiting bodies, pallid, brown-olive, yellow or red in color, but with no signs of the living green of other plants; and this fact reveals their history. Some of them are parasites, as certain species of bracket fungi which are the deadly enemies of living trees; but most of the fungus species that we ordinarily see are saprophytes, and live on dead vegetation. Fungi, as a whole, are a great boon to the world. Without them our forests would be choked out with dead wood. Decay is simply the process by which fungi and other organisms break down dead material, so that the major part of it returns to the air in gaseous form, and the remainder, now mostly humus, mingles with the soil.

As a table delicacy, mushrooms are highly prized. A very large number of species are edible. But every year the newspapers report deaths resulting from eating the poisonous kinds—the price of an ignorance which comes from a lack of the powers of observation developed in nature-study. It would be very unwise for any teacher to give rules to guide her pupils in separating edible from poisonous mushrooms, since the most careful directions may be disregarded or misunderstood. She should emphasize the danger incurred by mistaking a poisonous for an edible species. One small button of the deadly kind, if eaten, may cause death. A few warning rules may be given, which if firmly impressed on the pupils, may result in saving human life.

White form of the deadly Amanita (A. phalloides). Note the form of the ring and the cup at base of stem.
Photo by G. F. Atkinson.

First and most important, avoid all mushrooms that are covered with scales, or that have the base of the stem included in a sac, for two of the poisonous species, often mistaken for the common edible mushroom, have these distinguishing characters. Care should be taken that every specimen be collected in a way to show the base of the stem, since in some poisonous species this sac is hidden beneath the soil.

Second, avoid the young, or button, stages, since they are similar in appearance in species that are edible and in those that are poisonous.

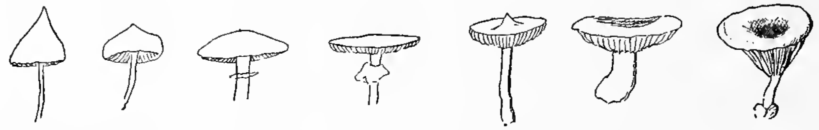
Third, avoid those that have milky juices; unless the juices are reddish in color, the mushrooms should not be eaten.

Fourth, avoid those with shiny, thin, or brightly colored caps, and those with whitish or clay-colored spores.

Fifth, no mushroom or puffball should be eaten after its meat has begun to turn brown or has become infested with fly larvæ.

How Mushrooms Look and How They Live

HERE are many kinds of mushrooms varying greatly in form, color and size, but wherever they appear it means that sometime previous the mushroom spores have been planted there. There they threw out threads which have penetrated the food substance and gained a successful growth, which finally resulted in sending up into the world the fruiting organs. In general shape these consist of a stem with a cap upon it, making it usually somewhat umbrella-shaped. Attached to the cap, and usually under it, are plate-like growths called gills, or a fleshy surface which is full of pores. In the case of the gills, each side of each



Cone-shaped. Bell-shaped. Convex. Plane. Raised at center. Depressed Funnel form.

plate develops spores. These, as fine as dust, are capable of producing other mushrooms.

The common edible mushroom, in button stages, mycelium or spawn also shown.
Photo by G. F. Atkinson.

In the common edible species of mushroom (*Agaricus campestris*), the stem is white and almost cylindrical, tapering slightly toward the base; it is solid although the core is not so firm as the outside. When it first pushes above the ground, it is in what is called the "button stage" and consists of a little, rounded cap covered with a membrane which is attached to the stem. Later the cap spreads wide, for it is naturally umbrella-shaped, and it tears loose this membrane, leaving a piece of it attached to the stem; this remnant is called the ring or collar. The collar is very noticeable in many species, but in the common mushroom it soon shrivels and disappears. The cap is at first rounded and then convex; its surface is at first smooth, looking soft and silky; but as the plant becomes old, it is often broken up into triangular scales which are often dark brown; although the color of the cap is usually white or pale brown. The gills beneath the cap are at first white, but later, as the spores mature, they become brownish black because of the ripened spores.

References—Mushrooms, a most excellent and practical book with many beautiful pictures, written and illustrated by Professor George F. Atkinson; Henry Holt & Co., N. Y., $3.00; The Mushroom Book, Marshall, fully illustrated, $4.00, Doubleday, Page & Co.; One Thousand American Fungi, McIlvaine, illustrated, Bowen-Merrill Co., $5.00; Our Edible Toadstools and Mushrooms, W. H. Gibson, very fully illustrated, Harper and Bros., $3.50.

LESSON CLXXIX
Mushrooms

Leading thought—Mushrooms are the fruiting organs of the fungi which grow in the form of threads, spreading in every direction through the food material. The dust which falls from ripe mushrooms is made up of spores which are not true seeds, but which will start a new growth of the fungus.

Method—The ideal method would be to study the mushrooms in the field and forest, making an excursion for the purpose of collecting as many

Dark form of the Amanita (A. phalloides). Compare with white form on page 707.
Photo by George F. Atkinson.

species as possible. But the lesson may be given from specimens brought into the schoolroom by pupils, care being taken to bring with them the soil, dead wood or leaves on which they were found growing. After studying one species thus, encourage the pupils to bring in as many others as possible. There are a few terms which the pupils should learn to use, and the best method of teaching them is to place the diagrams shown on pages 708, 711, 712, on the blackboard, and leave them there for a time.

Since mushrooms are especially good subjects for water-color and pencil studies, it would add much to the interest of the work if each pupil, or the school as a whole, should make a portfolio of sketches of all the species found. With each drawing there should be made on a supplementary sheet a spore-print of the species. White paper should be covered very thinly with white of egg or mucilage, so as to hold fast the discharged spores when making these prints for portfolio or herbarium.

Observations—1. Where was the mushroom found? If on the ground, was the soil wet or dry? Was it in open fields or in woods? Or was it found on rotten wood, fallen leaves, old trees or stumps, or roots? Were there many or few specimens?

2. Is the cap cone-shaped, bell-shaped, convex, plane, concave, or funnel-form? Has it a raised point at the center? How wide is it?

3. What is the color of the upper surface of the cap when young? When old? Has it any spots of different colors on it? Has it any striate markings, dots or fine grains on its surface? Is its texture smooth or scaly? Is its surface dull, or polished, or slimy? Break the cap and note the color of the juice. Is it milky?

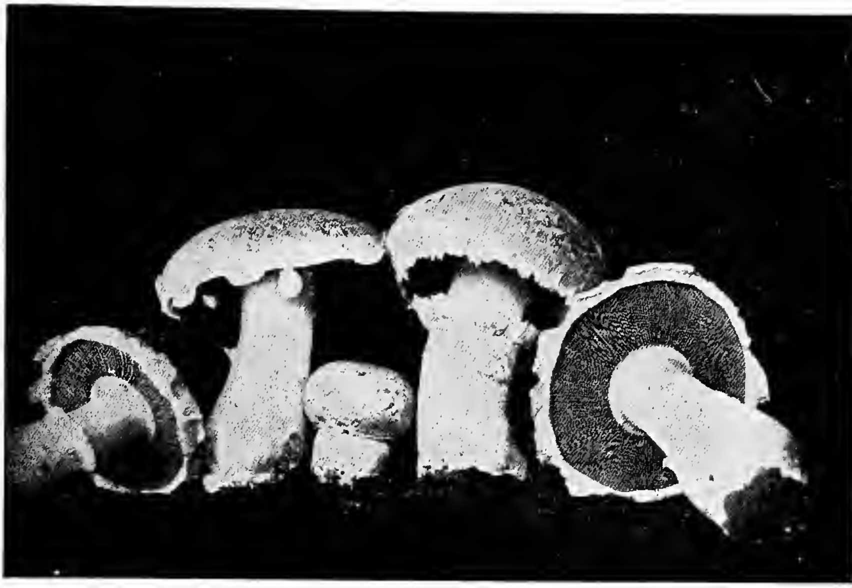
A spore print from the common edible mushroom.
Photo by George F. Atkinson.

4. Look beneath the cap. Is the under surface divided into plates like the leaves of a book, or is it porous?

5. The plates which may be compared to the leaves of a book are called gills, although they are not for the purpose of breathing, as are the gills of a fish. Are there more gills near the edge of the cap than near the stem? How does this occur? What are the colors of the gills? Are the gills the same color when young as when old? Are the lower edges of the gills sharp, blunt or saw-toothed?

6. Break off a cap and note the relation of the gills to the stem. If they do not join the stem at all they are termed "free." If they end by being joined to the stem, they are called "adnate" or "adnexed." If they extend down the stem they are called "decurrent."

7. Take a freshly opened mushroom, cut off the stem, even with the cap, and set the cap, gills down, on white paper; cover with a tumbler, or other dish to exclude draught; leave it for twenty-four hours and then remove the cover, lift the cap carefully and examine the paper. What color is the imprint? What is its shape? Touch it gently with a pencil and see what makes the imprint. Can you tell by the pattern where this fine dust came from? Examine the dust with a lens. This dust is made up of mushroom spores, which are not true seeds, but which do for mushrooms what seeds do for plants. How do you think the spores are scattered? Do you know that one little grain of this spore dust would start a new growth of mushrooms?

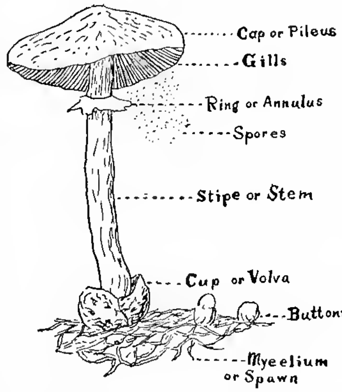


The common edible mushroom (Agaricus campestris), showing button stage, vanishing ring and gills.

Photo by George F. Atkinson.

8. Look at the stem. What is its length? Its color? Is it slender or stocky? Is its surface shiny, smooth, scaly, striate or dotted? Has it a collar or ring around it near the top? What is the appearance of this ring? Is it fastened to the stem, or will it slide up and down? Is the stem solid or hollow? Is it swollen at its base? Is its base set in a sac or cup, or is it covered with a membrane which scales off? Do you know that the most poisonous of mushrooms have the sac or the scaly covering at the base of the stem?

9. Examine with a lens the material on which the mushroom was growing; do you see any threads in it that look like mold? Find if you can what these threads do for the mushroom? If you were to go into the mushroom business what would you buy to start your beds? What is mushroom "spawn?"



Mushroom with parts named.

10. If you can find where the common edible mushrooms grow plentifully, or if you know of any place where they are grown for the market, get some of the young mushrooms when they are not larger than a pea and others that are larger and older. These young mushrooms are called "buttons." Find by your own investigation the relation between the buttons and the threads. Can you see the gills in the button?

Why? What becomes of the veil over the gills as the mushrooms grow large?

11. Do you know the difference between mushrooms and toadstools? Do you know the common edible mushroom when you see it? What characters separate this from the poisonous species? What is the "death cup," as it is called, which covers the base of the stem of the most common poisonous species?

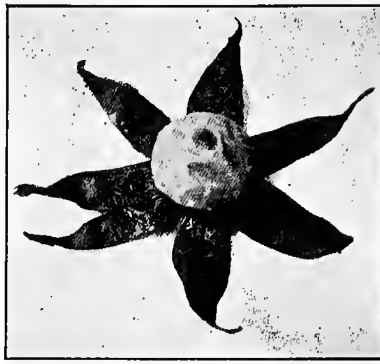
A common species of puffball, the three at the left showing early stages, the one at the right ripe and discharging spores.
Photo by G. F. Atkinson.

PUFFBALLS

Teacher's Story

The puffballs are always interesting to children, because of the "smoke" which issues from them in clouds when they are pressed between thumb and finger. The common species are white or creamy when young; and some of the species are warty or roughened, so that as children we called them "little lambs." They grow on the ground usually, some in wet, shady places, and others, as the giant species, in grassy fields in late summer. This giant puffball always excites interest, when found. It is a smoothish, white, rounded mass, apparently resting on the grass as if thrown there; when lifted it is seen that it has a connection below at its center, through its mycelium threads, which form a network in the soil. It is often a foot in diameter, and specimens four feet through have been recorded. When its meat is solid and white to the very center, it makes very good food. The skin should be pared off, the meat sliced and sprinkled with salt and pepper and fried in hot fat until browned. All the puffballs are edible, but ignorant persons might mistake the button stages of some of the poisonous mushrooms for little puffballs, and it is not well to encourage the use of small puffballs for the table.

A common species—"the beaker puffball"—is pear-shaped, with its small end made fast to the ground, which is permeated with its vegetative threads.



An earth-star.
Photo by Verne Morton.

The interior of a puffball, "the meat," is made up of the threads and spores. As they ripen, the threads break up so that with the spores they make the "smoke," as can be seen if the dust is examined through a microscope. The outer wall may become dry and brittle and break open to allow the spores to escape, or one or more openings may appear in it as spore doors. The spores of puffballs were used extensively in pioneer days to stop the bleeding of wounds and especially for nosebleed.

In one genus of the puffball family, the outer coat splits off in points on maturing, like an orange peel cut lengthwise in six or seven sections but still remaining attached to the base. There is an inner coat that remains as a protection to the spores, so that these little balls are set each in a little star-shaped saucer. These star points straighten out flat or even curl under in dry weather, but when damp they lift up and again envelop the ball to a greater or less extent.

LESSON CLXXX

Puffballs

Photo by Verne Morton.
A big puffball.

Leading thought—The puffballs are fungi that grow from the threads, or mycelium, which permeate the ground or other matter on which the puffballs grow. The puffballs are the fruiting organs, and "smoke" which issues from them is largely made up of spores, which are carried off by the wind and sown and planted.

Method—Ask the pupils to bring to school any of the globular or pear-shaped fungi in the early stages when they are white, taking pains to bring them on the soil or wood on which they are growing.

Observations—1. Where did you find the puffball? On what was it growing? Were there many growing in company? Remove the puffball, and examine the place where it stood with a lens to find the matted and crisscrossed fungus threads.

2. What is the size and shape of the puffball? Is its surface smooth or warty? What is its color inside and outside?

3. Have you ever found the giant puffball, which may become four inches to four feet through? Where was it growing? Have you ever eaten this puffball sliced and fried? Do you know by the looks of the meat when it is fit to eat?

4. If the puffball is ripe, what is its color outside and in? What is the color of its "smoke?" Does the smoke come out through the broken covering of the puffball, or are there one or more special openings to allow it to escape?

5. Puff some of the "smoke" on white paper and examine it with a lens. What do you think this dust is? Of what use is it to the puffball?

6. Have you ever found what are called earth-stars, which look like little puffballs set in star-shaped cups? If you find these note the following things:

a. Of what is the star-shaped base made? Was it always there?
b. Let this star saucer become very dry; how does it act?
c. Wet it; and how does it behave then?
d. Where and how does the spore dust escape from the earth-stars?

7. For what medicinal purpose is the "smoke" of the puffball sometimes used?

THE BRACKET FUNGI

Teacher's Story

Photo by Verne Morton.

A bracket fungus.

There are some naturalists who think that one kind of life is as good as another and therefore call all things good. Perhaps this is the only true attitude for the nature lover. To such the bracketlike fungi which appear upon the sides of our forest and shade trees are simply an additional beauty, a bountiful ornamentation. But some of us have become special pleaders in our attitude toward life, and those of us who have come to feel the grandeur of tree life can but look with sorrow upon these fungus outgrowths, for they mean that the doom of the tree is sealed.

There are many species of bracket fungi. Three of these are very common. The gray bracket, gray above and with creamy surface below (*Polyporous applanatus*) is a favorite for amateur etchers, who with a sharp point make interesting sketches upon this naturally prepared plate; this species often grows tc great size and is frequently very old. Another species (*P. lucidus*) is in color a beautiful mahogany, or coral-red above and has a peculiar stem from which it depends; the stem and upper surface are polished as if burnished and the lower surface is yellowish white. Another species (*P. sulphurens*) is sulphur yellow above and below; usually many of these yellow brackets are grouped together, their fan-shaped caps overlapping. Many of the shelf fungi live only on dead wood, and those are an aid in reducing dead branches and stumps until they crumble and become again a part of the soil. However, several of the species attack living trees and do great damage. They can gain access to the living tree only through an injured place in the bark, a break caused perhaps by the wind, by a bruise from a falling tree, or more often from the hack of the careless wood-chopper; often they gain entrance through an unhealed knot-hole. To one who understands trees and loves them, their patient striving to heal these wounds inflicted by forces they cannot withstand is truly pathetic. After the wound is made and before the healing is accomplished, the wind may sift into the wound the almost omnipresent spores of these fungi and the work of destruction begins. From the spores grows the mycelium, the fungus threads which push into the heart of the wood getting nourishment from it as they go. When we see wood thus diseased we say that it is rotting, but rotting merely means the yielding up of the body substance of the tree to these voracious fungus threads. They push in radially and then grow upward and downward, weakening the tree where it most needs strength to withstand the onslaught of the wind. Later these parasitic threads may reach the cambium layer, the living ring of the tree trunk, and kill the tree entirely; but many a tree has lived long with the fungus attacking its heartwood. A bracket fungus found by Professor Atkinson was eighty years old; however, this may have shortened the life of the tree a century or more.

After these fungus threads are thoroughly established in the tree, they again seek a wound in the protecting bark where they may push out and build the fruiting organ, which we call the bracket. This may be at the same place where the fatal entry was made, or it may be far from it. The bracket is at first very small and is composed of a layer of honeycomb cells, closed and hard above and opening below—cells so small that we can see the cell openings only with a lens. These cells are not hexagonal like the honeycomb, but are tubes packed together. Spores are developed in each tube. Next year another layer of cells grows beneath this first bracket and extends out beyond it; each year it is thus added to, making it thicker and marking its upper surface with concentric rings around the point of attachment. The creamy surface of the great bracket fungus on which etchings are made, is composed of a layer of these minute spore-bearing tubes. Not all bracket fungi show their age by these annual growths, for some species form new shelves every year, which decay after the spores are ripened and shed.

When once the mycelium of such fungus becomes established, the tree is doomed and its lumber made worthless even though, as sometimes happens, the tree heals its wounds so that the fungus is imprisoned and can never send out fruiting brackets. Thus it is most important to teach the pupils how to protect trees from the attacks of these enemies, which are devastating our forests and which sometimes attack our orchards and shade trees.

As soon as a tree is bruised, the wound should be painted or covered with a coat of tar. If the wind breaks a branch, the splinters left hanging should be sawed off, leaving a smooth stump, and this be painted. While ordinary paint if renewed each year will suffice, experiment has shown that the coat of tar is better and should be used.

Especially should teachers impress on pupils the harm done by careless hacking with axe or hatchet. We shall do an invaluable service in the protection of our forests, if we teach the rising generation the respectful treatment of trees—which is due living organisms whose span of life may cover centuries.

LESSON CLXXXI

Bracket Fungi

Leading thought—The fungi which we see growing shelflike from trees, are deadly enemies to the trees. Their spores germinate and penetrate at some open wound and the growing fungus weakens the wood.

Method—It is desirable that a tree on which shelf fungus grows should be studied by the class, for this is a lesson on the care of trees. After this lesson the fungus itself may be studied at leisure in the schoolroom.

Observations—1. On what kind of a tree is the bracket fungus growing? Is it alive or dead? If living, does it look vigorous or is it decaying?

2. Is the fungus bracket growing against the side of the tree, or does it stand out on a stem?

3. Look at the place where the bracket joined the tree. Does it seem to be a part of the wood?

4. What color is the fungus on its upper surface? How large is it? How thick near the tree? How thick at the edge? Can you detect concentric layers or rings? If it is the large species used for etching, cut down through it with a knife or hatchet and count the layers; this should show its age.

5. Look at the lower surface. How does it appear to the naked eye? If you scratch it with a pin or knife does the bruise show? Examine the surface with a lens and describe what you see. Cut or break the fungus and note that each of these holes is an opening to a little tube. In each of these tubes spores are borne.

6. Have you ever seen toadstools that, instead of having the leaflike gills, have beneath the cap a porous surface like a little honeycomb or like the under side of the shelf fungi?

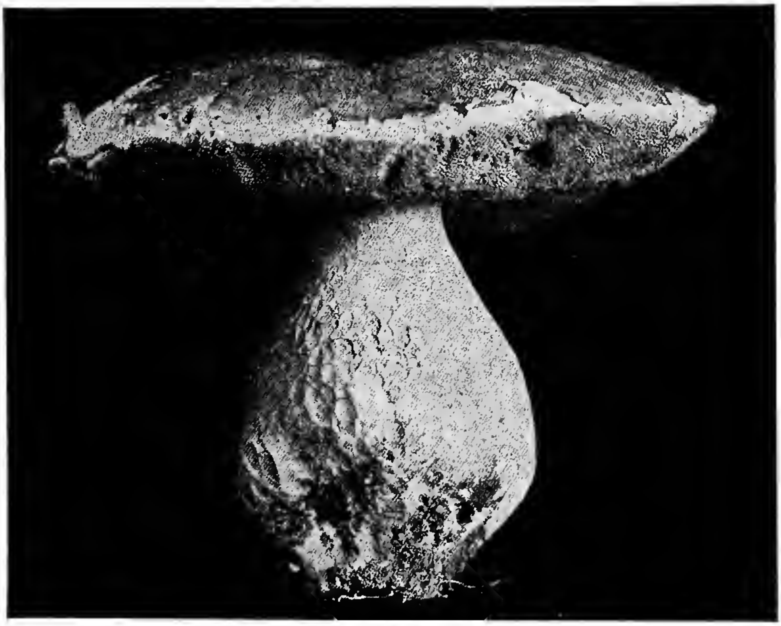
7. How many kinds of shelf fungi can you find? Which of them is on living trees, and which on stumps or dead wood?

8. If the fungus is on a living tree, then the tree is ruined, for the fungus threads have worked through it and weakened it so that it will break easily and is of no use as lumber. There must have been an open wound in the tree where the fungus entered; see whether you can find this

wound. There must also have been a wound where the shelf grew out; see whether you can detect it. If the tree should heal all its wounds after the fungus entered, what would become of the fungus?

9. What does the shelf fungus feed on? What part of it corresponds to the roots and leaves of other plants? What part may be compared to the flowering and fruiting parts of plants?

10. What treatment must we give trees to keep them free from this enemy?

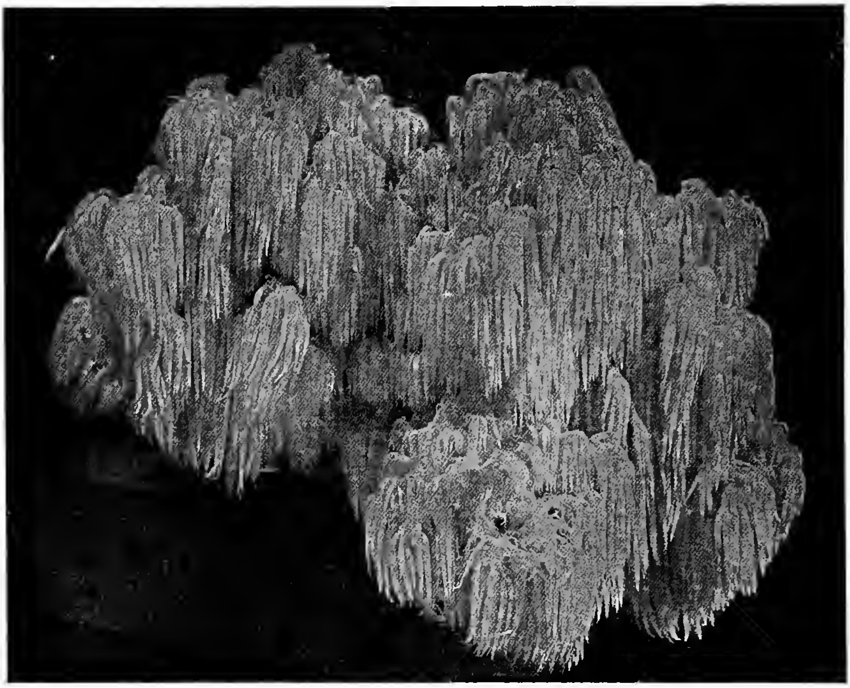


The edible Boletus (B. edulis). This has tubes below the cap instead of gills. The spores are developed within the tubes, as in the bracket fungi.
Photo by G. F. Atkinson.

LESSON CLXXXII

Hedgehog Fungi

There is something mysterious about all fungi, but perhaps none of these wonderful organisms so strangely impresses the observer as the fountainlike masses c creamy white or the branching white coral that we see growing on a dead tree trunk. The writer remembers as a child that the finding of these woodland treasures made her feel as if she were in the presence of the supernatural, as if she had discovered a fairy grotto or a kobold cave. The prosaic name of hedgehog fungi has been applied to these exquisite growths. Their life story is simple enough. The spores falling upon dead wood start threads which ramify within it and feed on its substance, until strong enough to send out a fruiting organ. This consists of a stem, dividing into ascending branches; from these branches, depending like the stalactites in a cave, are masses of drooping spines, the surface of each bearing the spores. And it is so natural for these spines to hang earthward that they are invariably so placed when the tree is in the posi-



The bear's head fungus.
Photo by George F. Atkinson.

tion in which they grew. There is one species called the "satyr's beard," sometimes found on living trees, which is a mere bunch of downward-hanging spines; the corallike species is called *Hydnum coraloides*, and the one that looks like an exquisite white frozen fountain, and may be seen in late summer or early autumn growing from dead limbs or branches, is the bear's head fungus; it is often eight inches across.

Observations—1. These fungi come from a stem which extends into the wood.

2. This stem divides into many branchlets.

3. From these branchlets there hang long fleshy fringes like miniature icicles.

4. These fringes always hang downward when the fungus is in natural position.

5. These fringes bear the spores.

LESSON CLXXXIII

The Scarlet Saucer (*Sarcocypha coccinea*)

The heart of the child, searching the woods for hepaticas—woods where snow banks still hold their ground on north slopes—is filled with delight at finding these exquisite saucerlike fungi. They are more often found on fallen rotting branches which are more or less buried in leaves, and there are likely to be several of different sizes on the same stick.

When they grow unhindered and while they are young, they are very perfectly saucer-shaped and range from the size of a pea to an inch or two across. But the larger they are the more likely are they to be distorted, either by environment or by the bulging of rapid growth. The under side of the saucer is beautifully fleshlike in color and feeling and is attached at

Scarlet saucer.

the middle to the stick. The inside of the saucer is the most exquisite scarlet shading to crimson. This crimson lining bears the spores in little sacs all over its surface.

Observations—1. Where did you find the fungus?

2. What is the shape of the saucer? How large is it? Is it regular and beautiful or irregular and distorted?

3. What is the color inside?

4. What is the color outside?

5. Turn the one you bring in bottom side up—that is, scarlet side down—on a piece of white paper, and see whether you can get a spore harvest.

LESSON CLXXXIV

The Morels

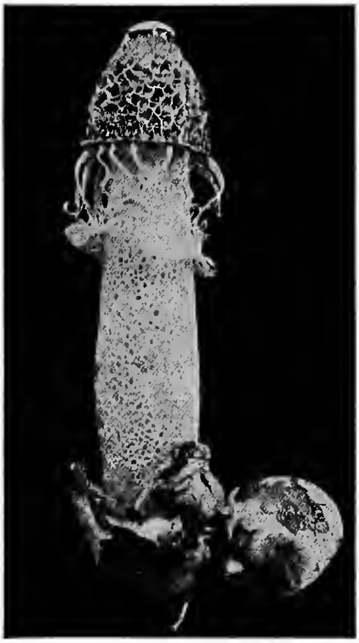
In May or June in open, damp places, as orchards or the moist fence corners of meadows, the morels may be found. This mushroom family contains no member that is poisonous, and the members are very unlike any other family in appearance. They are very pretty with their creamy white, thick, swollen stems and a cap more or less conical, made up of the deep-celled meshes of an unequal network. The outside edges of the network are yellowish or brownish when the morel is young and edible, but later turn dark as the spores develop. In some species the stems are comparatively smooth and in others their surface is more or less wrinkled. The spores are borne in the depressions of the network. These mushrooms should not be eaten after the cells change from creamy white to brownish.

An edible morel (Morchella esculents).
Photo by George F. Atkinson.

Observations—1. Where did you find the morels?

2. Describe the stem. Is it solid or hollow? Is it smooth or rough?

3. What is the shape of the cap? How does it look? What color is the outer edge of the net-



A stinkhorn.
Photo by George F. Atkinson.

work? What is the color within the meshes?

4. Take one of these fungi, lay it on a sheet of white paper, and note the color of the spores.

LESSON CLXXXV

The Stinkhorns

To give a nature-study lesson on the stinkhorn is quite out of the question, for the odor of these strange growths is so nauseating that even to come near to one of them in the garden is a disagreeable experience. The reason for mentioning them at all is because of the impression made by them that most mushrooms are ill smelling, which is a slander.

It is a pity that these fungi are so offensive that we do not care to come near enough to them to admire them, for they are most interesting in appearance. The scientific name of our commonest genus when translated means "the net bearers," and it is a most appropriate name. The stout, white stem is composed of network without and within. The outer covering of the stem seems to tear loose from the lower portion as the stem elongates, and is lifted so that it hangs as a veil around the bottom of the bell-shaped cap, which is always covered with a pitted network. The mycelium, or spawn, of the stinkhorn consists of strands which push their way through the ground or through the decaying vegetable matter on which they feed. On these strands are produced the stinkhorns, which at first look like eggs; but later the top of the egg is broken, and the strange horn-shaped fungus pushes up through it. The spores are borne in the chambers of the cap, and when ripe the substance of these chambers dissolves into a thick liquid in which the spores float. The flies are attracted by the fetid odor and come to feast upon these fungi and to lay their eggs within them, and incidentally they carry the spores away on their brushy feet, and thus help to spread the species.

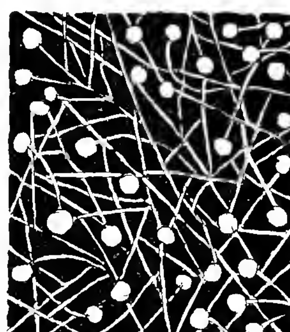
MOLDS

Teacher's Story

It is lucky for our peace of mind that our eyes are not provided with microscopic lenses, for then we should know that the dust, which seems to foregather upon our furniture from nowhere, is composed of all sorts of germs, many of them of the deadly kind. The spores of mold are very minute objects, the spore-cases being the little white globes, not larger than the head of a small pin which we see upon mold, yet each of these spore-cases breaks and lets out into the world thousands of spores, each one ready and anxious to start a growth of mold and perfectly able to do it under the right conditions; almost any substance which we use for food, if placed in a damp and rather dark place, will prove a favorable situation for the development of the spore which swells, bursts its wall and sends out a short thread. This gains nourishment, grows longer and branches, sending out many threads, some of which go down into the nutritive material and are called the mycelium. While these threads, in a way, act like roots, they are not true roots. Presently the tip ends of the threads, which are spread out in the air above the bread or other material, begin to enlarge, forming little globules; the substance (protoplasm) within them breaks up into little round bodies, and each develops a cell wall and thus becomes a spore. When these are unripe they are white but later, they become almost black. In the blue mold the spores are borne in clusters of chains, and resemble tiny tassels instead of growing within little globular sacs.

Molds, mildews, blights, rusts and smuts are all flowerless plants and, with the mushrooms, belong to the great group of fungi. Molds and mildews will grow upon almost any organic substance, if the right conditions of moisture are present, and the temperature is not too cold.

Molds of several kinds may appear upon the bread used in the experiments for this lesson. Those most likely to appear are the bread mold—consisting of long, white threads tipped with white, globular spore-cases, and the green cheese-mold—which looks like thick patches of blue-green powder. Two others may appear, one a smaller white mold with smaller spore-cases, and a black mold. However, the bread mold is the one most desirable for this lesson, because of its comparatively large size. When examined with a lens, it is a most exquisite plant. The long threads are fringed at the sides, and they pass over and through each other, making a web fit for fairies—a web all beset with the spore-cases, like fairy pearls. However, as the spores ripen, these spore-cases turn black, and after a time so many of them are developed and ripened that the whole mass of mold is black. The time required for the development of mold varies with the temperature. For two or three days nothing may seem to be happening upon the moist bread; then a queer, soft whiteness appears in patches. In a few hours or perhaps during the night, these white patches send up white fuzz which is soon dotted with tiny pearl-like spore-cases. At first there is no odor when the glass is lifted from the saucer, but after the spores ripen, the odor is quite disagreeable.



Bread mold, enlarged.

The special point to teach the children in this lesson is that dryness and sunlight are unfavorable to the development of mold; and it might be well to take one of the luxuriant growths of mold developed in the dark, uncover it and place it in the sunlight, and see how soon it withers. The lesson should also impress upon them that dust is composed, in part, of living germs waiting for a chance to grow.

LESSON CLXXXVI
Molds

Leading thought—The spores of mold are everywhere and help to make what we call dust. These spores will grow on any substance which gives them nourishment, if the temperature is warm, the air moist and the sunlight is excluded.

Method—Take bread in slices two inches square, and also the juice of apple sauce or other stewed fruit. Have each pupil, or the one who does the work for the class, provided with tumblers and saucers. Use four pieces of bread cut in about two-inch squares, each placed on a saucer; moisten two and leave the other two dry. With a feather or the finger take some dust from the woodwork of the room or the furniture and with it lightly touch each piece of bread. Cover each with a tumbler. Set one of the moistened pieces in a warm, dark place and the other in a dry, sunny place. Place a dry piece in similar situations. Let the pupils examine these every two or three days.

Put fruit juice in a saucer, scatter a little dust over it and set it in a warm, dark place. Take some of the same, do not scatter any dust upon it, cover it safely with a tumbler and put it in the same place as the other. A lens is necessary for this lesson, and it is much more interesting for the pupils if they can see the mold under a microscope with a three-fourths objective.

Observations—1. When does the mold begin to appear? Which piece of bread showed it first? Describe the first changes you noticed. What is the color of the mold at first? Is there any odor to it?

2. At what date did the little branching mold-threads with round dots appear? Is there an odor when these appear? What are the colors of the dots, or spore-cases, at first? When do these begin to change color? How does the bread smell then? What caused the musty odor?

3. Did the mold fail to appear on any of the pieces of bread? If so, where were these placed? Were they moist? Were they exposed to the sunlight?

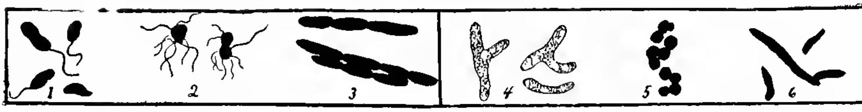
4. Did more than one kind of mold appear on the bread? If so, how do you know that they are different kinds? Are there any pink or yellow patches on the bread? If so, these are made by bacteria and not by mold.

5. From the results of the experiments, describe in what temperature mold grows best. In what conditions of dryness or moisture? Does it flourish in the sunlight or in the dark?

6. Where does the mold come from? What harm does it do? What should we do to prevent the growth of mold? Name all of the things on which you have seen mold or mildew growing.

7. Examine the mold through a microscope or a lens. Describe the threads. Describe the little round spore-cases. Look at some of the threads that have grown down into the fruit juice. Are they like the ones which grow in the air?

8. If you have a microscope cut a bit of the mold off, place it in a drop of water on a glass slide, put on a cover-glass. Examine it with a three-fourths objective, and describe the spores and spore-cases.



1. Cholera bacillus.
2. Typhoid bacillus.
3. A bacillus found in sewage.
These are all enlarged 2000 times.

4. Bacteria from tubercle on white sweet clover, much enlarged.
5 and 6. Bacteria of lactic acid ferments in ripening of cheese, much enlarged.

BACTERIA

Teacher's Story

The yellow, pink or purple spots developed upon the moist and moldy bread are caused by bacteria and yeast. Bacteria are one-celled organisms now classed as plants; they are the smallest known living beings, and can only be seen through a high power microscope.

Bacteria grow almost everywhere—in the soil, on all foods and fruits, in the water of ponds, streams and wells, in the mouths and stomachs of human beings, and in fact in almost all possible places, and occur in the air. Most of them are harmless, some of them are useful, and some produce disease in both plants and animals, including man.

What bacteria do would require many large volumes to enumerate. Some of them develop colors or pigments; some produce gases, often ill-smelling; some are phosphorescent; some take nitrogen from the air and fix it in the soil; some produce putrefaction; and some produce disease. Nearly all of the "catching diseases" are produced by bacteria. Diphtheria, scarlet fever, typhoid fever, consumption, influenza, grippe, colds, cholera, lockjaw, leprosy, blood poisoning and many other diseases are the result of bacteria. On the other hand, many of the bacteria are beneficial to man. Some forms ripen the cream before churning, others give flavor to butter; while some are an absolute necessity in making cheese. The making of cider into vinegar is the work of bacteria; some clear the pollution from ponds and streams; some help to decompose the dead bodies of animals, so that they return to the dust whence they came.

We have in our blood little cells whose business it is to destroy the harmful bacteria which get into the blood. These little fighting cells move everywhere with our blood, and if we keep healthy and vigorous by right living, right food and exercise, these cells may prove strong enough to kill the disease germs before they harm us. Direct sunlight also kills some of the bacteria. Seven or eight minutes exposure to bright sunlight is said to kill the germs of tuberculosis. Exposure to the air is also a help in subduing disease germs. Bichloride of mercury, carbolic acid, formaldehyde and burning sulphur also kill germs, and may be applied to clothing or to rooms in which patients suffering from these germ diseases have been. We can do much to protect ourselves from harmful bacteria by being very clean in our persons and in our homes, by bathing frequently and washing our hands with soap often. We should eat only pure and freshly cooked food, we should get plenty of sleep and admit the sunlight to our homes; we should spend all the time possible in the open air and be careful to drink pure water. If we are not sure that the water is pure, it should be boiled for twenty minutes and then cooled for drinking.

In Experiment A the milk vials and the corks are all boiled, so that we may be sure that no other bacteria than the ones we chose are present, since boiling kills these germs. As soon as the milk becomes discolored we know that it is full of bacteria.

Experiment B shows that bacteria can be transplanted to gelatin, which is a material favorable for its growth. But the point of this experiment is to show the child that a soiled finger will have upon it germs which, by growing, cloud the gelatin. They should thus learn the value of washing their hands often or of keeping their fingers out of their mouths.

Experiment C shows the way the destructive bacteria attack the potato. The discolored spots show where the decay begins, and the odor is suggestive of decay. If a potato thus attacked is put in the bright sunlight the bacteria are destroyed, and this should enforce the moral of the value of sunshine.

References—The Story of the Bacteria; Dust and its Dangers, M. T. Prudden, Putnam's. Bacteria in Relation to Country Life, Lipman.

LESSON CLXXXVII

Bacteria

Leading thought—Bacteria are such small plants that we cannot see them without the aid of a microscope, but they can be planted and will grow. The object of this lesson is to enforce cleanliness.

Method—Experiment A—The bread used for the mold experiment is likely to develop spots of yellow, red or purple upon it, and cultures from these spots may be used in this lesson as follows: Take some vials, boil them and their corks, and nearly fill them with milk that has been boiled. Take the head of a pin or hairpin, sterilize the point by holding in a flame, let it cool, touch one of the yellow spots on the bread with the point, being careful to touch nothing else, and thrust the point with the bacteria on it into the milk; then cork the vials.

Experiment B—Prepare gelatin as for the table but do not sweeten. Pour some of this gelatin on clean plates or saucers. After it has cooled let one of the children touch lightly the gelatin in one saucer for a few seconds with his soiled finger. Note the place. Ask him to wash his hands thoroughly with soap and then apply a finger to the surface of the gelatin in the other plate. Cover both plates to keep out the dust and leave them for two or three days in a dark place. The plates touched by the soiled finger will show a clouded growth in the gelatin; the other plate will show a few irregular, scattered growths or none.

Experiment C—Take a slice of boiled potato, place in a saucer, leave it uncovered for a time or blow dust upon it, label with date, then cover with a tumbler to keep from drying and place in a cool, somewhat dark place.

The pupils should examine all these cultures every day and make the following notes:

Experiment A—How soon did you observe a change in the color of the milk? How can you tell when the milk is full of the bacteria? How do you know that the bacteria in the milk was transplanted by the pin?

Experiment B—Can you see that the gelatin is becoming clouded where the soiled finger touched it? This is a growth of the bacteria which were on the soiled finger.

Experiment C—What change has taken place in the appearance of the slice of potato? Are there any spots growing upon it? What is the odor?

What makes the spots? Describe the shape of the spots. The color. Are any of them pimple-shaped? Make a drawing of the slice of potato showing the bacteria spots. What are the bacteria doing to the potato? Take a part of the slice of potato with the bacteria spots upon it, and put it in the sunshine. What happens? Compare this with the part kept in the dark.

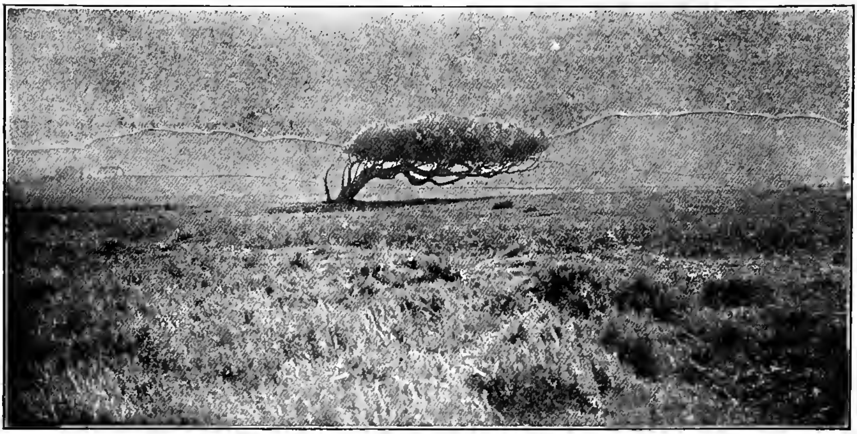
After this lesson the children should be asked the following questions.

1. Why should the hands always be washed before eating?
2. Why should the finger nails be kept clean?
3. Why should we never bite the finger nails nor put the fingers in the mouth?
4. Why should we never put coins in the mouth?
5. Why should wounds be carefully cleansed and dressed at once?
6. Why should clothing, furniture and the house be kept free from dust?
7. Why should sweeping be done as far as possible without raising dust?
8. Why are hardwood floors more healthful than carpets?
9. Why is a damp cloth better than a feather duster for removing dust?
10. Why should the prohibition against spitting in public places be strictly enforced?
11. Why should the dishes, clothes and other articles used bysick persons be kept distinctly separate from those used by well members of the family?
12. Why should food not be exposed for sale on the street?
13. Why, during an epidemic, should water be boiled before drinking?

"This habit of looking first at what we call the beauty of objects is closely associated with the old conceit that everything is made to please man: man is only demanding his own. It is true that everything is man's because he may use it or enjoy it, but not because it was designed and 'made' for 'him' in the beginning. This notion that all things were made for man's special pleasure is colossal self-assurance. It has none of the humility of the psalmist, who exclaimed, 'What is man, that thou art mindful of him?'"

"'What were these things made for, then?' asked my friend. Just for themselves! Each thing lives for itself and its kind, and to live is worth the effort of living for man or bug. But there are more homely reasons for believing that things were not made for man alone. There was logic in the farmer's retort to the good man who told him that roses were made to make man happy. 'No, they wa'n't', said the farmer, 'or they wouldn't a had prickers.' A teacher asked me what snakes are 'good for.' Of course there is but one answer: they are good to be snakes."

—"The Nature Study Idea", L. H. Bailey.



A Pacific Coast live oak showing the effects of constant, strong winds from one direction.
Photo by G. K. Gilbert. Courtesy of U. S. Geological Survey.

TREE STUDY

Teacher's Story

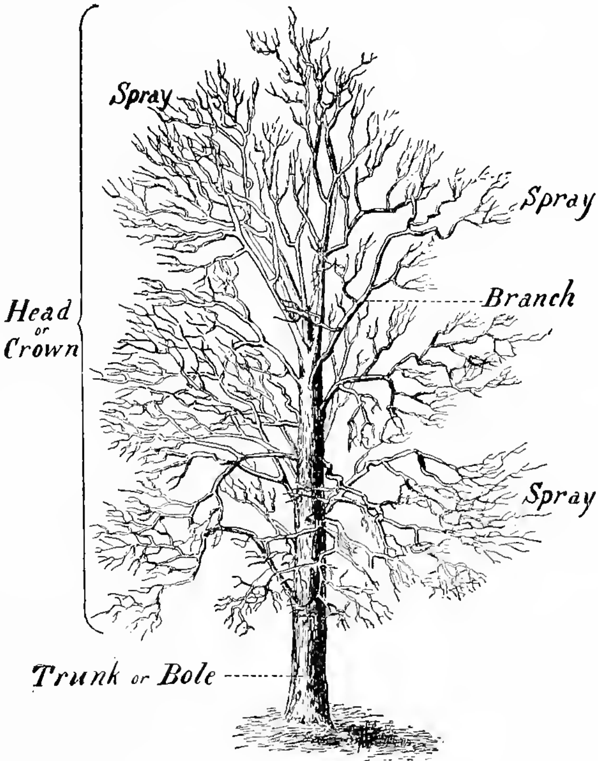
"I wonder if they like it—being trees?
I suppose they do.
It must feel so good to have the ground so flat,
And feel yourself stand straight up like that.
So stiff in the middle, and then branch at ease,
Big boughs that arch, small ones that bend and blow,
And all those fringy leaves that flutter so.
You'd think they'd break off at the lower end
When the wind fills them, and their great heads bend.
But when you think of all the roots they drop,
As much at bottom as there is on top,
A double tree, widespread in earth and air,
Like a reflection in the water there."

—"Tree Feelings" by Charlotte Perkins Stetson

NATURAL is our love for trees! A tree is a living being, with a life comparable to our own. In one way it differs from us greatly: it is stationary, and it has roots and trunk instead of legs and body; it is obliged to wait to have what it needs come to it, instead of being able to search the wide world over to satisfy its wants.

THE PARTS OF THE TREE

The *head*, or *crown*, is composed of the branches as a whole, which in turn are composed of the larger and smaller branches and twigs. The *spray* is the term given to the outer twigs, the finest divisions of the trunk, which bear the leaves and fruit. The branches are divisions of the *bole*, or *trunk*, which is the body, or stem, of the tree. The bole, at the base, divides into roots, and the roots into rootlets, which are covered with root-hairs. It is important to understand what each of the parts of a tree's anatomy does to help carry on the life of the tree.



A tree with parts named.

The roots, which extend out in every direction beneath the surface of the ground, have two quite different offices to perform: First, they absorb the water which contains the tree food dissolved from the soil; second, they hold the tree in place against the onslaught of the winds. If we could see a tree standing on its head with its roots spread in the air in the same manner as they are in the ground, we could then better understand that there is as much of the tree hidden below ground as there is in sight above ground, although of quite different shape, being flatter and in a more dense mass. The roots seem to know in which direction to grow to reach water; thus, the larger number of the roots of a tree are often found to extend out toward a stream flowing perhaps some distance from the tree; when they find plenty of food and water the rootlets interlace forming a solid mat. On the Cornell Campus are certain elms which, every six or seven years, completely fill and clog the nearby sewers; these trees send most of their roots in the direction of the sewer pipe. The fine rootlets upon the tree-roots are covered with root-hairs, which really form the mouths by which the liquid food is taken into the tree.

To understand how firm a base the roots form to hold up the tall trunk, we need to see an uprooted tree. The great roots seem to be molded to take firm grasp upon the soil. It is interesting to study some of the "stump fences" which were made by our forefathers, who uprooted the white pines when the land was cleared of the primeval forest, and made fences of their widespreading but rather shallow extending roots. Many of these fences stand to-day with branching, out-reaching roots, white and weather-worn, but still staunch and massive as if in memory of their strong grasp upon the soil of the wilderness.

The upturned roots of a white pine; a part of a stump fence a century old.

The trunk, or bole, or stem of the tree has also two chief offices: It holds the branches aloft, rising to a sufficient height in the forest so that its head shall push through the leaf canopy and expose the leaves to the sunlight. It also is a channel by which the water containing the food surges from root to leaf and back again through each growing part. The branches are divisions of the trunk, and have the same work to do.

In cross-section, the tree trunk shows on the outside the layer of protective bark; next to this comes the cambium layer, which is the vital part of the trunk; it builds on its outside a layer of bark, and on its inside a layer of wood around the trunk. Just within the cambium layer is a lighter colored portion of the trunk, which is called the sap-wood because it is filled with sap which moves up and down its cells in a mysterious manner; the sap-wood consists of the more recent annual rings of growth. Within the sap-wood are concentric rings to the very center or pith; this portion is usually darker in color and is called the heartwood; it no longer has anything to do with the life of the tree, but simply gives to it strength and staunchness. The larger branches, if cut across, show the same structure as the trunk,—the bark on the outside, the cambium layer next, and within this the rings of annual growth. Even the smaller branches and twigs show similar structure, but they are young and have not attained many annual rings.

The leaves are borne on the outermost parts of the tree. A leaf cannot grow, and if it could would be of no use, unless it can be reached by the sunlight. Therefore the trunk lifts the branches aloft, and the branches hold the twigs far out, and the twigs divide into the fine spray, so as to spread the leaves and hold them out into the sunshine.

In structure, the leaf is made up of the stem, or petiole, and the blade, or widened portion of the leaf, which is sustained usually with a framework of many ribs or veins. The petioles and the veins are sap channels like the branches and twigs.

WOOD-GRAIN

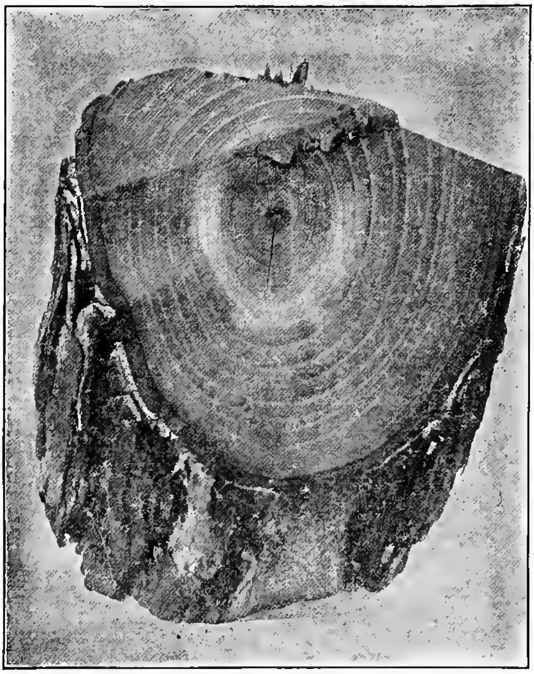
This is the way that the sap-river ran
From the root to the top of the tree
Silent and dark,
Under the bark,
Working a wonderful plan
That the leaves never know,
And the branches that grow
On the brink of the tide never see.

—John B. Tabb.

THE WAY A TREE GROWS

THE places of growth on a tree may be found at the tips of the twigs and the tips of the rootlets; each year through this growth the tree pushes up higher, down deeper and out farther at the sides. But in addition to all of these growing tips, there is a layer of growth over the entire tree—over every root, over the trunk, over the limbs and over each least twig, just as if a thick coat of paint had been put over the complete tree. It is a coat of growth instead, and these coats of growth make the concentric rings which we see when the trunks or branches are cut across. Such growth as this cannot be made without food; but the tree can take only liquid food from the soil; the root-hairs take up the water in which the "fertilizer" is dissolved, and it is carried up through the larger roots, up through the sap-wood of the trunk, out through the branches to the leaves, where in the leaf-factories the water and free oxygen is given off to the air, and the nourishing elements retained and mixed with certain chemical elements of the air, thus becoming tree food. The leaf is a factory; the green pulp in the leaf cells is part of the machinery; the machinery is set in motion by sunshine power; the raw materials are taken from the air and from the sap containing food from the soil; the finished product is largely starch. Thus, it is well, when we begin the study of the tree, to notice that the leaves are so arranged as to gain all the sunlight possible, for without sunlight the starch factories would be obliged to "shut down." It has been estimated that on a mature maple of vigorous growth there is exposed to the sun nearly a half acre of leaf surface. Our tree appears to us in a new phase when we think of it as a starch factory covering half an acre.

Starch is plant food in a convenient form for storage, and it is stored in sap-wood of the limbs, the branches and trunk, to be used for the growth of the next year's leaves. But starch cannot be assimilated by plants in this form, it must be changed to sugar before it may be used to build up the plant tissues. So the leaves are obliged to perform the office of stomach and digest the food they have made for the tree's use. In the mysterious laboratory of the leaf-cells, the starch is changed to sugar; and nitrogen, sulphur, phosphorus and other substances are taken from the sap and starch added to them, and thus are made the proteids which form another part of the tree's diet. It is interesting to note that while the starch factories can operate only in the sunlight, the leaves can digest the food and it can be transported and used in the growing tissues in the *dark*. The leaves are also an aid to the tree in breathing, but they are not especially the lungs of the tree. The tree breathes in certain respects as we do; it takes in oxygen and gives off carbondioxid; but the air containing the oxygen is taken in through the numerous pores in the leaves called stomata, and also through lenticels in the bark; so the tree really breathes all over its active surface.

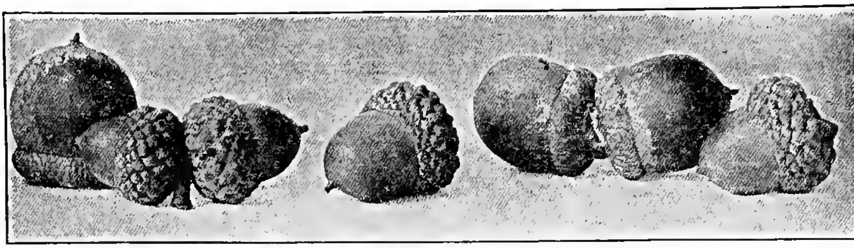


A stump showing rings of growth.

The tree is a rapid worker and achieves most of its growth and does most of its work by midsummer. The autumn leaf which is so beautiful has completed its work. The green starch-machinery or chlorophyl, the living protoplasm in the leaf cells, has been withdrawn and is safely secluded in the woody part of the tree. The autumn leaf which glows gold or red, has in it only the material which the tree can no longer use. It is a mistake to believe that the frost causes the brilliant colors of autumn foliage; they are caused by the natural old age and death of the leaves—and where is there to be found old age and death more beautiful? When the leaf assumes its bright colors, it is making ready to depart from the tree; a thin, corky layer is being developed between its petiole and the twig, and when this is perfected, the leaf drops from its own weight or the touch of the slightest breeze.

A tree, growing in open ground, records in its shape, the direction of the prevailing winds. It grows more luxuriantly on the leeward side. It touches the heart of the one who loves trees to note their sturdy endurance of the onslaughts of this, their most ancient enemy.

Reference Books for Tree Study—The Tree Book, Julia Rogers; Our Native Trees, Harriet Keeler; Our Northern Shrubs, Harriet Keeler; The Trees of the Northern States, Romayne Hough. The Trees, N. L. Britton; Getting Acquainted with the Trees, J. Horace McFarland; Familiar Trees and their Leaves, Schuyler Mathews; Our Trees and How to Know Them, Clarence Moores Weed; A Guide to the Trees, Alice Lounsberry; The First Book of Forestry, Filibert Roth; Practical Forestry, John Gifford; Trees in Prose and Poetry, Stone & Fickett; The Primers of Forestry, Pinchot.



Acorns of the red and the scarlet oaks.
Photo by O. L. Foster.

HOW TO BEGIN TREE STUDY

Teacher's Story

DURING autumn the attention of the children should be attracted to the leaves by their gorgeous colors. It is well to use this interest to cultivate their knowledge of the forms of leaves of trees; but the teaching of the tree species to the young child should be done quite incidentally and guardedly. If the teacher says to the child bringing a leaf, "This is a white oak leaf," the child will soon quite unconsciously learn that leaf by name. Thus, tree study may be begun in the kindergarten or the primary grades.

1. Let the pupils use their leaves as a color lesson by classifying them according to color, and thus train the eye to discriminate tints and color values.

2. Let them classify the leaves according to form, selecting those which resemble each other.

3. Let each child select a leaf of his own choosing and draw it. This may be done by placing the leaf flat on paper and outlining it with pencil or with colored crayon.

4. Let the pupils select paper of a color similar to the chosen leaf and cut a paper leaf like it.

5. Let each pupil select four leaves which are similar and arrange them on a card in a symmetrical design. This may be done while the leaves are fresh, and the card with leaves may be pressed and thus preserved.

In the fourth grade, begin with the study of a tree which grows near the schoolhouse. In selecting this tree and in speaking of it, impress upon the children that it is a living being, with a life and with needs of its own. I believe so much in making this tree seem an individual, that I would if necessary name it Pocahontas or Martha Washington. First, try to ascertain the age of the tree. Tell an interesting story of who planted it and who were children and attended school in the schoolhouse when the tree was planted. To begin the pupils' work, let each have a little note-book in which shall be written, sketched or described all that happens to this particular tree for a year. The following words with their meaning should be given in the reading and spelling lessons: *Head, bole, trunk, branches, twigs, spray, roots, bark, leaf, petiole, foliage, sap.*

Mountain maple, sugar maple and red maple.

LESSON CLXXXVIII

Tree Study

Autumn Work—1. What is the color of the tree in its autumn foliage? Sketch it in water colors or crayons, showing the shape of the head, the relative proportions of head and trunk.

2. Describe what you can see of the tree's roots. How far do you suppose the roots reach down? How far out at the sides? In how many ways are the roots useful to the tree? Do you suppose, if the tree were turned bottomside up, that it would show as many roots as it now shows branches?

3. How high on the trunk from the ground do the lower branches come off? How large around is the trunk three feet from the ground? If you know how large around it is, how can you get the distance through? What is the color of the bark? Is the bark smooth or rough? Are the ridges fine or coarse? Are the furrows between the ridges deep or shallow? Of what use is the bark to the tree?

4. Describe the leaf from your tree, paying special attention to its shape, its edges, its color above and below, its veins or ribs, and the relative length and thickness of its petiole. Are the leaves set opposite or alternate upon the twigs? As the leaves begin to fall, can you find two which are exactly the same in size and shape? Draw in your note-book the two leaves which differ most from each other of any that grew on your tree. At what date do the leaves begin to fall from your tree? At what date are they all off the tree?

5. Do you find any fruit or seed upon your tree? If so describe and sketch it, and tell how you think it is scattered and planted.

Winter Study of the Tree—1. Make a sketch of the tree in your notebook, showing its shape as it stands bare. Does the trunk divide into branches, or does it extend through the center of the tree and the branches come off from its sides? Of what use are the branches to a tree? Is the spray, or the twigs at the end of the branches, coarse or fine? Does it lift up or droop? Is the bark on the branches like that on the trunk? Is the color of the spray the same as of the large branches? Why does the tree drop its leaves in winter? Does the tree grow during the winter? Do you think that it sleeps during the winter?

2. Study the cut end of a log or stump and also study a slab. Which is the heart-wood and which is the sap-wood? Can you see the rings of growth? Can you count these rings and tell how old was the tree from which this log came? Describe if you can, how a tree trunk grows larger each year. What is it makes the grain in the wood which we use for furniture? If we girdle a tree why does it die? If we place a nail in a tree three feet from the ground this winter, will it be any higher from the ground ten years from now? How does the tree grow tall?

3. Take a twig of a tree in February and look carefully at the buds. What is their color? Are they shiny, rough, sticky or downy? Are they arranged on the twigs opposite or alternate? Can you see the scar below the buds where the last year's leaf was borne? Place the twig in water and put in a light, warm place, and see what happens to the buds. As the leaves push out, what happens to the scales which protected the buds?

4. What birds do you find visiting your tree during winter? Tie some strips of beef fat upon its branches, and note all of the kinds of birds which come to feast upon it.

Trees in winter.

Spring Work—1. At what date do the young leaves appear upon your tree? What color are they? Look carefully to see how each leaf was folded in the bud. Were all the leaves folded in the same way? Are the young leaves thin, downy and tender? Do they stand out straight as did the old leaves last autumn, or do they droop? Why? Will they change position and stand out as they grow stronger? Why do the leaves stand out from the twigs in order to get sunshine? What would happen to a tree if it lost all its leaves in spring and summer? Tell all of the things you know which the leaves do for the tree?

2. Are there any blossoms on your tree in the spring? If so, how do they look? Are the blossoms which bear the fruit on different trees from those that bear the pollen, or are these flowers placed separately on the same tree? Or does the same flower which produces the pollen also produce the seed? Do the insects carry the pollen from flower to flower, or does the wind do this for your tree? What sort of seeds are formed by these flowers? How are the seeds scattered and planted?

3. At what date does your tree stand in full leaf? What color is it now? What birds do you find visiting it? What insects? What animals seek its shade? Do the squirrels live in it?

4. Measure the height of your tree as follows: Choose a bright, sunny morning for this. Take a stick 3½ feet long and thrust it in the ground so that three feet will project above the soil. Immediately measure the length of its shadow and of the shadow which your tree makes from its base to the shadow of its topmost twigs. Supposing that the shadow from the stick is 4 feet long and the shadow from your tree is 80 feet long, then your example will be: 4 ft.:3 ft.:: 80 ft.:? Which will make the tree 60 feet high.

To measure the circumference of the tree, take the trunk three feet from the ground and measure it exactly with a tape measure. To find the thickness of the trunk, divide the circumference just found by 3.15.

Supplementary Reading—Among Green Trees, Rogers; Chap. I in A Primer of Forestry, Pinchot; Part I in A First Book of Forestry, Roth; Chapter IV in Practical Forestry, Gifford.

LESSON CLXXXIX

How to Make Leaf Prints

A very practical help in interesting children in trees, is to encourage them to make portfolios of leaf-prints of all the trees of the region. Although the process is mechanical, yet the fact that every print must be correctly labeled makes for useful knowledge. One of my treasured possessions is such a portfolio made by the lads of St. Andrews School of Richmond, Va., who were guided and inspired in this work by their teacher, Professor W. W. Gillette. The impressions were made in green ink and the results are as beautiful as works of art. Professor Gillette gave me my first lesson in making leaf prints.

Material—1. A smooth slate, or better, a thick plate of glass, about 12 x 15 inches.

2. A tube of printer's ink, either green or black, and costing 50 cents; one tube contains a sufficient supply of ink for making several hundred prints. Or a small quantity of printer's ink may be purchased at any printing office.

3. Two six-inch rubber rollers, such as photographers use in mounting prints, which cost 15 cents each. A letter-press may be used instead of one roller.

4. A small bottle of kerosene to dilute the ink, and a bottle of benzine for cleaning the outfit after using, care being taken to store them safe from fire.

5. Sheets of paper 8½ x 11 inches. The paper should be of good quality, with smooth surface in order that it may take and hold a clear out-

Leaf print of a sycamore maple.

line. The ordinary paper used in printers' offices for printing newspapers works fairly well. I have used with success the paper from blank note-books which cost five cents a piece.

To make a print, place a few drops of ink upon the glass or slate, and spread it about with the roller until there is a thin coat of ink upon the roller and a smooth patch in the center of the glass or slate. It should never be so liquid as to "run," for then the outlines will be blurred. Ink the leaf by placing it on the inky surface of the glass and passing the inked roller over it once or twice until the veins show that they are smoothly filled. Now place the inked leaf between two sheets of paper and roll *once* with the *clean* roller, bearing on with all the strength possible; a second passage of the roller blurs the print. Two prints are made at each rolling, one of the upper, and one of the under side of the leaf. Dry and wrinkled leaves may be made pliant by soaking in water, drying between blotters before they are inked.

Prints may also be made a number at a time by pressing them under weights, being careful to put the sheets of paper with the leaves between the pages of old magazines or folded newspapers, in order that the impression of one set of leaves may not mar the others. If a letter-press is available for this purpose, it does the work quickly and well.

SAP

Strong as the sea and silent as the grave,
It flows and ebbs unseen,
Flooding the earth, a fragrant tidal wave,
With mists of deepening green.

—JOHN B. TABB.

THE MAPLES

Teacher's Story

THE sugar maple, combining beauty with many kinds of utility, is dear to the American heart. Its habits of growth are very accommodating; when planted where it has plenty of room, it shows a short trunk and oval head, which, like a dark green period, prettily punctuates the summer landscape; but when it occurs in the forest, its noble bole, a pillar of granite gray, rises to uphold the arches of the forest canopy; and it attains there the height of 100 feet. It grows rapidly and is a favorite shade tree, twenty years being long enough to make it thus useful. The foliage is deep green in the summer, the leaf being a glossy, dark green above and paler beneath. It has five main lobes, the two nearest the stem being smaller; the curved edges between the lobes are marked with a few, smoothly cut, large teeth; the main veins extend directly from the petiole to the sharp tips of the lobes; the petiole is long, slender, and occasionally red. The leaves are placed opposite. The shade made by the foliage of the maple is so dense that it shades down the plants beneath it, even grass growing but sparsely there. If a shade tree stands in an exposed position, it grows luxuriously to the leeward of the prevailing winds, and thus makes a one-sided record of their general direction.

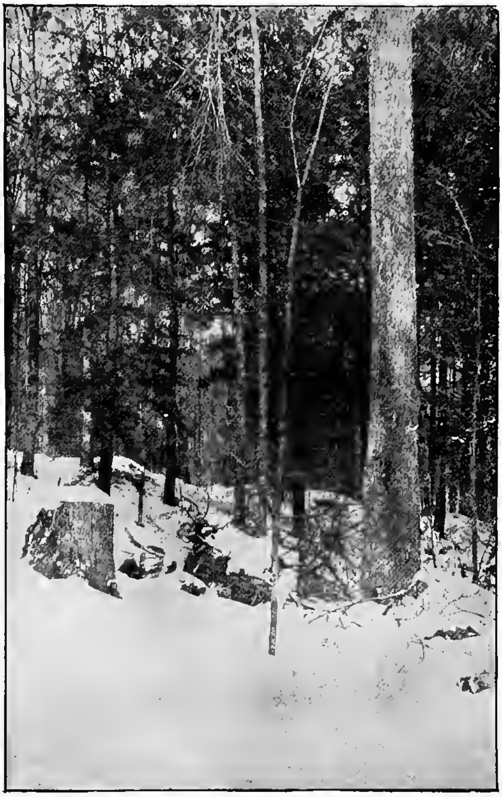
It is its autumn transfiguration which has made people observant of the maple's beauty; yellow, orange, crimson and scarlet foliage make these trees gorgeous when October comes. Nor do the trees get their color uniformly; even in September, the maple will show a scarlet branch in the midst of its green foliage. I believe this is a hectic flush and a premonition of death to the branch which, less vigorous than its neighbors, is being pruned out by Nature's slow but sure method. After the vivid color is on the maple, it begins to shed its leaves. This is by no means the sad act which the poets would have us believe; the brilliant colors are an evidence that the trees have withdrawn from the leaves the green life-substance, the protoplasm-machinery for making the starch, and have stored it snugly in trunk and branch for winter keeping. Thus, only the mineral substances are left in the leaf, and they give the vivid hues. It is a mistake to think that frost causes this brilliance; it is caused by the natural, beautiful, old age of the leaf. When the leaves finally fall, they form a mulch-carpet for the tree that bore them, and add their substance to the humus from which the tree draws new powers for growth.

After every leaf has fallen, the maple shows why its shade is dense. It has many branches set close and at sharp angles to the trunk, dividing into fine, erect spray, giving the tree a resemblance to a giant whisk-broom. Its dark, deep-furrowed bark smoothes out and becomes light gray on the larger limbs, while the spray is purplish, a color given it by the winter buds. These buds are sharp-pointed and long. In February, their covering of scales shows premonitions of spring by enlarging, and as if due to the soft influence, they become downy, and take on a sunshine color before they are pushed off by the leaves. The leaves and the blossoms appear together. The leaves are at first, yellowish, downy and drooping, thus shunning the too hot sun and the violent pelting rains and fierce spring winds. The flowers appear in tassellike clusters, each downy drooping thread of the tassel bearing at its tip a five-lobed calyx, which may hold seven or eight long,

Sugar maple leaves.

A foretaste. Photo by Verne Morton

drooping stamens or a pistil with long, double stigmas. The flowers are greenish yellow, and those that bear pollen and those that bear the seeds may be borne on separate trees or on the same tree, but they are always in different clusters. If on the same tree, the seed-bearing tassels are at the tips of the twigs, and those bearing pollen are along the sides.


The trunk of sugar maple in forest.

The ovary is two-celled, but there is usually only one seed developed in the pair which forms a "key;" to observe this, however, we have to dissect the seeds; they have the appearance of two seeds joined together, each provided with a thin, closely veined wing and the two attached to the tree by a single long, drooping stem. This twin-winged form is well fitted to be whirled off by the autumn winds, for the seeds ripen in September. I have seen seedlings growing thickly for rods to the leeward of their parent tree, which stood in an open field. The maples bear blossoms and seeds every year. There are six species of native maples which are readily distinguishable. The silver and the red maples and the box elder are rather large trees; the mountain and the striped (or goose-foot) maples are scarcely more than shrubs, and mostly grow in woods along streams. The Norway and the sycamore maples have been introduced from Europe for ornamental planting. The cut-leaf silver maple comes from Japan.

The maple wood is hard, heavy, strong, tough and fine-grained; it is cream-color, the heart-wood showing shades of brown; it takes a fine polish and is used as a finishing timber for houses and furniture. It is used in construction of ships, cars, piano action and tool handles; its fine-grained quality makes it good for wood-carving; it is an excellent fuel and has many other uses.

MAPLE-SUGAR MAKING

Although we have tapped the trees in America for many hundred years, we do not as yet understand perfectly the mysteries of the sap flow. In 1903, the scientists at the Vermont Experiment Station did some very remarkable work in clearing up the mysteries of sap movement. Their results were published in their Bulletins 103 and 105, which are very interesting and instructive.

The starch which is changed to sugar in the sap of early spring was made the previous season and stored within the tree. If the foliage of the tree is injured by caterpillars one year, very little sugar can be made from that tree the next spring, because it has been unable to store enough starch in its sapwood and in the outer ray-cells of its smaller branches to make a good supply of sugar. During the latter part of winter, the stored starch disappears, being converted into tree-food in the sap, and then begins that wonderful surging up and down of the sap tide During the first part of a typical sugar season, more sap comes from above down than from below up; toward the end of the season, during poor sap days, there is more sap coming up from below than down from above. The ideal sugar weather consists of warm days and freezing nights. This change of temperature between day and night acts as a pump. During the day when the branches of the tree are warmed, the pressure forces into the hole bored into the trunk all the sap located in the adjacent cells of the wood. Then the suction which follows a freezing night drives more sap into those cells, which is in turn forced out when the top of the tree is again warmed. The tree is usually tapped on the south side, because the action of the sun and the consequent temperature-pump more readily affects that side.

Sugar maple blossoms.

"Tapping the sugar bush" are magical words to the country boy and girl. Well do we older folk remember those days in March when the south wind settled the snow into hard, marblelike drifts, and the father would say, "We will get the sap-buckets down from the stable loft and wash them, for we shall tap the sugar-bush soon." In those days the buckets were made of staves and were by no means so easily washed as are the metal buckets of to-day. Well do we recall the sickish smell of musty sap that greeted our nostrils, when we poured in the boiling water to clean those old brown buckets. Previously during the winter evenings, we all had helped fashion sap-spiles from stems of sumac. With buckets and spiles ready when the momentous day came, the large, iron caldron kettle was loaded on a stoneboat together with a sap-cask, log-chain, ax and various other utensils, and as many children as could find standing room; then the oxen were hitched on and the procession started across the rough pasture to the woods, where it eventually arrived after numerous stops for reloading almost everything but the kettle.

When we came to the boiling place, we lifted the kettle into position and flanked it with two great logs against which the fire was to be kindled. Meanwhile the oxen and stoneboat returned to the house for a load of buckets. The oxen blinking, with bowed heads, or with noses lifted aloft to keep the underbrush from striking their faces, "gee'd and haw'd" up hill and down dale through the woods, stopping here and there while the men with augers bored holes in certain trees near other holes which had bled sweet juices in years gone by. When the auger was withdrawn, the sap followed it, and enthusiastic young tongues met it half way, though they received more chips than sweetness therefrom; then the spiles were driven in with a wooden mallet.

The next day after "tapping," those of us large enough to wear the neck-yoke donned cheerfully this badge of servitude and with its help brought pails of sap to the kettle, and the "boiling" began. As the evening shades gathered, how delicious was the odor of the sap steam, permeating the woods farther than the shafts of firelight pierced the gloom! How weird and delightful was this night experience in the woods! And how cheerfully we swallowed the smoke which the contrary wind seemed ever to turn toward us! We poked the fire to send the sparks upward, and now and then added more sap from a barrel, and removed the scum from the boiling liquid with a skimmer thrust into the cleft of a long stick for a handle. As the evening wore on, we drew closer to each other as we told stories of the Indians, bears, panthers and wolves which had roamed these woods when our father was a little boy; and came to each of us a disquieting suspicion that perhaps they were not all gone yet, for everything seemed possible in those night-shrouded woods; and our hearts suddenly "jumped into our throats" when near by there sounded the tremulous, blood-curdling cry of the screech owl.

Sugar maple growing in the open.

After about three days of gathering and boiling sap, came the "siruping down." During all that afternoon we added no more sap and we watched carefully the tawny, steaming mass in the kettle; when it threatened to boil over, we threw in a thin slice of fat pork which seemed to have some mysterious calming influence. The odor grew more and more delicious and presently the sirup was pronounced sufficiently thick. The kettle was swung off the logs and the sirup dipped through a cloth strainer into a carrying-pail. Oh, the blackness of the residue left on that strainer! But it was clean woods-dirt and never destroyed our faith in the maple-sugar, any more than did the belief that our friends were made of dirt destroy our friendship for them. The next day our interests were transferred to the house where we "sugared off." There we boiled the sirup to sugar on the stove and pouring it thick and hot upon snow made that most delicious of all sweets—the maple-wax; or we stirred it until it "grained," before we poured it into the tins to make the "cakes" of maple-sugar.

Now the old stave bucket and the sumac spile are gone; in their place the patent galvanized spile not only conducts the sap but holds in place a tin bucket carefully covered. The old caldron kettle is broken, or lies rusting in the shed. In its place, in the new-fangled sugar-houses, are evaporating vats, set over furnaces with chimneys. But we may as well confess that the maple-sirup of to-day seems to us a pale and anaemic liquid, lacking the delicious flavor of the rich, dark nectar which we, with the help of cinders, smoke and various other things, brewed of yore in the open woods.

Maple seedling.

Photo by Slingerland.

Leaves of silver maple.

LESSON CXC

The Sugar Maple

Leading thought—The sugar maple grows very rapidly, and is therefore a useful shade tree. Its wood is used for many purposes, and from its sap is made a delicious sugar.

Method—This study of the maple should be done by the pupils out of doors, with a tree to answer the questions. The study of the leaves, blossoms and fruit may be made in the schoolroom. The maple is an excellent subject for Lesson CLXXXVIII. The observations should begin in the fall and continue at intervals until June.

Observations. Fall Work—

1. Where is the maple you are studying? Is it near other

trees? What is the shape of the head? What is the height of the trunk below the branches? What is the height of the tree? How large around

Blossoms of the silver maple.
Photo by Ralph Curtis.

is the trunk three feet from the ground? Can you find when the tree was planted? Can you tell by the shape of the tree from which direction the wind blows most often?

2. Can you find seeds on your tree? Each pair of seeds is called a key. Sketch a key, showing the way the seeds are joined and the direction of the wings. Sketch the stem which holds the key to the twig. Are both seeds of the key good or is one empty? How are the seeds scattered and planted?

Blossoms of mountain maple.
Photo by Ralph Curtis.

How far will a maple key fly on its wings? Plant a maple seed where you can watch it grow next year.

3. Make leaf prints and describe a leaf of the maple, showing its shape, its veins and petiole. Are the leaves arranged opposite or alternate on the twig? Make leaf-prints or sketches of the leaves of all the other kinds of maples which you can find. How can you tell the different kinds of maples by their leaves?

4. If your tree stands alone, measure the ground covered by its shadow from morning until evening. Mark the space by stakes. What grows beneath the tree? Do grass and other plants grow thriftily beneath the tree? Do the same plants grow there as in the open field?

5. Does your maple get its autumn colors all at once, or on one or two branches first? At what time do you see the first autumn colors on your tree? When is it completely clothed in its autumn dress? Is it all red or all yellow, or mixed? If it is yellow this year do you think it will be red next year? Watch and see. Sketch your maple in water-colors.

6. At what time do the leaves begin to fall? Do those branches which first colored brightly shed their leaves before the others? At what date does your tree stand bare?

7. Find a maple tree in the forest and compare it with one that grows as a shade tree in a field. Why this difference?

Blossom of striped maple.
Photo by Ralph Curtis.

Winter Work—8. Make a sketch of your maple with the leaves off. What sort of bark has it? Is the bark on the branches like that on the trunk? Are the main branches large? At what angle do they come off the trunk? Does the trunk extend up through the entire tree? Is the spray fine or coarse? Is it straight or crooked?

9. Study the winter buds. Are they alternate or opposite on the twigs? Are they shining or dull?

Spring Study—10. At what time do we tap maple trees for sap? On which side of the tree do we make the hole? If we tapped the tree earlier would we get any sap? What kind of weather is the best for causing sap flow? Do you suppose that it is the sap going up from the root to the tree and the branches, or that coming down from the branches to the root which flows into the bucket? Why do we not make maple-sugar all summer? Do you suppose the sap ceases to run because there is no more sap in the tree?

Leaves and fruit of striped maple.
Photo by Ralph Curtis.

11. Write a story telling all you can find in books or that you know from your own experience about the making of maple-sugar.

12. When do the leaves of your maple first appear? How do they then look? Do they stand out or droop?

13. Do the blossoms appear with the leaves or after them? How do the blossoms look? Can you tell the blossoms with stamens from those with pistils? Do you find them in the same cluster? Do you find them on the same tree?

14. What uses do we find for maple wood? What is the character of the wood?

Supplementary reading—Trees in Prose and Poetry pp. 25–41.

Blossoms of red maple.
Photo by Ralph Curtis.

THE AMERICAN ELM

Teacher's Story

ALTHOUGH the American elm loves moist woods, it is one of those trees that enjoys gadding; and without knowing just how it has managed to do it, we can see plainly that it has planted its seeds along fence corners, and many elms now grace our fields on sites of fences long ago laid low. Because of its beautiful form and its rapid growth, the elm has been from earliest times a favorite shade tree in the Eastern and Middle States. Thirty years after being planted, the elms on the Cornell Campus clasped branches across the avenues; and the beauty of many a village and city is due chiefly to these graceful trees of bounteous shade. Moreover the elm is at no time more beautiful than when it traces its flowing lines against the background of snow and gray horizon. Whether the tree be shaped like a vase or a fountain, the trunk divides into great uplifting branches, which in turn divide into spray that oftentimes droops gracefully, as if it were made purposely to sustain from its fine tips the woven pocket-nest of the oriole. No wonder this bird so often chooses the elm for its roof-tree!

The elm in winter.

In winter, the dark, coarsely-ridged bark and the peculiar, wiry, thick spray, as well as the characteristic shape of the tree reveal to us its identity; it also has a peculiar habit of growing its short branches all the way down its trunk, making it look as if it were entwined with a vine. The elm leaf, although its ribs are straight and simple, shows a little quirk of its own in the uneven sides of its base where it joins the petiole: it is dark green and rough above, light green and somewhat rough below; but this leaf is rough only when stroked in certain directions, while the leaf of the slippery elm is rough whichever way it may be stroked. The leaf has the edges saw-toothed, which are in turn toothed; the petiole is short. The leaf comes out of the bud in the spring folded like a little fan; but before the fans are opened to the spring breezes, the elm twigs are furry with reddish green blossoms. The blossom consists of a calyx with an irregular number of lobes, and for every lobe, a stamen which consists of a thread-like filament from which hangs a bright red anther; at the center is a two-celled pistil with two light green styles. These blossoms appear in March or early April, before the leaves.

When full-grown the fruit hangs like beaded fringe from the twigs. The seed is flat and has a wide, much veined margin or wing, notched at the tip and edged with a white silken fringe; the seed is at the center, wrinkled and flat. Each seed shows at its base the old calyx and is attached by a slender threadlike stem to the twig at the axils of last year's leaves. A little later the lusty breezes of spring break the frail threads and release the seeds, although few of them find places fit for growth.

Elm blossoms.
Photo by Ralph Curtis.

The elm roots are water hunters and extend deep into the earth; they will grow towards water, seeming to know the way. The elm heart-wood is reddish, the sap-wood being broad and whitish in color; the wood is very tough because of the interlaced fibers, and therefore very hard to split. It is used for cooperage, wheel hubs, saddlery, and is now used more extensively for furniture; its grain is most ornamental. It is fairly durable as posts, but perhaps the greatest use of all for the tree is for shade. The slippery elm is much like the white elm, except that its inner bark is very mucilaginous, and children love to chew it. The cork elm has a peculiar corky growth on its branches, giving it a very unkempt look. The wahoo, or winged elm, is a small tree, and its twigs are ornamented on each side by a corky layer. The English elm has a solid, round head, very different from that of our graceful species. The elms are long-lived, some living for centuries. The Washington elm in Cambridge, and the William Penn elm in Philadelphia, which now has a monument to mark its place, were famous trees.

Elm seed.
Photo by Morgan.

LESSON CXCI

The Elm

Leading thought—The elm has a peculiarly graceful form, which makes it of value as a shade tree. It grows best in moist locations. Its wood is very tough.

Method—This work should be begun in the fall with the study of the shape of the tree and its foliage. Sketches should be made when the tree is clothed in autumn tints, and later it should be sketched again when its branches are naked. Its blossoms should be studied in March and April and its seeds in May.

Observations—1. Where does the elm grow? Does it thrive where there is little water? What is the usual shape of the elm? How does the trunk divide into branches to make this shape possible? What is the shape of the larger elms? Describe the spray. Describe the elm bark. How can you tell the elm from other trees in winter?

2. Study the elm leaf. What is its form? What kind of edges has it? How large is it? What is the difference in appearance and feeling between the upper and lower sides? Are the leaves rough above whichever way you stroke them? If a leaf is folded lengthwise are the two halves exactly alike? How are the leaves arranged on the twig? What is their color above and below? Describe the leafy growth along the trunk.

3. What is the color of the elm tree in autumn? Make a sketch of the elm tree you are studying.

4. What sort of roots has the elm? Do they grow deep into the earth? What is the character of its wood? Is it easy to split? Why? What are the chief uses of the elm?

5. Do you know what distinguishes the slippery elm, the cork elm, the winged elm, or wahoo, and the English elm from the common American or white elm which you have been studying?

6. Write an essay on two famous American elms.

7. What birds love to build in the elm trees?

Spring Study of the Elm

8. Which appear first, the blossoms or the leaves? Describe the elm blossom. How long before the seeds ripen? How are the seeds attached to the twig? Describe an elm seed. How are the seeds scattered? How are the young leaves folded as they come out of the bud?

Supplementary reading—Trees in Prose and Poetry, pp. 81–92.

THE OAK

Teacher's Story

HE symbol of rugged strength since man first gazed upon its noble proportions, the oak more than other trees has been entangled in human myth, legend and imagination. It was regarded as the special tree of Zeus by the Greeks. Virgil sang of it thus:

"Full in the midst of his own strength he stands
Stretching his brawny arms and leafy hands,
His shade protects the plains, his head the hills
commands."

While in primitive England the strange worship of the Druids centered around it.

Although the oak is a tree of grandeur when its broad branches are covered with leafage, yet it is only in winter when it stands stripped like an athlete that we realize wherein its supremacy lies. Then only can we appreciate the massive trunk and the strong limbs bent and gnarled with combating the blasts of centuries. But there are oaks and oaks, and each species fights time and tempest in his own peculiar armor and in his own way. Many of the oaks achieve the height of eighty to one hundred feet. The great branches come off the sturdy trunk at wide angles, branches that may be crooked or gnarled but are ever long and strong; the smaller branches also come off at wide angles, and in turn bear angular individual spray—all of

White oak leaves and acorn.

which, when covered with leaves, make the broad, rounded head which characterizes this tree. The oaks are divided into two classes which the children soon learn to distinguish, as follows:

A. *The white oak group*, the leaves of which have rounded lobes and are rough and light-colored below; the wood is light-colored, the acorns have

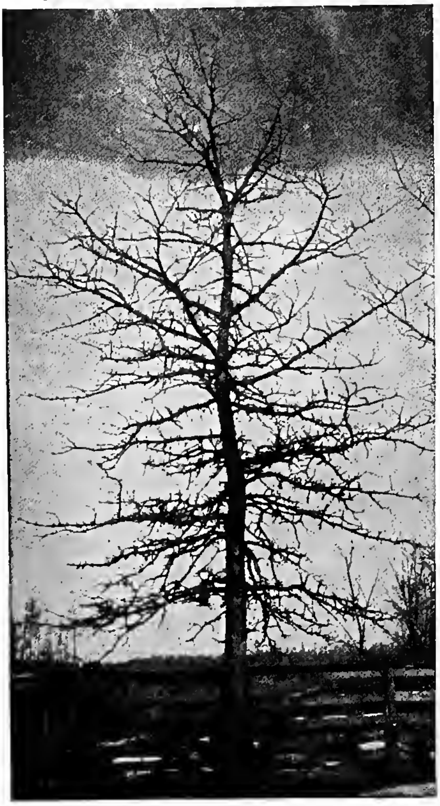
White oak in winter.
Drawing by W. C. Baker.

sweet kernels and mature in one year, so that there are no acorns on the branches in winter. To this class belong the white, chestnut, bur, and post oaks.

AA. *The black oak group*, the leaves of which are nearly as smooth below as above, and have angular lobes ending in sharp points. The bark is dark in color, the acorns have bitter kernels and require two years for maturing, so that they may be seen on the branches in winter. To this group belong the red, scarlet, Spanish, pin, scrub, black-jack, laurel and willow oaks.

There is a great variation in the shape of the leaves on the same tree, and while the black, the red and the scarlet oaks are well-marked species, it is possible to find leaves on these three different trees which are similar in shape. Oaks also hybridize, and thus their leaves are a puzzle to the botanist; but in general, the species can be determined by any of the tree books, and the pupils should learn to distinguish them.

The acorns and their scaly saucers are varied in shape, and are a delight to children as well as to pigs. The great acorns of the red oak are made

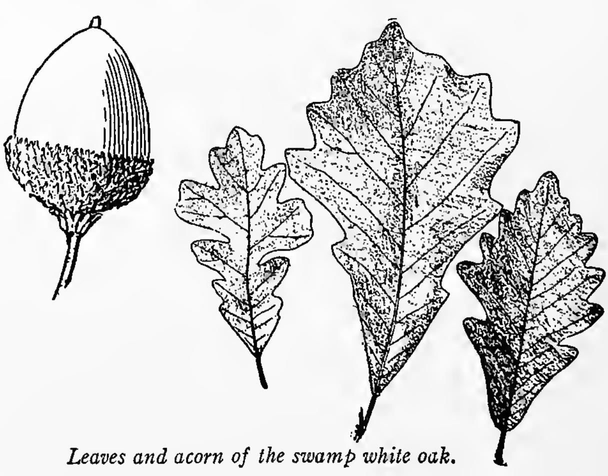


Swamp white oak in winter.

into cups and saucers by the girls, and those of the scarlet oak into tops by the boys. The white oaks turn a rich wine-color in the autumn, while the bur and the chestnut are yellow. The red oak is a dark, wine-red; the black oak russet, and the scarlet a deep and brilliant red. When the oak leaves first come from the buds in the spring, they are soft and downy and drooping, those of the red and scarlet being reddish, and those of the white, pale green with red tints. Thoreau says of them, "They hang loosely, flaccidly down at the mercy of the wind, like a new-born butterfly or dragonfly."

The pollen-bearing flowers are like beads on a string, several strings hanging down from the same point on the twig, making a fringe, and they are attractive to the eye that sees. The pistillate flowers are inconspicuous, at the axils of the leaves, and have irregular or curved stigmas; they are on the same branch as the pollen-bearing flowers.

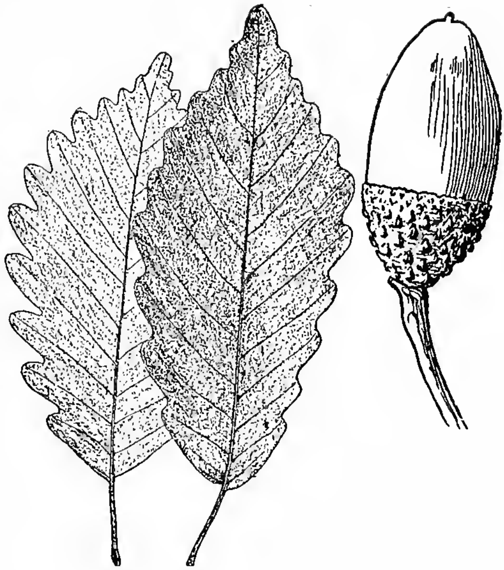
The oak is long-lived; it does not produce acorns until about twenty years of age and requires a century to mature. Although from two to three hundred years is the average age of most oaks, yet a scarlet oak of my acquaintance is about four hundred years old, and there are oaks still living in England which were there when William, the Conquerer came. The famous Wadsworth Oak at Geneseo, N.Y. had a circumference of twenty



Leaves and acorn of the swamp white oak.

seven feet. This was a swamp white oak. One reason for their attaining great age is long, strong, tap-roots which plant them deep, also the great number of roots near the surface which act as braces, and their large and luxurious heads.

Oak wood is usually heavy, very strong, tough and coarse. The heart is brown, the sap-wood whitish. It is used for many purposes—ships, furniture, wagons, cars, cooperage, farm implements, piles, wharves, railway ties, etc. The white and live oaks give the best wood. Oak bark is used extensively for tanning.



Leaves and acorn of chestnut oak.

LESSON CXCII

The Oaks

Leading thought—The oak tree is the symbol of strength and loyalty. Let us study it and see what qualities in it have thus distinguished it.

Method—Any oak tree may be used for this lesson; but whatever species is used, the lesson should lead to the knowledge of all the species of oaks in the neighborhood. The tree should be sketched, essays concerning the connection of the oak with human history should be written, while the

Blossoms of chestnut oak.

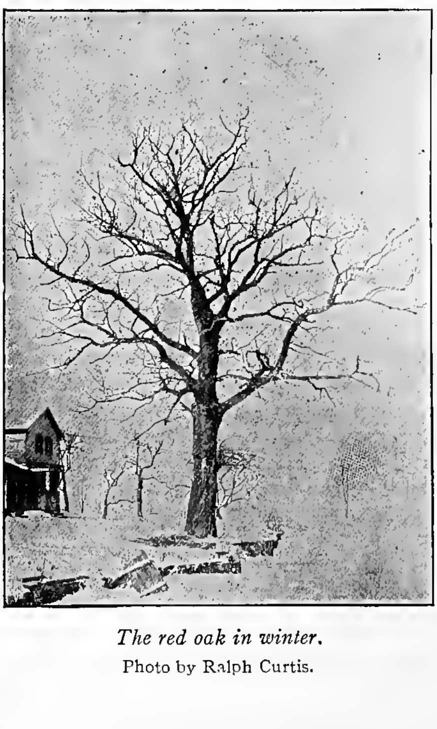
leaves and acorns may be brought into the schoolroom for study. Use Lesson CLXXXIX for a study of leaves of all the oaks of the neighborhood.

Observations—1. Describe the oak tree which you are studying. Where is it growing? What shape is its head? How high in proportion to the head is the trunk? What is the color and character of its bark? Describe its roots as far as you can see. Are the branches straight or crooked? Delicate or strong? Is the spray graceful or angular?

Cup and saucer made from the acorns of red oak

2. What is the name of your oak tree? What is the color of its foliage in autumn? Find three leaves from your tree which differ most widely in form, and sketch them or make leaf prints of them for your note-book. Does the leaf have the lobes rounded, or angular and tipped with sharp points? Is the leaf smooth on the lower side or rough? Is there much difference in color between the upper and the lower side?

3. Describe the acorns which grow on your oak. Has the acorn a stem, or is it set directly on the twig. How much of the acorn does the cup cover? Are the scales on the cup fine or coarse? Is the cup rounded inwards at its rim? What is the length of the acorn including the cup? The diameter? Are there acorns on your oak in winter? If so, why? Is the kernel of the acorn sweet or bitter? Plant an acorn and watch it sprout.



The red oak in winter.
Photo by Ralph Curtis.

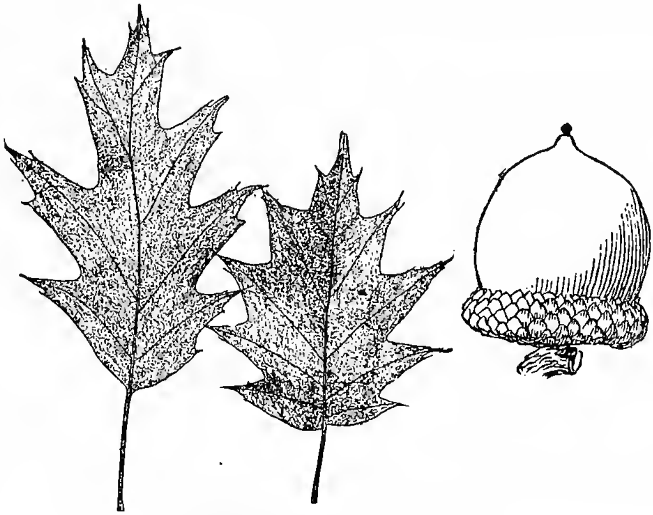
4. Read all the stories you can find about oak trees, and write them in your note-book.

5. How great an age does the oak attain? Describe how the country round about looked when the oak tree you are studying was planted.

6. How many kinds of oaks do you know? What is the difference in leaves between the white and the black oak groups? What is the difference in the length of time required for the acorns to mature in these two groups? The difference in taste of the acorns? The difference in the general color of the bark? Why is the chestnut oak an exception to this latter rule?

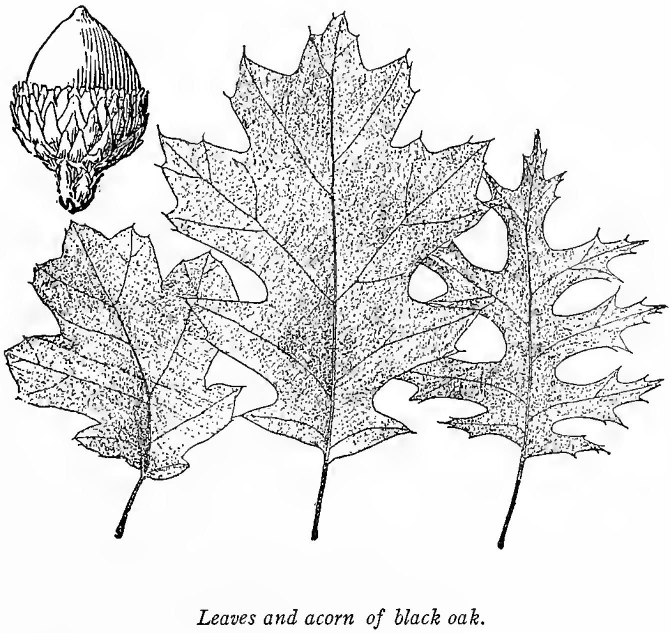
7. How do the oak leaves look when they first come out of the bud in spring? What is the color of the tree covered with new leaves? When does your oak blossom? Find the pollen-bearing blossoms which are hung in

long, fuzzy, beady strings. Find the pistillate flower which is to form the acorn. Where is it situated in relation to the pollen-bearing flower?

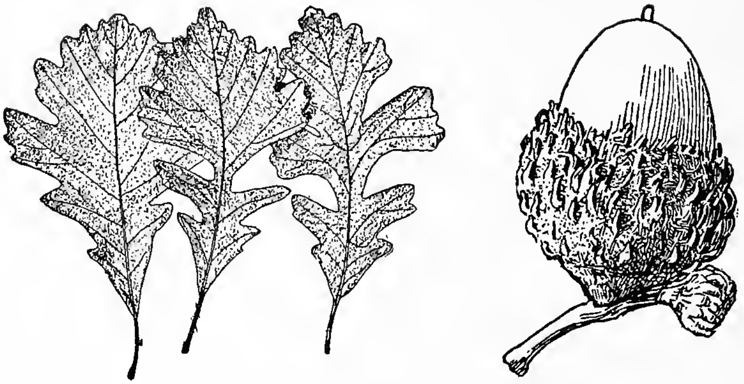


The leaves and acorn of red oak.

8. Make a sketch of your oak tree in the fall, and another in the winter. Write the autobiography of some old oak tree in your neighborhood.

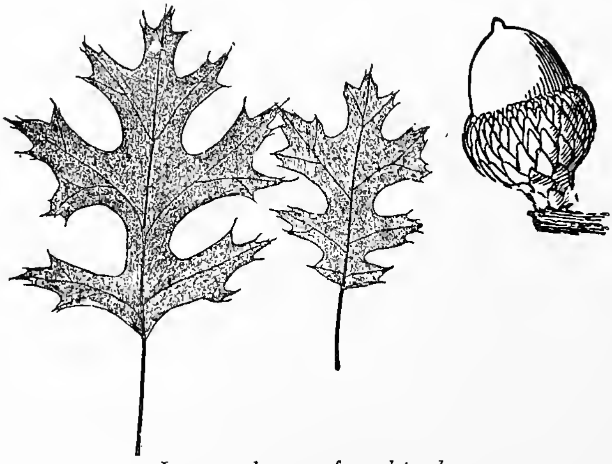


Leaves and acorn of black oak.



Leaves and acorn of bur oak.

9. For what is the oak wood used? How is the bark used?
Supplementary reading—Trees in Prose and Poetry, pp. 111–129.



Leaves and acorn of scarlet oak.

THE SHAGBARK HICKORY

Teacher's Story

HOW pathetically the untidy bark of this dignified tree suggests the careless raiment of a great man! The shagbark is so busy being something worth while that it does not seem to have time or energy to clothe itself in tailor-made bark, like the beech, the white ash and the basswood. And just as we like a great man more because of his negligence to fashion's demands, so do we esteem this noble tree, and involuntarily pay it admiring tribute as we note its trunk with the bark scaling off in long, thin plates that curve outward at the top and bottom and seem to be only slightly attached at the middle.

In general shape, the shagbark resembles the oak; the lower branches are large and, although rising as they leave the bole, their tips are deflected; and, for their whole length, they are gnarled and knotted as if to show their strength. The bark on the larger branches may be scaly toward their bases but above is remarkably smooth. The spray is angular and extends in almost every direction. The leaves, like those of other hickories, are compound. There are generally five leaflets, but sometimes only three and sometimes seven. The basal pair is smaller than the others. The hickory leaves are borne alternately on the twig, and from this character the hickory may be distinguished from the ashes, which have leaves of similar type, but which are placed opposite on the twigs. The shagbark usually has an unsymmetrical oblong head; the lower branches are usually shorter than the upper ones, and the latter are irregularly placed, causing gaps in the foliage.

The nut is large, with a thick, smooth, outer husk channeled at the seams and separating readily into sections; the inner shell is sharply angled and pointed and slightly flattened at the sides; the kernel is sweet. The winter buds of the shagbark are large, light brown, egg-shaped and downy; they swell greatly before they expand. There are from eight to ten bud-scales; the inner ones, which are red, increase to two or three inches in length before the leaves unfold, after which they fall away. The young branches are smooth, soft, delicate in color, and with conspicuous leaf scars.

The hickory bears its staminate and pistillate flowers on the same tree. The pollen-bearing flowers grow at the base of the season's shoots in slender, pendulous, green catkins, which occur usually in clusters of three swinging from a common stem. The pistillate flowers grow at the tips of the season's shoots singly or perhaps two or three on a common stem. In the shagbark the middle lobe of the staminate calyx is nearly twice as long as the other two, and is tipped with long bristles; it usually has four stamens with yellow anthers; its pistillate calyx is four-toothed and hairy, and has two large, fringed stigmas.

The big shagbark, or king nut, is similar to the shagbark in height, manner of growth, and bark. However, its leaves have from seven to nine leaflets, which are more oblong and wedgelike than are those of the shagbark; they are also more downy when young and remain slightly downy beneath. The nut is very large, thick-shelled, oblong, angled, and pointed at both ends. The kernel is large and sweet but inferior in flavor to the smaller shagbark. The big shagbark has larger buds than has the other.

Their fringy, reddish purple, inner scales grow so large that they appear tuliplike before they fall away at the unfolding of the leaves.

Hickory wood ranks high in value; it is light-colored, close-grained, heavy, and very durable when not exposed to moisture. It is capable of resisting immense strain, and, therefore, it is used for the handles of spades, plows and other tools, and also for spokes and thills in carriage-making. As a fuel, it is superior to most woods, making a glowing, hot and quite lasting fire.

LESSON CXCIII

The Shagbark

Leading thought—The hickories are important trees commercially. They have compound leaves which are set alternately upon the twig. The shagbark can be told from the other hickories by its ragged, scaling bark.

Method—This lesson may be begun in the winter when the tree can be studied carefully as to its shape and method of branching. Later, the unfolding of the leaves from the large buds should be watched, as this is a most interesting process; and a little later the blossoms may be studied. The work should be taken up again in the fall, when the fruit is ripe.

Observations Winter study—1. What is the general shape of the whole tree? Are the lower branches very large? At what angle do the branches, in general, grow from the trunk? Are there many large branches?

2. Where is the spray borne? What is its character—that is, is it fine and smooth, or knotted and angled? What is its color?

3. Describe the bark. Is the bark on the limbs like that on the trunk?

4. What is the size and shape of the buds? Are the buds greenish-yellow, yellowish brown, or do they have a reddish tinge?

5. Count the bud-scales. Are they downy or smooth?

Spring study—6. Describe how the hickory leaf unfolds from its bud. How is each leaflet folded within the bud?

7. Describe the long greenish catkins which bear the pollen. On what part of the twigs do they grow? Do they grow singly or in clusters?

8. Take one of the tiny, pollen-bearing flowers and hold it under a lens on the point of a pin. How many lobes has the calyx? Count the stamens, and note the color of the anthers.

9. Upon what part of the twigs do the pistillate flowers grow? How many points or lobes has the pistillate calyx? Describe the growth of the nut from the flower.

Autumn study—10. Does the hickory you are studying grow in open field or wood?

11. Are the trunk and branches slender and lofty, or sturdy and wide spreading?

12. Note the number and shape of the leaflets. Are they slim and tapering, or do they swell to the width of half their length? Are they set directly upon or are they attached by tiny stems to the mid-stem? Are they smooth or downy on the under side? Are the leaves set upon the twigs alternately or opposite each other? How are the leaflets set upon the mid-stem?

13. Describe the outer husk of the nut. Into how many sections does it open? Does it cling to the nut and fall with it to the ground? Is the nut angled and pointed, or is it roundish and without angles? Is the kernel sweet or bitter?

Photo by Verne Morton.

Chestnut blossoms.

Note the two pistillate flowers above the staminate catkins.

THE CHESTNUT

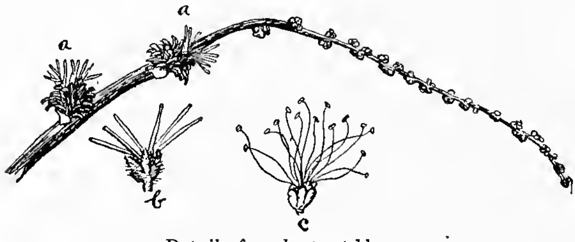
Teacher's Story

THIS splendid tree, sometimes reaching the height of one hundred feet, seldom receives the admiration due to it, simply because humanity is so much more interested in food than in beauty. The fact that the chestnuts are sought so eagerly has taken away from interest in the appearance of the tree. The chestnut has a great round head set firmly on a handsome bole, which is covered with grayish brown bark divided into rather broad, flat, irregular ridges. The foliage is superb; the long, slender, graceful leaves, tapering at both ends, are glossy, brilliant green above and paler below; and they are placed near the ends of the twigs, those of the fruiting twigs seeming to be arranged in rosettes to make a background for blossom or fruit. The leaves are placed alternately and have deeply notched edges, the veins extending straight and unbroken from midrib to margin; the petiole is short. The leaf is like that of the beech, except that it is much longer and more pointed; it resembles in general shape the leaf of the chestnut oak, except that the edges of the latter have rounded scallops instead of being sharply toothed. The burs appear at the axils of the leaves near the end of the twig. Thoreau has given us a most admirable description of the chestnut fruit:

"What a perfect chest the chestnut is packed in! With such wonderful care Nature has secluded and defended these nuts as if they were her most precious fruits, while diamonds are left to take care of themselves. First, it bristles all over with sharp, green prickles, some nearly a half inch long, like a hedgehog rolled into a ball; these rest on a thick, stiff, barklike rind one-sixteenth to one-eighth of an inch thick, which again is most daintily lined with a kind of silvery fur or velvet plush one-sixteenth of an inch thick, even rising into a ridge between the nuts, like the lining of a casket in which the most precious commodities are kept. At last frost comes to unlock this chest; it alone holds the true key; and then Nature drops to the rustling leaves a 'done' nut, prepared to begin a chestnut's course again. Within itself again each individual nut is lined with a reddish velvet, as if to preserve the seed from jar and injury in falling, and perchance from sudden damp and cold; and within that a thin, white skin envelops the germ. Thus, it has lining within lining and unwearied care, not to count closely, six coverings at least before you reach the contents."

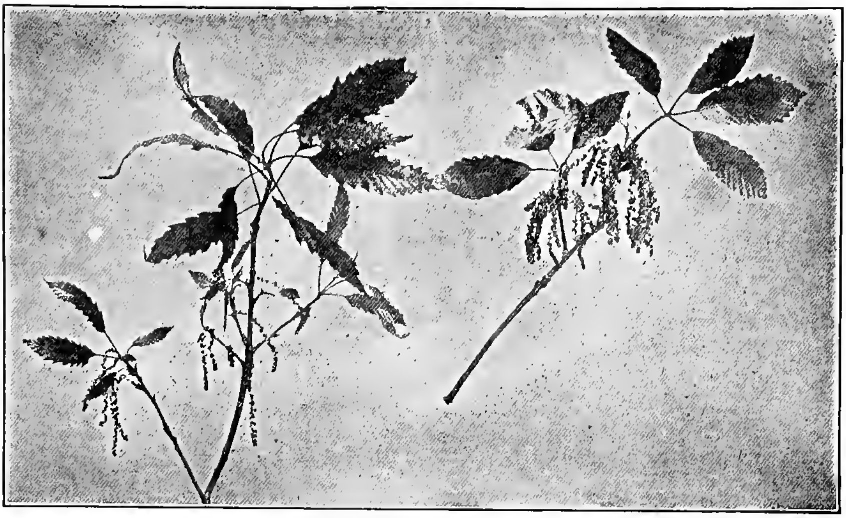
The red squirrels, as if to show their spite because of the protection of this treasure chest, have the reprehensible habit of cutting off the young burs and thus robbing themselves of a rich later harvest—which serves them right. There are usually two nuts in each bur, set with flat sides together; but sometimes there are three and then the middle one is squeezed so that it has two flat sides. Occasionally there is only one nut developed in a bur—an only child, so well cared for that it grows to be almost globular. The color we call chestnut is derived from the beautiful red-brown of the polished shell of the nut, polished except where the base joins the bur, and the apex which is gray and downy.

The chestnut is always a beautiful tree, whether green in summer or glowing golden yellow in autumn; but it is most beautiful during late June and July, when covered with constellations of pale yellow stars. Each of these stars is a rosette of the pollen-bearing blossoms; each ray consists of a catkin often six or eight inches in length, looking like a thread of yellowish chenille fringe; clothing this thread in tufts for its whole length are the stamens, standing out like minute threads tipped with tiny anther balls. If we observe the blossom early enough, we can see these stamens curled up as they come forth from the tiny, pale yellow, six-lobed calyx. One calyx, although scarcely one-sixteenth of an inch across, develops from ten to twenty of these stamens; these tiny flowers are arranged in knots along



Detail of a chestnut blossom.

a. a. pistillate flowers set in a base of scales; *b*, pistillate flower enlarged; *c*, staminate flower enlarged.



Leaves and flowers of chestnut and chestnut oak showing the differences.
Photo by G. F. Morgan.

the central thread of the catkin. No wonder it looks like chenille! There are often as many as thirty of these catkin rays in the star rosette; the lower ones come from the axils of the leaves; but toward the tips of the twig, the leaves are ignored and the catkins have possession. In one catkin I estimated that there were approximately 2,500 stamens developed, each anther packed with pollen. When we think that there may be thirty of the catkins in a blossom-star, we get a glimmering of the amount of pollen produced.

And what is all this pollen for? Can it be simply to fertilize the three or four inconspicuous flowers at the tip of the twig beyond and at the center of the star? These pistillate flowers are little bunches of green scales with some short, white threads projecting from their centers; and beyond them a skimpy continuation of the stem with more little green bunches scattered along it, which are undeveloped pistillate blossoms. The one or two flowers at the base of the stem get all the nourishment and the others do not develop. If we examine one of these nests of green scales, we find that there are six threads belonging to one tiny, green flower with a six-lobed calyx; the six threads are the stigmas, each one reaching out and asking for no more than one grain of the rich shower of pollen.

Chestnut wood is light, rather soft, stiff, coarse and not strong. It is used in cabinet work, cooperage, for telegraph poles and railway ties. When burned as fuel, it snaps and crackles almost equal to hemlock.

LESSON CXCIV
The Chestnut

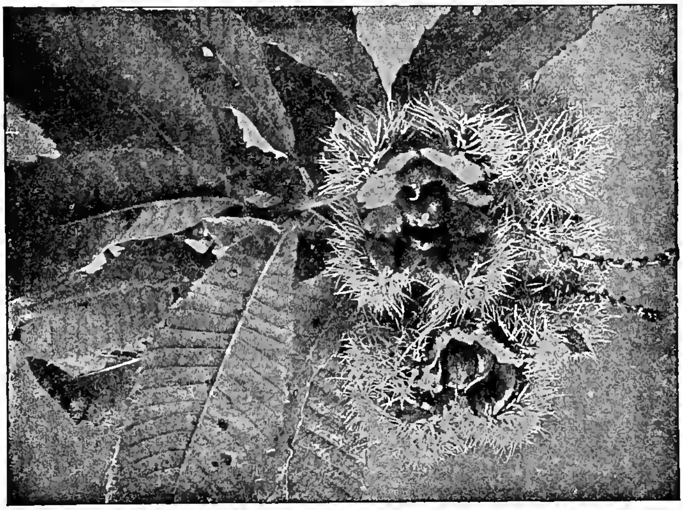
Leading thought—The chestnut is one of our most beautiful trees. We should learn to appreciate it by observing the beauty of its blossoms and of its foliage when green and when brilliant yellow in autumn. Until the chestnut fruit is ripe, it is well protected by its spiny bur.

Method—This study may be begun in the fall when chestnuts are ripe. Ask the boys to describe the trees from which they get this longed-for harvest. The leaves, burs and nuts may be studied in the schoolroom.

Observations—1. Where do chestnut trees grow? What is the general form of the head of the tree? How high is the trunk below the branches? Do the branches divide into fine twigs or spray at the tips?

2. Sketch and describe a chestnut leaf, showing the veins, edges and petiole. Are the leaves placed opposite or alternate? What is their color above and below? How do the chestnut leaves differ from those of the beech and of the chestnut oak? What is the color of the chestnut foliage in autumn?

3. Where on the branch is the bur borne? How does the green chestnut bur look? Why is this prickly exterior beneficial to the fruit? Does the



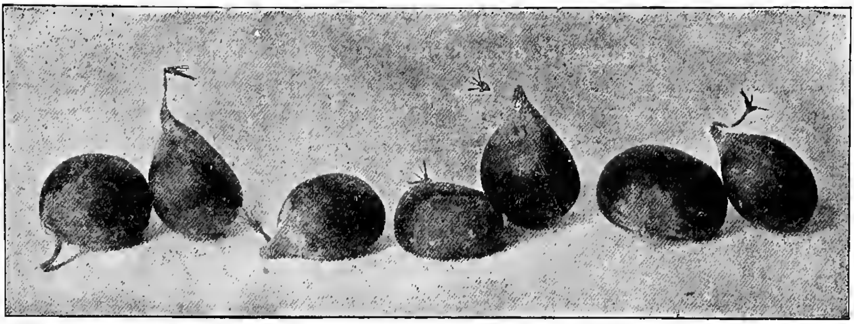
Chestnuts in burs.
Photo by Verne Morton

bur open easily when green? What causes the chestnut bur to open? Into how many lobes does it open? Describe an open bur outside and in.

4. Where in the bur are the chestnuts set? How many in one bur? How can you tell by the shape of the chestnut whether it grew as a twin or single in a bur. Are there ever three in a bur? If so, what shape is the middel one? Do the burs fall when the chestnuts are ripe?

5. Take a single chestnut. Describe its shape and color. What is the mark on its large end? Describe the coloring and covering of the tip. Open the shell and note the lining. Describe how the meat is finally protected. Can you see where the germ is? Plant a chestnut and watch it grow.

6. Study the chestnut blossom in late June or July. What kind of blossoms are those which look like yellow stars all over the tree? Study one of the catkins which makes a ray of the star, and describe it. Can you see the anthers and the pollen? How many of these pollen-bearing flowers are



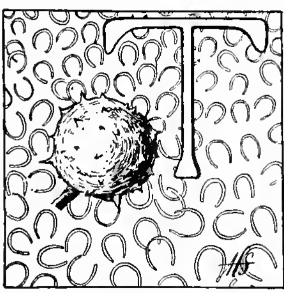
Chestnuts.
Photo by O. L. Foster.

on one stem? Where are the pistillate flowers which will grow into young chestnuts? Describe them.

7. How much are chestnuts worth per bushel? To what uses is chestnut timber put? What is the character of the wood?

THE HORSE-CHESTNUT

Teacher's Story



THE wealth of children is, after all, the truest wealth in this world; and the horse-chestnuts, brown and smooth, looking so appetizing and so belying their looks, have been used from time immemorial by boys as legal tender—a fit use, for these handsome nuts seem coined purposely for boys' pockets.

The horse-chestnut is a native of Asia Minor. It has also a home in the high mountains of Greece. In America, it is essentially a shade tree. Its head is a broad cone, its dark green foliage is dense and, when in blossom, the flower clusters stand out like little white pyramids against the rich back-ground in a most striking fashion. "A pyramid of green supporting a thousand pyramids of white" is a clever description of this tree's blossoming. The brown bark of the trunk has a tendency to break into plates, and the trunk is just high enough to make a fitting base for the handsome head.

The blossom panicle is at the tip end of the twig and stops its growth at that point; the side buds continue to grow thus making a forking branch. Each blossom panicle stands erect like a candle

a, *blossom of the sweet buck-eye and young fruit;* b, *blossom and young fruit of horse-chestnut.*

Horse-chestnut blossoms.
Photo by Verne Morton.

flame, and the flowers are arranged spirally around the central stem, each pedicel carrying from four to six flowers. The calyx has five unequal lobes, and it and the stem are downy. Five spreading and unequal petals with ruffled margins are raised on short claws, to form the corolla; seven stamens with orange colored anthers are thrust far out and up from the flower. The blossoms are creamy or pinkish white and have purple or yellow blotches in their throats. Not all the flowers have perfect pistils. The stigmas ripen before the pollen, and are often thrust forth from the unopened flower. The flowers are fragrant and are eagerly visited by bumblebees, honey-bees and wasps.

Very soon after the blossom falls, there may be seen one or two green, prickly balls which are all the fruits one flower cluster could afford to mature. By October the green, spherical husk breaks open in three parts, showing its white satin lining and the roundish, shining, smooth nut at its center. At first there were six little nuts in this husk, but all except one gave up to the burly occupant. The great, round, pale scar on the nut is where it joined the husk. Very few American animals will eat the nut; the squirrels scorn it and horses surely disown it.

In winter, the horse-chestnut twig has at its tip a large bud and looks like a knobbed antenna thrust forth to test the safety of the neighborhood. There are, besides the great varnished buds at the ends of the twigs, smaller buds opposite to each other along the sides of the twig, standing out stiffly. On each side of the end bud, and below each of the others, is a horseshoe-shaped scar left by the falling leaf of last year. The "nails" in this horseshoe are formed by the leafy fibres which joined the petiole to the twig.

The great terminal buds hold both leaves and flowers. The buds in winter are brown and shining as if varnished; when they begin to swell, they open, displaying the silky gray floss which swaddles the tiny leaves. The leaves unfold rapidly and lift up their green leaflets, looking like partly opened umbrellas, and giving the tree a very downy appearance, which Lowell so well describes:

> "And gray hoss-chestnut's leetle hands unfold
> Softer'n a baby's be at three days old."

The leaf, when fully developed, has seven leaflets, of which the central ones are the larger. They are all attached around the tip of the petiole. The number of leaflets may vary from three to nine, but is usually seven. The leaflets are oval in shape, being attached to the petiole at the smaller end; their edges are irregularly toothed. The veins are large, straight and lighter in color; the upper surface is smooth and dark green, the under side is lighter in color and slightly rough. The petiole is long and shining and enlarges at both ends; when cut across, it shows a woody outer part encasing a bundle of fibres, one fiber to each leaflet. The places where these fibers were attached to the twig make the nails in the horseshoe scar. The leaves are placed opposite on the twigs.

Very different from that of the horse-chestnut is the flower of the yellow or sweet, buckeye; the calyx is tubular, long and five-lobed; the two side petals are on long stalks and are closed like spoons over the stamens and anthers; the two upper petals are also on long stalks, lifting themselves up and showing on their inner surfaces a bit of color to tell the wandering bee that here is a tube to be explored. The flowers are greenish yellow. The flowers of the Ohio buckeye show a stage between the sweet buckeye and the horse-chestnut. The Ohio buckeye is our most common native relative of the horse-chestnut. Its leaves have five leaflets instead of seven. The Sweet buckeye is also an American species and grows in the Alleghany mountains.

LESSON CXCV

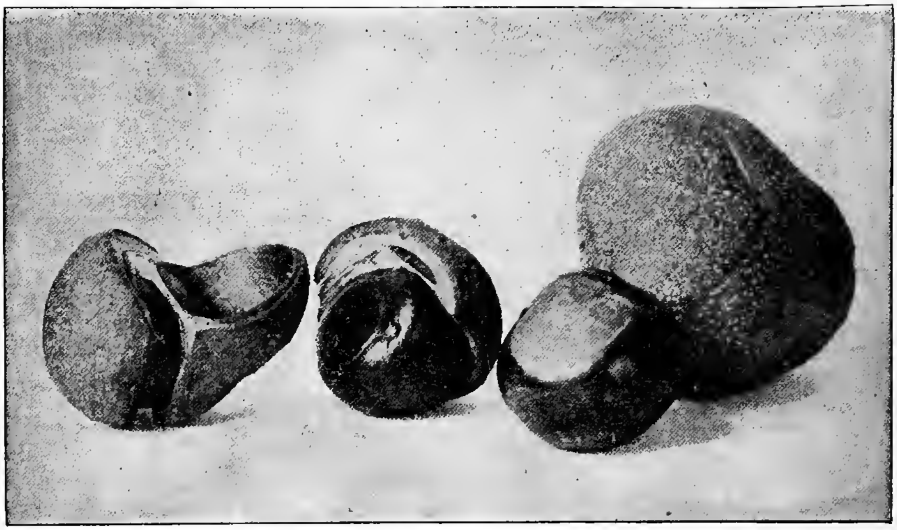
The Horse-Chestnut

Leading thought—The horse-chestnut has been introduced into America as a shade tree from Asia Minor and southern Europe. Its foliage and its flowers are both beautiful.

Method—This tree is almost always at hand for the village teacher, as it is so often used as a shade tree. Watching the leaves develop from the buds is one of the most common of the nature-study lessons. The study of the buds, leaves and fruits may be made in school; but the children should observe the tree where it grows and pay special attention to its insect visitors when it is in bloom.

Observations—1. Describe the horse-chestnut tree when in blossom. At what time does this occur? What is there in its shape and foliage and flowers which make it a favorite shade tree? Where did it grow naturally? What relatives of the horse-chestnut are native to America?

2. Study the blossom cluster; are the flowers borne on the ends or on the sides of the twig? Describe the shape of the cluster. How are the flowers arranged on the main flower stalk to produce this form? Do the flowers open all at once from top to bottom of the cluster? Are all the flowers in the cluster the same color? Are they fragrant? What insects visit them?



Horse-chestnuts, the coin of the small boy.
Photo by O. L. Foster.

3. Take a single flower; describe the form of the calyx. Is it smooth or downy? Are the lobes all the same size? Are the petals all alike in size and shape? What gives them the appearance of Japanese paper? Are any connected together? Are they all splashed with color alike?

4. How many stamens are there? Where do you see them? What color are the anthers? Search the center of a flower for a pistil with its green style. Do you find one in every flower? Could a bee reach the nectar at the base of the blossom without touching the stigma? Could she withdraw without dusting herself with pollen?

5. How long after the blossom does the young fruit appear? How does it look? How many nuts are developed from each cluster of blossoms? What is the shape of the bur? Into how many parts does it open? Describe the outside; the inside. Describe the shape of the nuts, their color and markings. Which make the best "conquerers," those which grow single in the bur or as twins? Open a nut. Can you find any division in the kernel? Is it good to eat?

Horse-chestnut Twigs and Leaves in Spring—6. Are the buds on the twigs nearly all the same size? Where are the larger ones situated? What is the color of the buds? How are the scales arranged on them? Are they shiny or dull? What do the scales enfold? Can you tell without opening them which buds contain flowers and which ones leaves?

7. Describe the scars below the buds. What caused them? What marks are on them? What made the "nails" in the horseshoe? Has the twig other scars? How do the ring-marks show the age of the twig? Do you see the little, light colored dots scattered over the bark of the twig? What are they?

8. Describe how the leaf unfolds from the bud. What is the shape of the leaf? Do all the leaves have the same number of leaflets? Do any of

them have an even number? How are the leaflets set upon the petiole? Describe the leaflets, including shape, veins, edges, color above and below. Is the petiole pliant, or stiff and strong? Is it the same shape and size throughout its length? Break a petiole, is it green throughout? What can you see at its center? Are the leaves opposite or alternate? When they fall, do they drop entire or do the leaflets fall apart from the stem?

9. Sketch the horse-chestnut tree.

10. How do the flowers and leaves of the horse-chestnut differ from those of the sweet buckeye and of the Ohio buckeye?

Supplementary reading—Trees in Prose and Poetry, p. 17.

THE WILLOWS

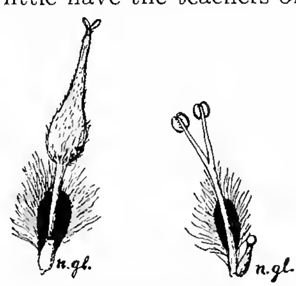
Teacher's Story

They shall spring up among the grass, as willows by the water courses.
—ISAIAH.

"*When I cross opposite the end of Willow Row the sun comes out and the trees are very handsome, like a rosette, pale, tawny or fawn color at base and red-yellow or orange-yellow for the upper three or four feet. This is, methinks, the brightest object in the landscape these days. Nothing so betrays the spring sun. I am aware that the sun has come out of the cloud just by seeing it light up the osiers.*"—THOREAU.

THE willow, Thoreau noted, is the golden osier, a colonial dame, a descendent from the white willow of Europe. It is the most common tree planted along streams to confine them to their channels, and affords an excellent subject for a nature-study lesson. The golden osier has a short though magnificent trunk, giving off tremendous branches, which in turn branch and uphold a mass of golden terminal shoots. But there are many willows besides this, and the one who tries to determine all the species and hybrids must conclude that of making willows there is no end. The species beloved by children is the pussy willow which is often a shrub, rarely reaching twenty feet in height. It loves moist localities, and on its branches in early spring are developed the silky, furry pussies. These are favorite objects for a nature-study lesson, and yet how little have the teachers or pupils known about these flowers!

The willow pussies are the pollen-bearing flowers; they are covered in winter by a brown, varnished, double, tentlike bract. The pussy in full bloom shows beneath each fur-bordered scale two stamens with long filaments and plump anthers; but there are no pistils in this blossom. The flowers which produce seed are borne on another tree entirely and in similar greenish gray catkins, but not so soft and furry. In the pistillate catkin each fringed scale has at its base a pistil which thrusts out a Y-shaped stigma. The question of how the pollen from one gets to



Enlarged willow blossoms.

Pistillate blossom showing nectar, gland, (n.gl.)

Staminate flower showing the nectar, gland (n.gl.)

The willow pussies. The staminate blossoms of the willow.
Photo by Verne Morton.

the pistils of another is a story which the bees can best tell. The willow flowers give the bees almost their earliest spring feast and, when they are in blossom, the happy hum of the bees working in them can be heard for some distance from the trees. The pollen gives them bee bread for their early brood, and they get their honey supply from the nectar which is produced in little jug-shaped glands, at the base of each pollen-bearing flower on the "pussy" catkin, and in a long pocket at the base of each flower on the pistillate catkin. So they pass back and forth, carrying their pollen loads to fertilize the stigmas on trees where there is no pollen. It has been asserted that the pussies, or pollen-bearing flowers, yield no nectar but give only pollen, so that the bee is obliged to seek both trees in order to secure a diet of "balanced ration;" but the person who made this statement had never taken the pains to look at the tiny jugs over-flowing with nectar found at their bases.

In June the willow seed is ripe. The catkin then is made up of tiny pods, which open like milkweed pods and are filled with seed equipped with balloons. When these fuzzy seeds are being set free people say that the willows "shed cotton."

Although the seed of the willow is produced in abundance, it is hardly needed for preserving the species. Twigs which we place in water to develop flowers will also put forth roots; even if the twigs are placed in water wrong side up, rootlets will form. A twig lying flat on moist soil will push out rootlets along its entire length as though it were a root; and shoots will grow from the buds on its upper side. This habit of the willows and the fact that the roots are long, strong and fibrous make these trees of great use as soil binders. There is nothing better than a thick hedge of willows to hold streams to their proper channels during floods; the roots reach out in all directions, interlacing themselves in great masses, and thus hold the soil of the banks in place. The twigs of several of the species, notably the crack and sand-bar willows, are broken off easily by the wind and carried off down stream, and where they lodge, they take root; thus, many streams are bordered by self-planted willow hedges.

The willow foliage is fine and makes a beautiful, soft mass with delicate shadows. The leaf is long, narrow, pointed and slender, with finely toothed edges and short petiole; the exact shape of the leaf, of course, depends upon the species, but all of them are much lighter in color below than above. The willows are, as a whole, water lovers and quick growers.

Although willow wood is soft and exceedingly light, it is very tough when seasoned and is used for many things. The wooden shoes of the European peasant, artificial limbs, willowware, and charcoal of the finest grain used in the manufacture of gunpowder, are all made from the willow wood. The toughness and flexibility of the willow twigs have given rise to many industries; baskets, hampers, carriage bodies and furniture are made of them. To get these twigs the willow trees are pollarded, or cut back every year between the fall of the leaves and the flow of the sap in the spring. This pruning results in many twigs. The use of willow twigs in basketry is ancient. The Britons fought the Roman soldiers from behind shields of basket work; and the wattled huts in which they lived were woven of willow saplings smeared with clay. Salicylic acid, used widely in medicine, is made from willow bark, which produces also tannin and some unfading dyes.

The pistillate blossoms of the willow.
Photo by Verne Morton.

There are many insect inhabitants of the willow, but perhaps the most interesting is the little chap which makes a conelike object on the twig of certain species of willow growing along our streams. This cone is naturally considered a fruit by the ignorant, but we know that the willow seeds are grown in catkins instead of cones. This willow cone is made by a small gnat which lays its egg in the tip of the twig; as soon as the little grub hatches, it begins to gnaw the twig, and this irritation for some reason stops the growth. The leaves instead of developing along the stem are dwarfed and overlap each other. Just in the center of the cone at the tip of the twig the little larva lives its whole life surrounded by food and protected from enemies; it remains in the cone all winter, in the spring changes to a pupa, and after a time comes forth—a very delicate little fly. The larva in this gall is very hospitable. It has its own little apartment at the center but does not object to having a tenant in its outer chambers, a fact which is taken advantage of by another gall-gnat which breeds there in large numbers. It is well to gather these cones in winter; examine one by cutting it open to find the larva, and place others in a fruit jar with a cover so as to see the little flies when they shall issue in the spring. (See p. 362). For supplementary reading see "Outdoor Studies," page 24.

There is another interesting winter tenant of willow leaves, but it is rather difficult to find. On the lower branches may be discovered, during winter and spring, leaves rolled lengthwise and fastened, making elongated cups. Each little cup is very full of a caterpillar which just fits it, the caterpillar's head forming the plug of the opening. This is the partially grown larva of the viceroy butterfly. It eats off the tip of the leaf each side of the midrib for about half its length, fastens the petiole fast to the twig with silk, then rolls the base of the leaf into a cup, lines it with silk and backs into it, there to remain until fresh leaves on the willow in spring afford it new food.

"My willow-tent."
Photo by W. C. Baker.

LESSON CXCVI
The Willows

Leading thought—The willows have their pollen-bearing flowers and their seed-bearing flowers on separate trees; the bees carry the pollen from one to the other. The willow pussies are the pollen-bearing flowers.

Method—As early in March as is practicable, have the pupils gather twigs of as many different kinds of willows as can be found; these should be put in jars of water and placed in a warm, sunny window. The catkins will soon begin to push out from the bud-scales, and the whole process of flowering may be watched.

Observations—1. How can you tell the common willow tree from afar? In what localities do these trees grow? What is the general shape of the big willow? How high is the trunk, or bole? What sort of bark has it? Are the main branches large or small? Do they stand out at a wide angle or lift up sharply? What color are the terminal shoots, or spray?

2. Are the buds opposite or alternate on the twigs? Is there a bud at exactly the end of any twig? How many bracts are there covering the bud?

3. Which appear first, the leaves or the blossoms? Study the pussies on your twigs and see if they are all alike. Is one kind more soft and furry than the other? Are they of different colors?

4. Take one of the furry pussies. Describe the little bract, which is like a protecting hood at its base. What color is the fur? After a few days, what color is the pussy? Why does it change from silver color to yellow? Pick one of the catkins apart and see how the fur protects the stamens.

5. Take one of the pussies which is not so furry. Can you see the little pistils with the Y-shaped stigmas set in it? Is each little pistil set at the base of a little scale with fringed edges?

6. Since the pollen-bearing catkins are on one tree and the seed-bearing catkins are on the other, and since the seeds cannot be developed without the pollen, how is the pollen carried to the pistils? For this answer, visit the willows when the pussies are all in bloom and listen. Tell what you hear. What insects do you see working on the willow blossoms? What are they after?

Seeds of willow.
Photo by Verne Morton.

7. What sort of seed has the willow? How is it scattered? Do you think the wind or water has most to do with planting willow seed?

Work for May or September—8. Describe willow foliage and leaves. How can you tell willow foliage at a distance?

9. What sort of roots has the willow? Why are the willows planted along the banks of streams? If you wished to plant some willow trees how would you do it? Would you plant seeds or twigs?

10. For what purposes is willow wood used? How are the twigs used? Why are they specially fitted for this use? What is pollarding a tree? What medicine do we get from willow bark?

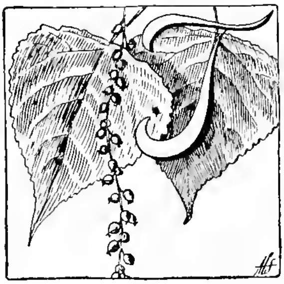
11. Do you find willow cones on your willows? Cut one of these cones through and see if you can find any seeds? What is in the middle of it? What do you think made the scales of the cone? Do you think this little insect remains in here all winter?

12. In winter, hunt the lower branches of willows for leaves rolled lengthwise making a winter cradle for the young caterpillars of the viceroy.

Supplementary reading—Trees in Prose and Poetry, p. 137.

THE COTTONWOOD, OR CAROLINA POPLAR

Teacher's Story

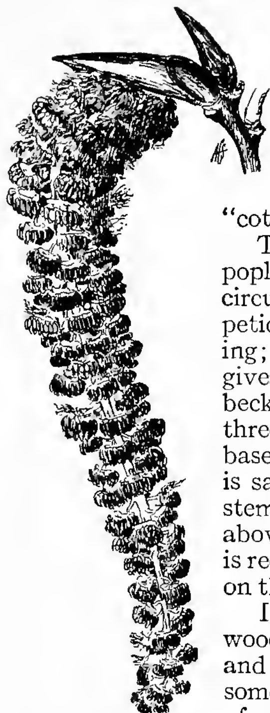


THE sojourner on our western plains where streams are few and sluggish, disappearing entirely in summer, soon learns to love the cottonwoods, for they will grow and cast their shade for men and cattle where no other tree could endure. The cottonwood may be unkempt and ragged, but it is a tree, and we are grateful to it for its ability to grow in unfavorable situations. In the Middle West it attains its perfection, although in New York we have some superb specimens—trees which are more than one hundred feet in height and with majestic trunks, perhaps five or six feet through. The deep-furrowed, pale gray bark makes a handsome covering. The trunk divides into great out-swinging, widely spaced branches, which bear a fine spray on their drooping ends. Sargent declares that at its best the cottonwood is one of the statliest inhabitants of our eastern forests. The variety we plant in cities we call the Carolina poplar, but it is a cottonwood. It is a rapid grower, and therefore a great help to the "boom towns" of the West and to the boom suburbs in the East; although for a city tree its weak branches break too readily in wind storms in old age. However, it keeps its foliage clean, the varnished leaves shedding the dust and smoke; because of this latter quality it is of special use in towns that burn soft coal.

The cottonwood twigs which we gather for study in the spring are yellowish or reddish, those of last year's growth being smooth and round, while those showing previous growth are angular. The buds are red-brown and shining, and covered with resin which the bees like to collect for their glue. The leaf buds are slender and sharp-pointed; the flower buds are wider and plumper.

The two sexes of the flowers are borne on separate trees. The trees bearing pollen catkins are so completely covered with them that they take on a very furry, purplish appearance when in blossom. These catkins are from three to five inches long and half an inch thick, looking fat and pendulous; each fringed scale of the catkin has at its base a disc looking like a white bracket, from which hang the reddish purple anthers; these catkins fall after the pollen is shed and look like red caterpillars upon the ground.

The seed-bearing flowers are very different; they look like a string of little, greenish beads loosely strung. Each pistil is globular and set in a tiny cup, and it has three or four stigmas which are widened or lobed; as



Staminate catkin of cottonwood.
Drawn by Anna Stryke.

it matures, it becomes larger and darker green, and the string elongates to six or even ten inches. The little pointed pods open into two or more valves and set free the seeds, which are provided with a fluff of pappus to sail them off on the breeze; so many of the seeds develop that every object in the neighborhood is covered with their fuzz, and thus the tree has gained its name "cottonwood."

The foliage of the cottonwood is like that of other poplars, trembling with the breeze. The heavy, subcircular leaf is supported on the sidewise flattened petiole, so that the slightest breath of air sets it quaking; a gentle breeze sets the whole tree twinkling and gives the eye a fascinating impression as of leaves beckoning. The leaf is in itself pretty. It is from three to five inches long, broad, slightly angular at the base and has a long, tapering, pointed tip. The edge is saw-toothed, and also slightly ruffled except near the stem where it is smooth; it is thick and shining green above and paler beneath. The long, slender petiole is red or yellowish, and the leaves are placed alternate on the twigs.

In the autumn the leaves are brilliant yellow. The wood is soft, weak, fine-grained, whitish or yellowish, and has a satiny luster; it is not durable. It is used somewhat for building and for furniture, in some kinds of cooperage, and also for crates and woodenware; but its greatest use is for making the pulp for paper. Many newspapers and books are printed on cottonwood paper. It is common from the Middle States to the Rocky Mountains and from Manitoba to Texas.

LESSON CXCVII

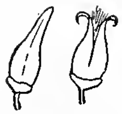
The Cottonwood

Leading thought—The cottonwood is a poplar. It grows rapidly and flourishes on the dry western plains where other trees fail to gain a foothold. It grows well in the dusty city, its shining leaves shedding the smoke and dirt.

Method—Begin this study in spring before the cottonwoods bloom. Bring in twigs in February, give them water and warmth, and watch the development of the catkins. Afterwards watch the unfolding of the leaves and study the tree.

Observations—1. What is the color of the bark on the cottonwood? Is it ridged deeply? What is the color of the twigs? Are they round or angular, or both? Describe the winter buds and bud-scales. Can you tell which bud will produce leaves and which flowers?

2. Describe the catkin as it comes out. Has this catkin anthers and pollen, or will it produce seed? Do you think the seeds are produced on the same trees as the pollen?

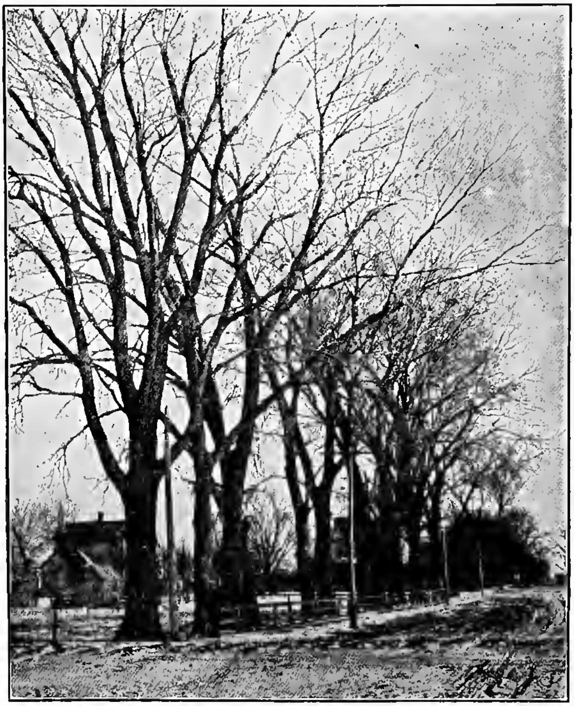


Seed-pod of poplar, shut and open.

3. Find a pollen-bearing catkin. Describe the stamens. Can you see anything but the anthers? On what are they set? What color are they? What color do they give to the tree when they are in blossom? What happens to the catkins after their pollen is shed?

4. Find a seed-bearing catkin. How long is it? Do you see why this tree is called the necklace poplar? Describe the pistils which make the beads on the necklace.

5. When do the seeds ripen? If you have been near the tree, how do you know when they are ripe? How long is the catkin with the ripened



Cottonwoods.

Courtesy of U. S. Forest Service.

seeds? How many balls on the necklace now? What is the color? How many seeds come out of each little pod? How are the seeds floated on the air? Why do we call this tree "cottonwood?"

6. How large is the largest cottonwood that you know? Sketch it to show the shape of the tree. Are the main branches large? Do they droop at the tips?

7. How does the foliage of the cottonwood look? Does it twinkle with the wind? Examine the leaves upon a branch and see why they twinkle. Are the petioles round or flat? Are they flattened sidewise or up and down? Are they stiff or slender? Describe the leaves, giving their shape,

veins, edges, color and texture above and below. Are the edges ruffled as well as toothed? Is the leaf heavy? If a breeze comes along how would it affect such a heavy, broad leaf on such a slender, thin petiole? Blow against the leaves and see how they move? Do you understand, now, why they twinkle? Can you see why the leaves shed smoke and dust, when used for shading city streets?

8. Why is the cottonwood used as a shade tree? Do you think it makes a beautiful shade tree? How long does it take it to grow? What kind of wood does it produce? For what is it used?

Supplementary reading—Trees in Prose and Poetry, pp. 139–149.

The growing fruit of the cottonwood.
Photo by Cyrus Crosby

Pistillate blossoms of white ash.
Photo by G. F. Morgan.

THE WHITE ASH

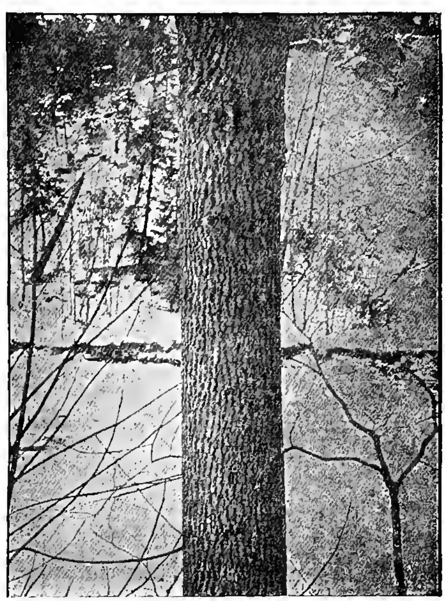
Teacher's Story

MYTHS and legends cluster about the ash tree. It was, in the Norse mythology, the tree "Igdrasil," the tree of the universe, which was the origin of all things. It is a pity that it was not the Tree of Life in the Garden of Eden, for if another myth is true, no snake will go near it or cross its branches. There is a widespread belief that it draws lightning, just as the beech repels the thunderbolts. "As straight as a white ash tree" was the highest compliment that could be paid to the young pioneer; so straight is its fiber and so strong its quality, that the American Indians made their canoe paddles from it.

The ashes have the most beautiful bark in the world. It is divided into fine, vertical ridges, giving the trunks the look of being shaded with pencil lines; the bark smooths out on the lower branches. But even more characteristic than the bark, are the ash branches and twigs; the latter are sparse, coarse and clumsy, those of the white ash being pale orange or gray and seemingly warped into curves at the ends; they are covered with whitish gray dots, which reveal themselves under the lens to be breathing-pores.

The white ash loves to grow in rich woods or in rich soil anywhere, even though it be shallow; at its best, it reaches the height of 130 feet, with a trunk six feet through. Its foliage is peculiarly graceful; the leaves are from eight to twelve inches long and are composed of from five to nine leaflets. The leaflets have little petioles connecting them with the middle stem; in shape they are ovate with edges obscurely toothed or entire; the two basal leaflets are smaller than the others and the end one largest; in texture, they are satiny, dark green above, whitish beneath, with feather-like veins, often hairy on the lower side. The petioles are swollen at the base. The leaves are set opposite upon the twig; except the horsechestnut, the ashes are our only trees with compound leaves which have the leaves opposite. This character alone readily distinguishes the ashes from the hickories. The autumn foliage has a very peculiar color; the leaves are dull purple above and pale yellow below; this brings the sunshine color into the shadowy parts of the tree, and gives a curious effect of no perspective. Notwithstanding this, the autumn coloring is a joy to the artistic eye and is very characteristic.

The seeds of the ash are borne in crowded clusters; the delicate stem, from three to five inches long, is branched into smaller stems to which are joined two or three keys, and often several of these main stems come from the same bud at the tip of last year's wood so that they seem crowded. The seed is winged, the wing being almost twice as long as the seed set at its base. Thoreau says: "The keys of the white ash cover the trees profusely, a sort of mulberry brown, an inch and a half long, and handsome." The seeds cling persistently to the tree, and I have often observed them being blown over the surface of the snow as if they were skating to a planting place.



Bole of white ash showing the beautiful bark.
Photo by Ralph Curtis.

The flowers appear in April or May, before the leaves. The pistillate flowers make an untidy fringe, curling in every direction around the twigs. The chief flower stem is three to four inches long, quite stout, pale green, and from this arise short, fringed stems, each carrying along its sides the knobs on little stems—which are the pistillate flowers. Each tiny flower seems to be bristling with individuality, standing off at its own angle to get its own pollen. The flower has the calyx four-lobed; the style is long and slender and is divided into a V-shaped purple stigma.

The staminate flowers appear early in the spring, and look like knobs on the tips of the coarse, sparse twigs; they consist of masses of thick, green anthers with very short, stout filaments; each calyx is four-lobed.

Staminate blossoms of white ash.
Photo by G. F. Morgan.

These flowers are attached to a five-branching stem; but the stem and its branches cannot be seen unless the anthers are plucked off, because they hang in such a crowded mass. Later the leaves come out beyond them.

The leaf buds in winter are very pretty; they are white, bluntly pointed, with a pale gray half-circle below, on which was set last year's leaf. Another one of nature's miracles is the bouquet of leaves coming from one of the big four-parted terminal buds, which is made up of four scales, two of which are longer and narrower than the others. Within the bud each little compound leaflet is folded like a sheet of paper lengthwise, and folded with the other leaflets like the leaves of a book; and when they first appear they look like tiny, scrawny, birds' claws. But it is not merely one pair of leaves that comes from this bud, but many, each pair being set on a twig opposite and at right angles to the next pair on either side. Even as many as five pairs of these splendid compound leaves come from this one prolific bud. As they push out, the green stem of the new wood grows, thus spacing the pairs properly for the making of beautiful foliage.

LESSON CXCVIII

Ash Trees

Leading thought—The ashes are our most valuable timber trees; the white ash is one of the most beautiful and useful of them all. It does not make forests, but it grows in them, and its wood is of great value for many things.

Method—The pupils should all see the tree where it grows. The questions should be given to them for their field note-books. The lesson should begin in the fall and be continued in the spring.

Observations—1. What is there about the bark of the ash tree which distinguishes it from other trees? Where does the white ash grow? What is the height and thickness of the ash tree you are studying?

2. The ash leaf is a compound leaf; of how many leaflets is it composed? What is the texture and shape of the leaflets? Describe the veins. Do the leaflets have petioles (petiolules)? Are the edges of the leaflets toothed? Which of the leaflets is largest? Which smallest? Is the petiole swollen at the base? How are the leaves arranged on the twigs? How does this distinguish the ashes from all other of our trees having compound leaves? How do the hickories have their leaves arranged? What color is the ash foliage in autumn?

3. Describe the seeds of the ash and the way they are arranged on their stems. Where are they placed on the tree? How long do they cling? How does the snow help to scatter them?

4. When does the white ash blossom? Are the pistillate and staminate flowers together or separate? Find and describe them.

5. What are our uses for ash timber? For what are the saplings used? How did the Indians use the white ash? Write a theme on all the interesting things you can find about the ash trees.

6. How many species of the ash trees do you know?

Supplementary reading—Trees in Prose and Poetry, pp. 60–71.

"I care not how men trace their ancestry,
To ape or Adam; let them please their whim;
But I in June am midway to believe
A tree among my far progenitors,
Such sympathy is mine with all the race,
Such mutual recognition vaguely sweet
There is between us. Surely there are times
When they consent to own me of their kin,
And condescend to me and call me cousin,
Murmuring faint lullabies of eldest time,
Forgotten, and yet dumbly felt with thrills
Moving the lips, though fruitless of the words."

—From "Under the Willows," Lowell.

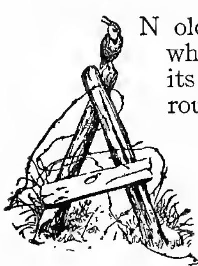
A baldwin apple tree.

THE APPLE TREE

Teacher's Story

As the apple tree among the trees of the wood, so is my beloved among the sons. I sat down under his shadow with great delight, and his fruit was sweet to my taste.

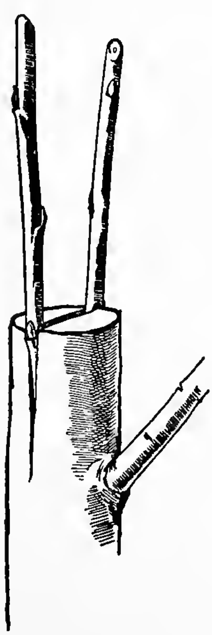
—THE SONG OF SOLOMON.



AN old-fashioned orchard is always a delight to those of us who love the picturesque. The venerable apple tree with its great twisted and gnarled branches, rearing aloft its rounded head, and casting its shadow on the green turf below, is a picture well worthy of the artist's brush. And that is the kind of orchard I should always have, because it suits me, just as it does bluebirds, downies and chickadees, as a place to live in. However, if I wished to make money by selling apples, I should need to have an orchard of comparatively young trees, which should be straight and well pruned, and the ground beneath them well cultivated; for there is no plant that responds more generously to cultivation than does the apple tree. In such an orchard, a few annual crops might be grown while the trees were young, and each year there should be planted in August or September the seed of crimson clover or of some other good cover-crop. This would grow so as to protect the ground from washing during the heavy rains and thaws of fall and winter, and in the spring it would be plowed under to add more humus to the soil.

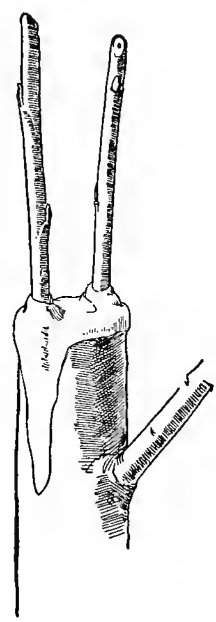
The apple originally came from southwestern Asia and the neighboring parts of Europe, but it has been cultivated so long that we have no accounts of how it began. The prehistoric lake-dwellers of Switzerland ate this fruit. In this country the apple thrives best on clay loam, although it grows on a great variety of soils; where wheat and corn grow, there will the apple also grow. In general, the shape of the apple tree head is rounded or broadly pyramidal; however, this differs somewhat with varieties. The trunk is short and rather stocky, the bark is a beautiful soft gray and is decidedly scaly, flaking off in pieces which are more or less quadrangular. The wood is very fine-grained and heavy. On this account for many years it was used for wood-engraving and is also a favorite wood for wood-carving; it makes a most excellent fuel. The spray is fine, and while at the tips of the limbs it may be drooping or horizontal, it often grows erect along the upper sides of the limbs, each shoot looking as if it were determined to be a tree in itself. The leaves are oval, with toothed edges and long petioles. When the leaves first appear each has two stipules at its base. The shape of the apple leaves depends to some extent upon the variety of the apple.

It has long been the practice not to depend upon the seeds for reproducing a variety; for, since the bees do such a large work in pollenating the apple flowers, it would be quite difficult to be sure that a seed would not be a result of a cross between two varieties. Therefore, the matter is made certain by the process of grafting or budding. There are several modes of grafting, but perhaps the one in most common use is the cleft-graft. A



Cleft-graft.
One-half natural size.

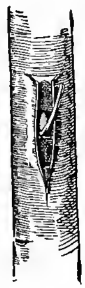
Scion for cleft-grafting.
One-half natural size.



The graft waxed.

scion which is a twig bearing several buds, is cut from a tree of the desired variety, and its lower end is cut wedge-shaped. The branch of the tree to be grafted is cut off across and split down through the end to the depth of about two inches; the wedge-shaped end of the scion is pressed into this cleft, so that its bark will come in contact with the inner edge of the bark on one side of the cleft branch. The reason for this is that the growing part of the tree is the cambium layer, which is just inside of the bark, and if the cambium of the scion does not come in contact with the cambium of the branch they will not grow together. After the graft becomes well-established, the other branches of the tree are cut off and the tree produces apples only from that part of it which grows from the graft. After the scion has been set in the stock, all of the wounded parts are covered with grafting wax, which keeps in the moisture and keeps out disease germs.

Shield-budding.
The T-shaped slit and the bud.
One-half natural size.



The bud set in the slit.
One-half natural size.

The bud tied.

Budding is done on a similar principle, but in a different fashion. A seedling apple tree about a year and a half old has a T-shaped slit cut into its bark; into this suture a bud, cut from a tree of the desired variety is inserted, and is bound in with yarn. The next spring this tree is cut back to just above the place where the bud was set in, and this bud-shoot grows several feet; the next year the tree may be sold to the orchardist. Budding is done on a large scale in the nurseries, for it is by this method that the different varieties are placed on the market.

Most varieties of apple trees should be set forty feet apart each way. It is possible, if done judiciously, to raise some small crops on the land with the young orchard, but care should be taken that they do not rob the trees of their rightful food. The dwarf varieties begin to bear much sooner than the others, but an orchard does not come into full bearing until after it has been planted fifteen or twenty years. The present practice is to prune a tree so that the trunk shall be very short. This makes the picking of the fruit much easier and also exposes the tree less to wind and sun-scald.

There are certain underlying principles of pruning that every child should know: The pruning of the root cuts down the amount of food which the tree is able to get from the soil. The pruning of the top throws the food into the branches which are left and makes them more vigorous. If the buds at the tips of the twigs are pruned off, the food is forced into the side buds and into the fruit, which make greater growth. Thinning the branches allows more light to reach down into the tree, and gives greater vigor to the branches which are left. A limb should be pruned off smoothly where it joins the larger limb, and there should be no stump projecting; the wound should be painted so as not to allow fungus spores to enter.

We should not forget that we have a native apple, which we know as the thornapple. Its low, broad head in winter makes a picturesque point along the fences; its fine, thick spray, spread horizontally, makes a fit framework for the bridal bouquet which will grow upon it in June; and it is scarcely less beautiful in autumn, when covered with the little, red apples called "haws." Though we may refrain from eating these native apples, which consist of a bit of sweet pulp around large seeds, the codling-moth finds them most acceptable

LESSON CXCIX

The Apple Tree

Leading thought—The tree of each variety of apple has its own characteristic shape, although all apple trees belong to one general type. The variety of the apple grown upon the tree is not determined by the kind of seed which is planted to produce the tree, but by the process of grafting or budding the young tree.

Method—A visit to a large, well-grown orchard in spring or autumn will aid in making this work interesting. Any apple tree near at hand may be used for the lesson.

Observations—1. How tall is the largest apple tree you know? What variety is it? How old is it? How can you distinguish old apple trees from young ones at a glance?

2. Choose a tree for study: How thick is its trunk? What is the shape of its head? Does the trunk divide into large branches or does it extend up through the center of the head?

3. What sort of bark has it? What is the color of the bark?

4. Does the spray stand erect or is it gnarled and querly? Does the spray grow simply at the ends of the branches or along the sides of the branches?

5. Are the leaves borne at the tip of the spray? Are the leaves opposite or alternate? Describe or sketch an apple leaf. Does it have stipules at its base when it first appears?

6. What is the character of apple-tree wood? What is it used for?

7. Did this tree come from a seed borne in an apple of the same variety which it produces? What is the purpose of grafting a tree? What is a scion? How and why do we choose a scion? How do we prepare a branch to receive the scion? If you should place the scion at the center of the branch would it grow? Where must it be placed in order to grow? How do we protect the cut-end of the branch after it is grafted? Why?

8. What is meant by the term "budding?" What is the difference between grafting and budding? Describe the process of budding.

9. Where is budding done on a large scale? How do nurserymen know what special varieties of apples their nursery stock will bear? How old is a tree when it is budded? How old when it is sold to the orchardist?

10. Why should the soil around apple trees be tilled? Is this the practice in the best-paying orchards?

11. What is often used as a cover crop in orchards? When is this planted? For what purpose?

12. How far apart should apple trees be set? How may the land be utilized while the trees are growing? How old must the apple tree be to come into bearing?

13. Is the practice now to allow an apple tree to grow tall? Why is an apple tree with a short trunk better?

14. What does it do to a tree to prune its roots? What does it do to a tree to prune its branches?

15. How does it affect a tree to prune the buds at the tips of the twigs?

16. How does it affect a tree to thin the branches? Describe how a limb should be pruned and how the wound thus made should be treated. Why?

HOW AN APPLE GROWS

Teacher's Story

An apple tree in full blossom is a beautiful sight. If we try to analyze its beauty we find that on the tip of each twig there is a cluster of blossoms, and set around them, as in a conventional bouquet, are the pale, soft, downy leaves. These leaves and blossoms come from the terminal winter buds, which are protected during winter by little scales which are more or less downy. With the bursting of the bud, these scales fall off, each one leaving its mark crosswise on the twig, marking the end of the year's growth; these little ridges close together and in groups mark the winters which the twig has experienced, and thus reveal its age.

There is a difference in varieties of apples and in the season as to whether the blossoms or the leaves push out first. The white, downy leaves at first have two narrow stipules at the base of their petioles. They are soft, whitish and fuzzy, as are also the flower stem and the calyx, which holds fast in its slender, pointed lobes the globular flower bud. We speak of the lobes of the calyx because they are joined at the base, and are not entirely separate as are sepals. The basal part of the calyx is cup-shaped, and upon its rim are set the large, oval petals, each narrowing to a slender stem at its base. The petals are set between the sepals or lobes of the calyx, the latter appearing as a beautiful, pale green, five-pointed star at the bottom of the flower. The petals are pink on the outside and white on the inside, and are veined from base to edge like a leaf; they are crumpled more than are the cherry petals.

The many pale, greenish white stamens of different lengths and heights stand up like a column at the center of the flower. They are tipped with pale yellow anthers, and are attached to the rim of the calyx-cup. They are really attached in ten different groups but this is not easy to see.

The five pale green styles are very silky and downy and are tipped with green stigmas. The pistils all unite at their bases making a five-lobed, compound ovary. The upper part of this ovary may be seen above the calyx-cup, but the lower portion is grown fast to it and is hidden within it. The calyx-cup is what develops into the pulp of the apple, and each of these pistils becomes one of the five cells in the apple core. If one of the stigmas does not receive pollen, its ovary will develop no seed; this often makes the apple lop-sided. When the petals first fall, the calyx-lobes are spread wide apart; later they close in toward the center, making a tube. To note exactly the time of this change is important; since the time of spraying for the codling moth is before the calyx-lobes close. These lobes may be seen in any ripe apple as five little, wrinkled scales at the blossom end; within them may be seen the dried and wrinkled stamens, and within the circle of stamens, the sere and blackened styles.

Just ready to spray. A pear and two apples from which the petals have recently fallen and with calyx lobes widely spread.
Photo by M. V. Slingerland.

There may be five or six, or even more blossoms developed from one winter bud, and there may be as many leaves encircling them, forming a bouquet at the tip of the twig. However, rarely more than two of these blossoms develop into fruit, and the fruit is much better when only one blossom of the bouquet produces an apple; if a tree bears too many apples it cannot perfect them.

The blossoms and fruit are always at the end of the twigs and spurs of the apple tree, and do not grow along the sides of the branches as do the cherry and the peach. However, there are many buds which produce only leaves; and just at the side and below the spur, where the apple is borne, a bud is developed, which pushes on and continues the growth of the twig, and will in turn be a spur and bear blossoms the following year.

Apple blossoms.
Photo by Verne Morton.

LESSON CC

How an Apple Grows

Leading thought—The purpose of the apple blossom is to produce apples which shall contain seeds to grow into more apple trees.

Method—This lesson should begin with the apple blossoms in the spring and should continue, with occasional observations, until the apples are well grown. If this is not possible, the blossom may be studied, and directly afterward, the apple may be observed carefully, noting its relation to the blossom.

The Apple Blossom

Observations—1. How are the apple buds protected in the winter? As the buds open what becomes of the protecting scales? Can you see the scars left by the scales after they have fallen. How does this help us to tell the age of a twig or branch?

2. As the winter buds open, which appear first—the flowers or the leaves? Do they both come from the same bud? Do all the buds produce both flowers and leaves?

3. Study the bud of the apple blossom. Describe its stem; its stipules; its calyx. What is the shape and position of the lobes, or sepals, of the calyx? Why do we usually call them the "lobes of the calyx" instead of sepals?

4. Sketch or describe an open apple blossom. How many petals? What is their shape and arrangement? Can you see the calyx-lobes between the petals as you look down into the blossom? What sort of a figure do they make? Are the petals usually cup-shaped? What is their color outside and inside? Why do the buds seem so pink and the blossoms so white?

5. How many stamens are there? Are they all of the same length? What is the color of the filaments and anthers? On what are they set?

6. How many pistils do you see? How many stigmas are there? Are the ovaries united? Are they attached to the calyx?

7. Describe the young leaves as they appear around the blossoms. What is their color? Have they any stipules? Why do they make the flowers look like a bouquet?

8. After the petals fall, what of the blossom remains? What part develops into the apple? Does this part enclose the ovaries of the pistils? How can you tell in the ripe apple if any stigma failed to receive pollen?

9. What is the position of the calyx-lobes directly after the petals fall? Do they change later? How does this affect spraying for the codling moth?

10. Watch an apple develop; look at it once a week and tell what parts of the blossom remain with the apple.

11. How many blossoms come from one winter bud? How many leaves? Do the blossoms ever appear along the sides of the branches, as in the cherries? How many blossoms from a single bud develop into apples?

12. Since the apple is developed on the tip of the twig how does the twig keep on growing?

13. Compare the apple with the pear, the plum, the cherry and the peach in the following particulars; position on the twigs; number of petals; number and color of stamens; number of pistils; whether the pistils are attached to the calyx-cup at the base.

THE APPLE

Teacher's Story

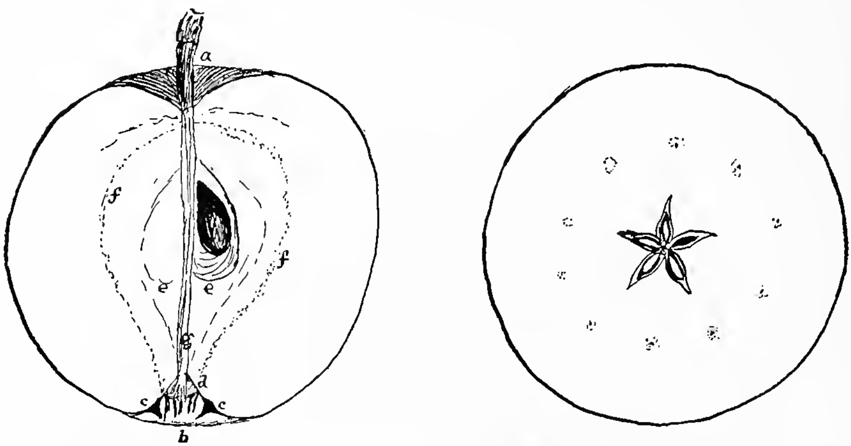
> "*Man fell with apples and with apples rose,*
> *If this be true; for we must deem the mode*
> *In which Sir Isaac Newton could disclose,*
> *Through the then unpaved stars, the turnpike road,*
> *A thing to counterbalance human woes.*"—BYRON.

APPLES seem to have played a very important part in human history, and from the first had much effect upon human destiny, judging from the trouble that ensued both to Adam and to Helen of Troy from meddling, even though indirectly, with this much esteemed fruit. It is surely no more than just to humanity—shut out from the Garden of Eden—that the apple should have led Sir Isaac Newton to discover the law which holds us in the universe; and that, in these later centuries, apples have been developed, so beautiful and so luscious as almost to reconcile us to the closing of the gates of Paradise.

While it is true that no two apples were ever exactly alike, any more than any two leaves, yet their shapes are often very characteristic of the varieties. From the big, round Baldwin to the cone-shaped gillyflower, each has its own peculiar form, and also its own colors and markings and its own texture and flavor. Some have tough skins, others bruise readily even with careful handling; but to all kinds, the skin is an armor against those ever-present foes, the fungus spores, myriads of which are floating in the air ready to enter the smallest breach, and by their growth bring about decay. Even the tip of a branch or twig swayed by the wind, may bruise an apple and cause it to rot; windfalls are always bruised and will not keep. Greater care in packing, wrapping, picking and storing, so as to avoid contact with other apples, is a paying investment of labor to the apple grower.

The cavities at the stem and basin-ends of the fruit are also likely to have, in the same variety, a likeness in their depth or shallowness, and thus prove a help in identifying an apple. At the blossom, or basin, end of the fruit may be seen five scales, which are all that remain of the calyx-lobes which enclosed the blossom; and within them are the withered and shrunken stamens and styles.

When the fruit is cut, we see that the inner parts differ as much in the different varieties as do the outer parts. Some have large cores, others



a, *cavity;* b, *basin;* c, *calyx lobes;* d, *calyx tube with the withered stamens attached;* e, *carpels;* f, *outer core-lines, terminating at a point where stamens are attached;* g, *fibres extending from stem to basin. Transverse section of apple showing the five carpels and the ten outer core-lines.*

small. The carpels, or seed-cells, are five in number, and when the fruit is cut across through the center these carpels show as a pretty, five-pointed star; in them the seeds lie, all pointing toward the stem. Some apples have both seeds and carpels smooth and shining, while in others they are tufted with a soft, fuzzy outgrowth. The number of seeds in each cell varies; the usual number is two. In case a carpel is empty, the apple is often lopsided, and this signifies that the stigma of that ovary received no pollen. The apple seed is oval, plump and pointed, with an outer shell, and a delicate inner skin covering the white meat; this separates readily into two parts, between which, at the point, may be seen the germ. The entire core, with the pulp immediately surrounding the seed cells, is marked off from the rest of the pulp by the core-lines, faint in some varieties but distinct in others. In our native crab-apples this separation is so complete that, when the fruit is ripe, the core may be plucked out leaving a globular cavity at the center of the apple.

Extending from the stem to the basin, through the center of the apple, is a bundle of fibers, five in number, each attached to the inner edge of a carpel, or seed-box. Other bundles of fibers pass through the flesh about half way between the core and the skin. Delicate as they are, so that no one observes them in eating the fruit, they show clearly as a second core-line, and each terminates at a point in the calyx-tube where the stamens were attached—as can be easily seen by dissecting an apple. In transverse section, these show as ten faint dots placed opposite each outer point and inner angle of the star at the center formed by the carpels. Sometimes the seed-cells are very close to the stem, and the apple is said to have a sessile core; if at the center of the fruit, it has a medium core; if nearest to the blossom end, it has a distant core. This position of the core marks different varieties.

Basket of apples.

Apples even of the same variety, differ much in yield and quality according to the soil and climate in which they grow. The snow apple grows best in the St. Lawrence Valley, and New York State is noted for the fine flavor of the Esopus spitzenburg, the northern spy, and the Newtown pippin, all of which originated and grow best within its boundaries. Thus, each locality has its favorite variety.

Too often in passing through the country, we see neglected and unprofitable orchards, with soil untilled, the trees unpruned and scale-infested, yielding scanty fruit, fit only for the cider mill and the vinegar barrel. This kind of orchard must pass away and give place to the new horticulture.

References—Popular Apple Growing, Green; The American Apple Orchard, Waugh; The Apple and How to Grow It, Farmers' Bulletin 113, U. S. Department of Agriculture.

LESSON CCI

The Apple

Leading thought—The apple is a nutritious fruit, wholesome and easily digested. The varieties of apple differ in shape, size, color, texture and flavor. A perfect apple has no bruise upon it and no worm-holes in it.

Method—Typical blossoms of different varieties of apples should be brought into the schoolroom, where the pupils may closely observe and make notes about their appearance. Each pupil should have one or two apples that may be cut in vertical and transverse sections, so that the pulp, core-lines, carpels and seeds may be observed. After this lesson there should be an apple exhibit, and the pupils should be taught how to score the apples according to size, shape, color, flavor and texture.

Observations—1. Sketch the shape of your apple. Is it almost spherical, or flattened, or long and egg-shaped, or with unequal tapering sides? How does the shape of the apple help in determining its variety?

2. What is the color of the skin? Is it varied by streaks, freckles or blotches? Has it one blushing cheek the rest being of a different color?

3. Is the stem thick and fleshy, or short and knobby, or slender and woody and long? Does each variety have a characteristic stem?

4. Is the cavity or depression where the stem grew narrow and deep like a tunnel, or shallow like a saucer?

5. Examine the blossom end, or basin. What is its shape? Can you find within it the remnants of the calyx-lobes, the stamens and the pistils of the flower?

6. What is the texture of the skin of the apple? Is it thin, tough, waxy or oily? Has it a bloom that may be rubbed off? From what sort of injury does the skin protect the apple?

Experiment 1. Take three apples of equal soundness and peel one of them; place them on a shelf. Place one of the unpeeled apples against the peeled one, and the other a little distance from it. Does the peeled apple begin to rot before the other two? Does the unpeeled apple touching the peeled one begin to decay first at the point of contact?

Experiment 2. Take an apple with a smooth, unblemished skin and vaccinate it with some juice from an apple that has begun to decay; perform the operation with a pin or needle, pricking first the unsound fruit and then the sound one; this may be done in patterns around the apple or with the initials of the operator's name. Where does this apple begin to decay? What should these two experiments teach us as to the care and storage of fruit?

7. Cut an apple through its center from stem to blossom end. Describe the color, texture and taste of the pulp. Is it coarse or fine-grained? Crisp or smooth? Juicy, or dry and mealy? Sweet or sour? Does it exhale a fragrance or have a spicy flavor?

8. Is the flesh immediately surrounding the core separated from the rest of the pulp by a line more or less distinct? This is called the core-line and differs in size and outline in different varieties. Can you find any connection between the stem and blossom ends and the core? Can you see the fibrous threads which connect them?

9. Cut an apple transversely across the middle. In what shape are the seed-cells arranged in the center? Do the carpels, or seed-cells, vary in shape in different varieties? Are they closed, or do they all open into a common cavity? Can you see, between the core-lines and the skin, faint little dots? Count, and tell how they are arranged in relation to the star formed by the core.

10. The stiff, parchment-like walls of the seed-cells are called carpels How many of these does the apple contain? Do all apples have the same number of carpels? Are the carpels of all varieties smooth and glossy, or

velvety? How many seeds do you find in a carpel? Do they lie with the points toward the stem-end or the blossom-end of the apple? Where are they attached to the apple? Describe the apple seed—its outer and inner coat and its "meat." Can you find the germ within it which will, after the seed is planted, produce another apple tree?

11. Is the core at the center of the apple, or is it nearer to the stem-end or to the blossom-end of the fruit? Are all apples alike in this particular?

12. Describe fully all the varieties of apples which you know, giving the average size, texture and color of the skin, the shape of the cavities at the stem and blossom ends, the color, texture and flavor of the pulp, and the position within the apple of the core.

Supplementary reading—Trees in Prose and Poetry, pp. 43–59.

THE PINE

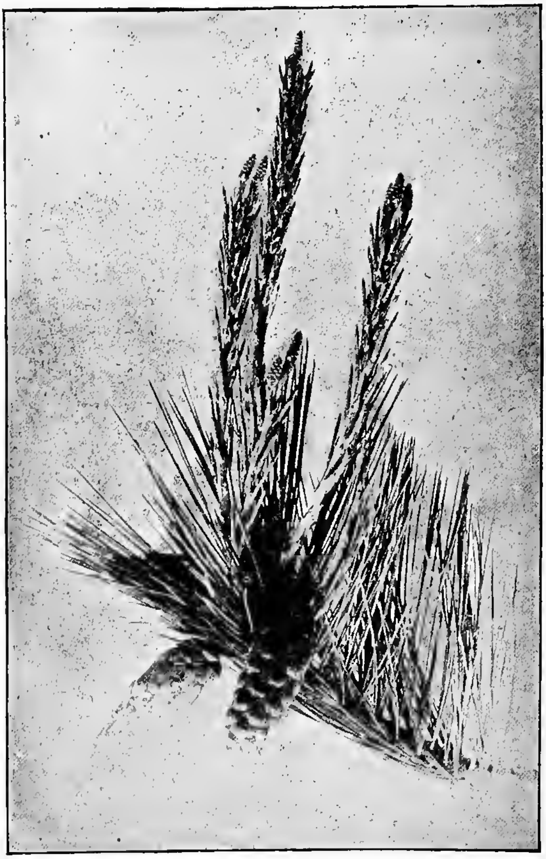
Teacher's Story

NONE other of our native trees is more beautiful than the pine. In the East, we have the white pine with its fine-tasselled foliage, growing often 150 to 200 feet in height and reaching an age of from two to three hundred years. On the Pacific coast, the splendid sugar pine lifts its straight trunk from two to three hundred feet in height; and although the trunk may be from six to ten feet in diameter yet it looks slender, so tall is the tree. A sugar pine cone on my desk measures 22 inches in length and weighs almost one pound, although it is dried and emptied of seed.

There is something majestic about the pines, which even the most ignorant feel. Their dark foliage outlined against wintry skies appeals to the imagination, and well it may, for it represents an ancient tree-costume. The pines are among the most ancient of trees, and were the contemporaries of those plants which were put to sleep, during the Devonian age, in the coal beds. It is because the pines and the other evergreens belong essentially to earlier ages, when the climate was far different than it is to-day, that they do not shed their leaves like the more recent, deciduous trees. They stand among us, representatives of an ancient race, and wrap their green foliage about them as an Indian sachem does his blanket, in calm disregard of modern fashion of attire.

All cone-bearing trees have typically a central stem from which the branches come off in whorls, but so many things have happened to the old pine trees that the evidence of the whorls is not very plain; the young trees show this method of growth clearly, the white pine having five branches in each whorl. Sometimes pines are seen which have two or three stems near the top; but this is a story of injury to the tree and its later victory.

The very tip of the central stem in the evergreens is called "the leader,' because it leads the growth of the tree upward; it stretches up from the center of the whorl of last year's young branches, and there at its tip are the buds which produce this year's branches. There is a little beetle which seems possessed of evil, for it likes best of all to lay its rascally eggs in the very tip of this leader; the grub, after hatching, feeds upon the bud and bores down into the shoot, killing it. Then comes the question of which

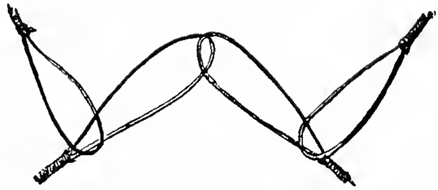


The young and the mature cones of white pine.
Photo by Ralph Curtis.

branch of the upper whorl shall be elected to rise up and take the place of the dead leader; but this is an election which we know less about than we do of those resulting from our blanket ballots. Whether the tree chooses, or whether the branches aspire, we may not know; but we do know .that one branch of this upper whorl arises and continues the growth of the tree. Sometimes there are two candidates for this position, and they each make such a good struggle for the place that the tree grows on with two stems instead of one—and sometimes with even three. This evil insect injures the leaders of other conifers also, but these are less likely to allow two competitors to take the place of the dead leader.

The lower branches of many of the pines come off almost at right angles from the bole; the foliage is borne above the branches, which gives the pines a very different appearance from that of other trees. The foliage of most of the pines is dark green, looking almost black in winter; the pitch pine has the foliage yellowish green, and the white pine, bluish green; each species has its own peculiar shade. There is great variation in the color and form of the bark of different species. The white pine has nearly smooth bark on the young trees, but on the older ones it has ridges that are rather broad, flat and scaly, separated by shallow sutures, while the pitch pine has its bark in scales like the covering of a giant alligator.

The foliage of the pine consists of pine needles set in little bundles on raised points which look like little brackets along the twigs. When the pine needles are young, the bundle is enclosed in a sheath making the twig look as if it were covered with pin-feathers. In many of the species this sheath remains, encasing the base of the bundle of needles; but in the white pine it is shed early. The number of leaves in the bundle helps to determine the tree; the white pine has five needles in each bunch, the pitch pine has three,



A part of a necklace of pitch pine needles.

while the Austrian pine has two. There is a great difference in the length and the color of the needles of different species of pine. Those of the white pine are soft, delicate and pliable, and from three to four inches in length; the needles of the pitch pine are stiff and coarse and about the same length; the white pine needles are triangular in section, and are set so as to form distinct tassels, while those of the Austrian pine simply clothe the ends of the twigs. The needles of the pine act like the strings of an aeolian harp; and the wind, in passing through the tree, sets them into vibration, making a sighing sound which seems to the listener like the voice of the tree. Therefore, the pine is the most companionable of all our trees and, to one who observes them closely, each tree has its own tones and whispers a different story.

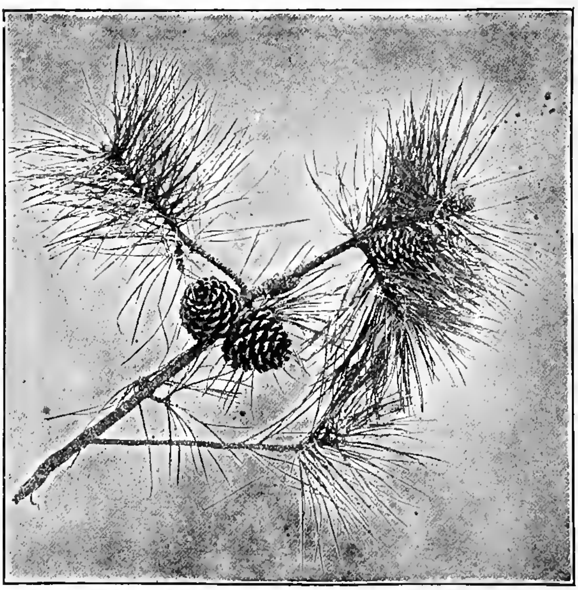
The appearance of the unripe cone is another convincing evidence that mathematics is the basis of the beautiful. The pattern of the overlapping

Austrian pine in blossom showing staminate flowers.
Photo by G. F. Morgan.

scales is intricate and yet regular—to appreciate it one needs to try to sketch it. Beneath each scale, when it opens wide, we find nestled at its base two little seeds in twin boxes; each provided with a little wing so that it can sail off with the wind to find a place to grow. The shape of the scales of the cone is another distinguishing character of the pine, and sketching the outside of scales from several different species of pine cones will develop the pupils' powers of observation; the tip of the scale may be thickened or armed with a spine, and one wonders if these spines are for the purpose of discouraging the squirrels from stealing the green seeds.

The pine cone requires two years for maturing; the pistillate flower from which it is developed is a tiny cone with each scale spread wide and standing upright to catch the pollen for the tiny ovule nestled within it. The pistillate flower of the white pine grows near the tip of the new twig, and is pinkish in color. In the Austrian pine it is the merest pink dot at first, but after a little shows itself to be a true cone with pink-purple scales, which stand up very erect and makes a pretty object when viewed through a lens; each scale is pink at its three-pointed tip, with pink wings just below, the inner portions being pale green. The cone is set just beside the growing tip of the twig, is pointed upward, and its sheath-scales are turned back like chaff around its base.

In June when the new shoots of the pine twigs stand up like pale green candles on a Christmas tree, at their bases may be found the staminate catkins set in radiating whorls, making galaxies of golden stars against the dark green background of foliage. In the Austrian pine, one of these pollen catkins may be an inch or two long and a half-inch in width; each little scale of this cone is an anther sac, filled to bursting with yellow pollen. From these starry pollen cones there descends a yellow shower every time a breeze passes; ɔr the pine trees depend upon the wind to sift their pollen dust into the lifted cups of the cone scales, which will close upon the treasure soon. The pollen grains of pine are very beautiful when seen through a microscope; and it seems almost incredible that the masses of yellow dust sifted in showers from the pines when in blossom, should be composed of these beautiful

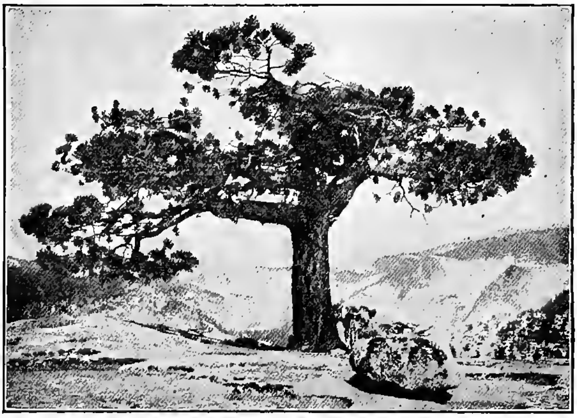


White pine, staminate blossoms and empty cones.
Photo by Morgan.

structures. When the pine forests on the shores of the Great Lakes are in bloom, the pollen covers the waves for miles out from the shores.

White pine.

If we examine the growing tips of the pine branches, we find the leaves look callow and pin-feathery. The entire leaf is wrapped in a smooth, shining, silken sheath, at the tip of which its green point protrudes. The sheath is tough like parchment and is cylindrical because the pine needles



Yellow pine on the brink of the Little Yosemite Valley.
Photo by G. K. Gilbert. Courtesy of U. S. Geological Survey.

within it are perfectly adjusted one to another in cylindrical form. The sheath is made up of several layers, one over the other, and may be pulled apart. The new leaves are borne on the new, pale green wood.

The uses of pines are many. The lumber of many of the species, especially that of the white pine, is free from knots and is used for almost everything from house-building to masts for ships. In the Southern States, the long-leafed pines are tapped for resin, which is not the sap of the tree, as is generally supposed. Pine sap is like other sap; the resin is a product of certain glands of the tree, and is of great use to it in closing wounds and thus keeping out the spores of destructive fungi. It is this effort of the tree to heal its wounds that makes it pour resin into the cuts made by the turpentine gatherers. This resin is taken to a distillery, where the turpentine is given off as a vapor and condensed in a coiled tube which is kept cold. What is left is known as "rosin."

The mountain pine of the Sierras.

This species stands upright normally and is often over one hundred feet high; but on the mountain tops, exposed to wind and snow, its trunk reclines on the ground and its branches look like shrubs, as shown in the foreground. Trees of the same species, wind-beaten but standing are shown in the background.

Photo by G. K. Gilbert. Courtesy of the U. S. Geological Survey.

LESSON CCII

The Pine

Leading thought—The pines are among our most ancient trees. Their foliage is evergreen but is shed gradually. The pollen-bearing and the seed-bearing flowers are separate on the tree. The seeds are winged and are developed in cones.

Method—At least one pine tree should be studied in the field. Any species will do but the white pine is the most interesting. The Austrian pine which is commonly planted in parks is a good subject. The leaves and cones may be studied in the schoolroom, each pupil having a specimen.

Observations—1. What is the general shape of the pine tree? Is there one central stem running straight up through the center of the tree to the top. Do you find any trees where this stem is divided into two or three near the top? Describe how the pine tree grows. What is the "leader?" What happens if the leader is injured? How do the topmost branches of the young pine look? Do they all come off from the same part of the stem? How many are there in a whorl?

2. What color is the bark? Is it ridged or in scales?

3. Do the branches come off the main stem at right angles or do they lift up or droop down? Where is the foliage borne on the branches? What is the color of the foliage? Is the pine foliage ever shed or does the pine leaf, when it comes, stay on as long as the tree lives?

4. Study the pine leaves. Why are they called needles? Note that they grow several together in what we call a bundle. How many in one bundle? Is the bundle enclosed in a little sheath at the base? Are the bundles grouped to make distinct tassels? Study one of the needles. How long is it? Is it straight or curved? Flexible or coarse and stiff? Cut it across and examine it with a lens. What is the outline in cross section? Why does the wind make a moaning sound in the pines?

5. Study a pine cone. Does it grow near the tip of the branch or along the sides? Does it hang down or stand out stiffly? What is its length? Sketch or describe its general shape. Note that it is made up of short, over-lapping scales. What pattern do the scales make as they are set together? Describe or sketch one scale; has it a thickened tip? Is there a spine at the tip of the scale?


White pine cone.

6. Where in the cone are the seeds? Describe or sketch a pine seed. How long is its wing? How is it carried and planted? When the cone opens, how are the seeds scattered? What creatures feed upon the pine seed?

7. Study the pine when in blossom, which is likely to occur in June. This time is easily determined because the air around the tree is then filled with the yellow pollen dust. Study the pollen-bearing flower. Is it conelike in form? Does it produce a great deal of pollen? If you have a microscope, look at the pollen through a high objective and describe it. How many of the pollen catkins are clustered together? On what part of the twigs are they borne? Where are the pistillate flowers which are to form the young cones? How large are they and how do they look at the time the pollen is flying? Do they point upward or droop downward? Why? Look beneath the scales of a little cone with a lens and see if you can find the flowers. What carries the pine pollen to the flowers in the cone?

8. Name all the uses for pine lumber that you know. Write an English theme on how turpentine is produced from pines and the effect of this industry upon pine forests. Where does resin appear on the pine? Of what use is it to the tree? Do you think it is pine sap? What is the difference between resin and rosin?

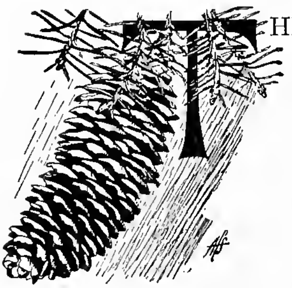
9. How long do the pine trees live? Write a story of all that has happened to your neighborhood since the pine tree which you have been studying was planted.

10. Make the following drawings: A bundle of pine needles showing the sheath and its attachment to the twig; the cone; the cone scale; the seed. Sketch a pine tree.

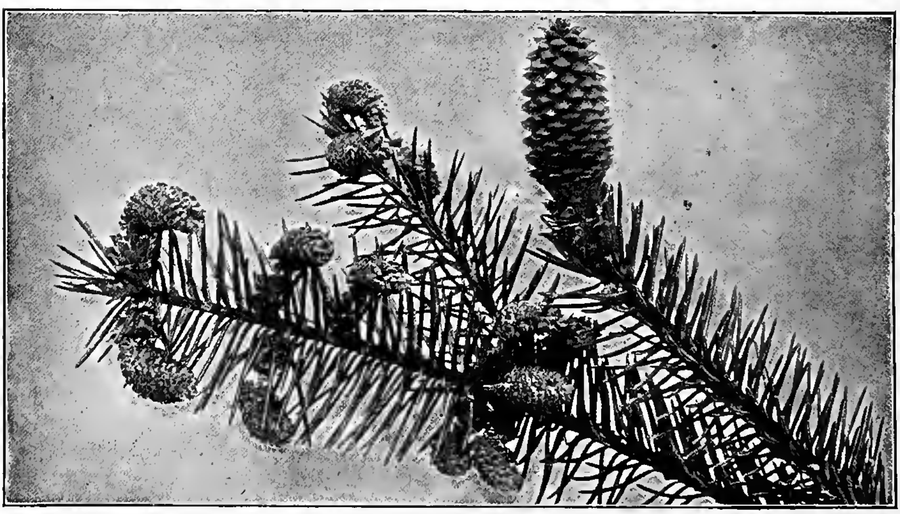
Supplementary reading—Trees in Prose and Poetry, pp. 32, 151, 152; The Spirit of the Pine, Bayard Taylor; To a Pine Tree, Lowell; Nature in Verse, pp. 15, 288.

THE NORWAY SPRUCE

Teacher's Story



THE Norway spruce is a native of Europe, and we find it in America the most satisfactory of all spruces for ornamental planting; it lifts its slender cone from almost every park and private estate in our country, and is easily distinguished from all other evergreens by the drooping, pendant habit of its twigs, which seem to hang down from the straight, uplifted branches. We have spruces of our own—the black, the white and the red spruces; and it will add much to the interest of this lesson for the pupils to read in the tree and forestry books concerning these American species. Chewing gum and spruce beer are the products of the black and red spruce of our eastern forests. The Douglas spruce, which is a fir and not a spruce, is also commonly planted as an ornamental tree, but



Staminate blossoms and young cone of a Norway spruce
Photo by G. F. Morgan.

it is only at its best on the Pacific Coast, where it is one of the most magnificent of trees.

The Norway spruce tree is in form a beautiful cone, slanting from its slender tip to the ground, on which its lower drooping branches rest; the upper branches come off at a narrower angle from the sturdy central stem than do the widespreading lower branches. On the older trees, the twigs hang like pendulous fringes from the branches, enabling them to shed the snow more readily—a peculiarity which is of much use to the tree, because it is a native of the snowy northern countries of Europe and also grows successfully in the high altitudes of the Alps and other mountains. If we stroke a spruce branch toward the tip, the hand slides smoothly over it; but brusn backward from the tip, and the hand is pricked by hundreds of the sharp, bayonet-pointed leaves; this is another arrangement for letting the snow slide off.

If we examine a twig of the present year's growth, we can see on every side of its brown stem the pointed leaves, each growing from a short ridge; but the leaves on the lower side stretch out sidewise to get the light, and those above lift up angularly. Perhaps the twig of last year's growth has shed its leaves which grew on the under side and thus failed to reach the sun. The leaf of the spruce is curved, stiff, four-sided and ends in a sharp point. It is dark yellowish above and lighter beneath and is set stiffly on the twig. The winter buds for next year's growth may be seen at the tips of the twigs, covered with little, recurved, brown scales quite flowerlike in form. In the balsam fir, which is often planted with the Norway spruce, these buds are varnished.

The cones are borne on the tips of the branches and hang down. In color they are pale, wood-brown; they are from four to six inches long, and are very conspicuous. They are made up of broad scales that are thin toward the notched tips; they are set around the central stem in spirals of five rows. If we follow one spiral around marking it with a winding string, it will prove to be the fifth row above the place where we started. These manifold spirals can be seen sometimes by looking into the tip end of a cone. The cone has much resin on it, and is a very safe box for seeds; but when it begins to open, squirrels impatiently tear it to pieces, harvesting the seeds and leaving a pile of cone-scales beneath the tree to tell of their piracy.

A cone of Norway spruce, showing that the spiral of the scales is in rows of five.

Photo by Cyrus Crosby.

A Norway spruce in blossom is a beautiful sight; the little, wine-red pistillate cones are lifted upwards from the tips of the twigs, while short, terminal branches are laden with the pollen-bearing catkins, which are soft and caterpillarish, growing on soft, white stems from the base of scales which enclosed and protected them during the winter; these catkins are filled with the yellow dust. The young cones continue to stand upright after the scales have closed on the pollen which has been sifted by the wind to the ovules which they guard; and for some time they remain most ornamentally purplish red. Before the cone is heavy enough to bend from its own weight, it turns deliberately around and downward, as if the act were a wilful deed, and then changes its color to green, ripening into brown in the fall.

The Norway spruce grows on the Alps abundantly, and like the youth with the banner, "excelsior" is not only its motto but its scientific name, (*Picea excelsa*). Here it grows to the height of one hundred to one hundred and fifty feet. Its wood is valuable and its pitch is marketed. In this country, it is used chiefly for ornamental planting and for wind-breaks.

LESSON CCIII

The Norway Spruce

A Norway spruce.
Photo by Cyrus Crosby

Leading thought—The Norway spruce is one of the most valuable of the trees which have come to America from Europe. It grows naturally in high places and in northern countries where there is much snow; its drooping twigs cannot hold a great burden of snow, and thus it escapes being crushed.

Method—This lesson should begin in the autumn when the cones are ripe. The tree should be observed by all of the pupils, and they should bring in twigs and cones for study in the schoolroom. The lesson should be taken up again in May when the trees are in blossom.

Observations—1. What is the general shape of the tree? Do the lower branches come off at the same angle as the upper? If untrimmed, what can you see of the trunk? Do the lower branches rest upon the ground? What advantage would this be to the tree in winter? Do the twigs stand out, or droop from the branches? Of what advantage is this in case of heavy snow? What is the color of the foliage? Where did the Norway spruce come from?

2. What is the color of the twig? How are the leaves set upon it? Are there more leaves on the upper than on the under side of the twigs of this year's growth? Of last year's growth? Brush your hand along a branch toward the tip. Do the leaves prick? Brush from the tip backward. Is the result the same? Why is this angle of the leaves to the twig a benefit during snowstorms?

3. Take a single leaf. What is its shape? How many sides has it? Is it soft or stiff? Is it sharp at the tip? Describe the buds which are forming for next year's growth. Look along the twigs and see if you can discover the scales of the bud which produced last year's growth?

4. Where are the cones borne? How long does it take a cone to grow? Is it heavy? Is there resin on it? Note that the scales are set in a spiral around the center of the cone. Wind a string around a cone following the same row of scales. How many rows between those marked with a string? Look into the tip of a cone and see the spiral arrangement. Sketch and describe a cone-scale, paying special attention to the shape of the tip. Try to tear a cone apart. Is this easily done? Hang a closed cone in a dry place and note what happens.

5. Describe the seed, its wings and where it is placed at the base of the scale. How many seeds under each scale? When do the cones open of themselves to scatter the seed? Do you observe squirrels tearing these apart to get the seed?

6. The Norway spruce blossoms in May. Find the little flower which will produce the cone, and describe it. What color is it? Is it upright or hanging down? Do the scales turn toward the tip or backward? Why is this? Where are the pollen-catkins borne? How many of them arise from the same place on the twig? Can you see the little scales at the base of each pistillate catkin? What are they? Are they very full of pollen? Do the insects carry the pollen for the Norway spruce, or does the wind sift it over the pistillate blossoms? After the pollen is shed, note if the scales of the young cones close up. How long before the cones begin to droop? Do you think it is their weight which causes them to droop?

7. What use do we make of the Norway spruce? What is it used for in Europe?

"All outward wisdom yields to that within,
Whereof nor creed nor canon holds the key;
We only feel that we have ever been
And evermore shall be.

And thus I know, by memories unfurled
In rarer moods, and many a nameless sign,
That once in Time, and somewhere in the world,
I was a towering pine.

Rooted upon a cape that overhung
The entrance to a mountain gorge; whereon
The wintry shade of a peak was flung,
Long after rise of sun.

There did I clutch the granite with firm feet,
There shake my boughs above the roaring gulf,
When mountain whirlwinds through the passes beat,
And howled the mountain wolf.

There did I louder sing than all the floods
Whirled in white foam adown the precipice,
And the sharp sleet that stung the naked woods,
Answer with sullen hiss.

I held the eagle till the mountain mist
Rolled from the azure paths he came to soar,
And like a hunter, on my gnarled wrist
The dappled falcon bore."

—From "The Spirit of the Pine," BAYARD TAYLOR.

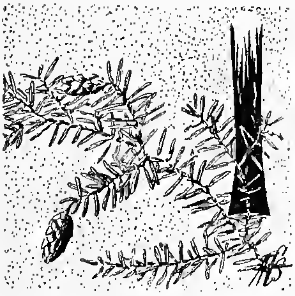
White pine. *Norway spruce*
Pitch pine *Hemlock*

THE HEMLOCK

Teacher's Story

"O'er lonely lakes that wild and nameless lie,
Black, shaggy, vast and still as Barca's sands
A hemlock forest stands. Oh forest like a pall!
Oh hemlock of the wild, Oh brother of my soul
I love thy mantle black, thy shaggy bole,
Thy form grotesque, thy spreading arms of steel."

—PATTEE.



IN ITS prime, the hemlock is a magnificent tree. It reaches the height of from sixty to one hundred feet, is cone-shaped, its fine, dense foliage and its drooping branches giving to its appearance exquisite delicacy; and I have yet to see elsewhere such graceful tree-spires as are the hemlocks of the Sierras, albeit they have bending tips. However, an old hemlock becomes very ragged and rugged in appearance; and dying, it rears its wind-broken branches against the sky, a gaunt figure of stark loneliness. The hemlock branches are seldom broken by snow; they droop to let the burden slide off. The bark is reddish, or sometimes gray, and is furrowed into wide, scaly ridges. The foliage is a rich dark green, but whitish when seen from below. The leaves of the hemlock are really arranged in a spiral, but this is hard to demonstrate. They look as though they were arranged in double rows along each side of the little twig; but they are not in the same plane and there is usually a row of short leaves on the upper side of the twig. The leaf is blunt at the tip and has a little petiole of its own which distinguishes it from the leaves of any other species of conifer; it is dark, glossy green above, pale green beneath, marked with two white, lengthwise lines. In June, the tip of every twig grows and puts forth new leaves which are greenish yellow in color, making the tree very beautiful and giving it the appearance of blossoming. The leaves are shed during the third year. The hemlock cones are small and are borne on the tips of the twigs. The seeds are borne, two beneath each scale, and they have wings nearly as large as the scale itself. Squirrels are so fond of them that probably but few have an opportunity to try their wings. The cones mature in one year, and usually fall in the spring. The hemlock blossoms in May; the pistillate flowers are very difficult to observe as they are tiny and greenish and are placed at the tip of the twig. The pollen-bearing flowers are little, yellowish balls on delicate, short stems, borne along the sides of the twig.

Hemlock bark is rich in tannin and is used in great quantities for the tanning of leather. The timber, which is coarse-grained, is stiff and is used in framing buildings and for railroad ties; nails and spikes driven into it cling with great tenacity and the wood does not split in nailing. Oil distilled from the leaves of hemlock is used as an antiseptic.

The dense foliage of the hemlock offers a shelter to birds of all kinds in winter; even the partridges roost in the young trees. These young tree often have branches drooping to the ground, making an evergreen tent which forms a winter harbor for mice and other beasties. The seed-eating birds which remain with us during the winter, feed upon the seeds; and as the cones grow on the tips of the delicate twigs, the red squirrels display their utmost powers as acrobats when gathering this, their favorite food.

Hemlock branch showing young and mature cones.

LESSON CCIV

The Hemlock

Leading thought—This is one of the most common and useful and beautiful of our evergreen trees. Its fine foliage makes it an efficient winter shelter for birds

Method—Ask the children the questions and request them to make notes on the hemlock trees of the neighborhood. The study of the leaves and the cones may be made in the schoolroom.

Observations—1. Where does the hemlock tree grow in your neighborhood? What is the general shape of the tree? What sort of bark has it? How tall does it grow? How are its branches arranged to shed the snow?

2. What is the color of the foliage? How are the leaves arranged on the twigs? Are all the leaves of about the same size? What is the position of the smaller leaves?

3. Break off a leaf and describe its shape; its petiole. Does the leaf of any other evergreen have a petiole? What is the color and marking of the hemlock leaf above? Below? At what time of year are the new leaves developed? How does the hemlock tree look at this time? Does the hemlock ever shed its leaves?

4. Are the hemlock cones borne on the tip of the twigs or along the side? How long does it take a cone to mature? When does it fall? How many scales has it? Where are the seeds borne? How many seeds beneath each scale? Describe and sketch a hemlock seed. How are the seeds scattered? Study the tree in May, and see if you can find the blossom?

5. Make drawings of the following: The hemlock twig, showing the arrangement of the leaves; single leaf, enlarged; cone; cone scale; seed.

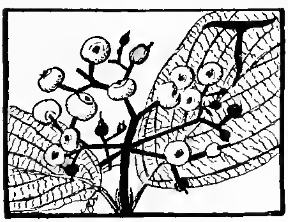
6. What creatures feed upon the hemlock seed? What birds find protection in the hemlock foliage in winter?

7. For what purposes is hemlock bark used? What is the timber good for? Is a nail easily pulled out from a hemlock board?

THE DOGWOOD

Teacher's Story

Through cloud rifts the sunlight is streaming in floods to far depths of the wood,
Retouching the velvet-leafed dogwood to crimson as vital as blood.



THERE is no prettier story among the flowers than that of the bracts of the dogwood, and it is a subject for investigation which any child can work out for himself. I shall never forget the thrill of triumph I experienced when I discovered for myself the cause of the mysterious dark notch at the tip of each great white bract, which I had for years idly noticed. One day my curiosity mastered my inertia, and I hunted a tree over for a flower bud, for it was rather late in the season; finally I was rewarded by finding the bracts in all stages of development.

The flowering dogwood forms its buds during the summer, and of course they must have winter protection; therefore, they are wrapped in four, close-clasping, purplish brown scales, one pair inside and one pair outside, both thick and well fitted to protect the bunch of tiny flower buds at their center. But when spring comes, these motherly bud-scales change their duties, and by rapid growth become four beautiful white or pinkish bracts calling aloud to all the insect world that here at their hearts is something sweet. For months they brood the flowers and then display them to an admiring world. The artistic eye loves the little notch at the tip of the bracts, even before it has read in it the story of winter protection, of which it is an evidence.

The study of the flowers at the center is more interesting if aided by a lens. Within each blossom can be seen its tube, set in the four-lobed calyx. It has four slender petals curled back, its four chubby, greenish yellow anthers set on filaments which lift them up between the petals; and at the center of all is the tiny green pistil. There may be twenty, more or less, of these perfect flowers in this tiny, greenish yellow bunch at the center of the four great, flaring bracts. These flowers do not open simultaneously, and the yellow buds and open flowers are mingled together in the rosette. The calyx

Blossom and bud of dogwood, enlarged.

shows better on the bud than on the open flower. It might be well to explain to the pupils that a bract is simply a leaf in some other business than that ordinarily performed by leaves.

The twigs have a beautiful, smooth bark, purplish brown above and greenish below. The flowers grow at the tips of the twigs; and the young leaves are just below the flowers and also at the tips of the twigs. These twigs are spread and bent in a peculiar way, so that each white flower-head may be seen by the admiring world and not be hidden behind any of its neighbors. This habit makes this tree a favorite for planting, since it forms a mass of white bloom.

The flowers of dogwood.
Photo by Cyrus Crosby.

The dogwood banners unfurl before the flowers at their hearts open, and they remain after the last flower has received within itself the gracious, vital pollen which will enable it to mature into a beautiful berry. This long period of bloom is another quality which adds to the value of the dogwood as an ornamental tree. At the time the bracts fall, the curly petals also fall out leaving the little calyx-tubes standing with style and stigma projecting from their centers, making them look like a bunch of liliputian churns with dashers. In autumn, the foliage turns to a rich, purplish crimson—a most satisfying color.

During the winter, the flowering dogwood, which renders our forests so beautiful in early spring, may be readily recognized by its bark, which is broken up into small scales and mottled like the skin of a serpent; and on the tips of its branches are the beautiful clusters of red berries, or speaking more exactly, drupes. This fruit is oval, with a brilliant, shining, red, pulpy covering which must be attractive to birds. At its tip it has a little purple crown, in the center of which may be seen the remnant of the style, but this attractive outside covers a seed with a very thick, hard shell, which is quite indigestible and fully able to protect, even from the attack of the digestive juices of the bird's stomach, the tender white kernel within it, which includes the stored food and the embryo. There are in the North two other common species of dogwood which have dark blue fruit.

LESSON CCV

The Dogwood

Leading thought—The petals are not the only means of attracting insects to the flowers. Sometimes other parts of the plant are made into banners to show insects where the nectar is to be found.

Method—Bring in a branch of the dogwood when it is in flower. The branch should have upon it some flowers that are unopened. Study the flower first, and ask the pupils to discover for themselves why the great white bracts have a notch in the tip. A lens is a great help to the interest in studying these tiny flowers.

The flower buds of the dogwood are formed during the previous season.

Observations—1. What is there at the center of the dogwood flower? How do the parts at the center look? Are they of the same shape? Are some opened and others not? Take a penknife and cut out one that is opened and describe it. Can you see how many petals this tiny flower has? Describe its calyx. How many stamens has it? Can you see the pistil? If a flower has a calyx and stamens and a pistil, has it not all that a flower needs?

2. How many of these flowers are there at the center of the dogwood "blossom?" What color are they? Would they show off much if it were not for the great white banners around them? Do we not think of these great white bracts as the dogwood flower?

3. Study one of these banners. What is its shape? Are the four white bracts the same shape and size? Make a sketch of these four bracts with the bunch of flowers at the center. What is there peculiar about each one of these white bracts. Why should this notch be there? Find one of the flower-heads which is not yet opened and watch it develop, and then write a little story of the work done in the winter for the flowers by these bracts and the different work done by them in the spring, all for the sake of the precious blossoms.

4. Sketch the bracts from below. Is one pair wider than the other? Is the wider pair inside or outside? Why is this so?

5. Where are the flowers of the dogwood borne? How are the twigs arranged so as to unfurl all the banners and not hide one behind another, so that the whole tree is a mass of white?

6. While studying the flowers, study where the young leaves come from. Can you still see the scales which protected the leaf buds?

7. What kind of fruit develops from the dogwood blossoms? What colors are its leaves in autumn?

THE VELVET, OR STAGHORN, SUMAC

Teacher's Story

The sumacs with flame leaves at half-mast, like wildfire spread over the glade;
Above them, the crows on frayed pinions move northward in ragged parade.

THE sumacs, in early autumn, form a "firing line" along the borders of woodlands and fences, before any other plant but the Virginia creeper has thought of taking on brighter colors. No other leaves can emulate the burning scarlet of their hues. The sumacs are a glory to our hills; and sometime, when Americans have time to cultivate a true artistic sense, these shrubs will play an important part in landscape gardening. They are beautiful in summer, when each crimson "bob" (a homely New England name for the fruit panicle) is set at the center of the bouquet of spreading, fernlike leaves. In winter nakedness they are most picturesque, with their broadly branching twigs bearing aloft the wine-colored pompons against the background of snow, and calling to the winter birds to come and partake of the pleasantly acid drupes. In spring, they put out their soft leaves in exquisite shades of pale pinkish green, and when in blossom their staminate panicles of greenish white cover them with loose pryamids of delicate bloom.

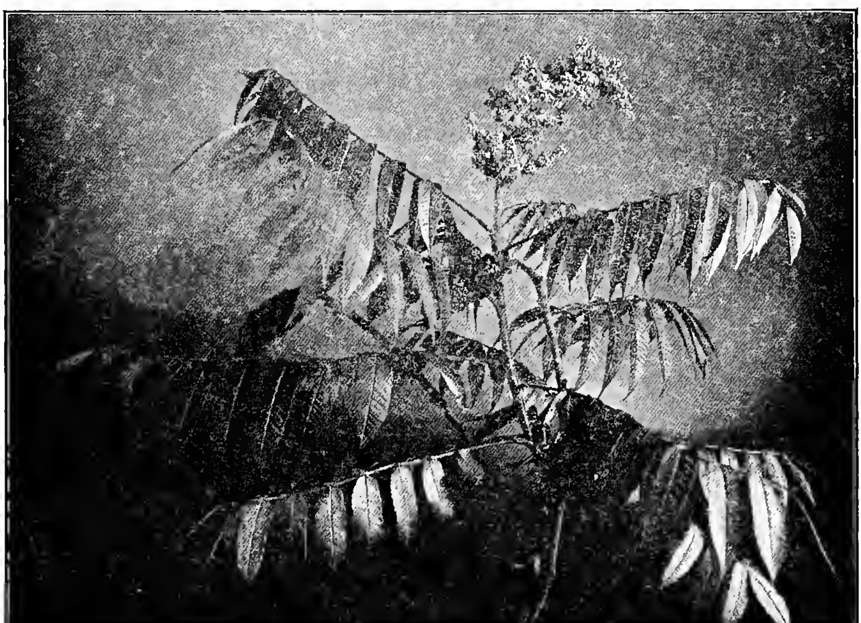
Well may it be called velvet sumac, for this year's growth of wood and the leaf stems are covered with fine hairs, pinkish at first, but soon white; if we slip our fingers down a branch, we can tell even without looking where last year's growth began and ended, because of the velvety feel. The name staghorn sumac is just as fitting, for its upper branches spread widely like a stag's horns and, like them, the new growth is covered with velvet.

The leaves are borne on the new wood, and therefore at the ends of branches; they are alternate; the petiole broadens where it clasps the branch, making a perfect nursery for the little next-year's bud, which is nestled below it. The leaves are compound and the number of leaflets varies from eleven to thirty-one. Each leaflet is set close to the midrib, with a base that is not symmetrical; the leaflets have their edges toothed, and are long and narrow; they do not spread out on either side the midrib like a fern, but naturally droop somewhat, and thus conceal their undersides, which are much lighter in color. The leaflets are not always set exactly opposite; the basal ones are bent back toward the main stem, making a fold in the base of each. The end leaflets are not always three, symmetrically set, but sometimes are two and sometimes one, with two basal lobes.

The wine-colored "bob" is cone-shaped, but with a bunchy surface. Remove all the seeds from it and note its framework of tiny branches, and again pay admiring tribute to nature's way of doing up compact packages. Each seed is a drupe, as is also the cherry. A drupe is merely a seed within a fleshy layer, all being enclosed in a firmer outside covering; here, the outside case is covered with dark red fuzz, a clothing of furs for winter, the fur standing out in all directions. The fleshy part around the seed has a pleasantly acid taste, and one of my childhood diversions was to share these fruits in winter with the birds. I probably inadvertently ate also many a little six-footed brother hidden away for winter safe-keeping, for every sumac panicle is a crowded insect-tenement.

It is only in its winter aspect that we can see the peculiar way of the sumac's branching, which is in picturesque zigzags, ending with coarse, wide-spreading twigs. As each terminal twig was a stem for the bouquet of blossom and fruit set about with graceful leaves, it needed room and this is reason enough for the coarse branching. The wood of the sumac has a pith, and is coarse in texture.

During late May the new growth starts near the end of last year's twig; the buds are yellowish and show off against the dark gray twigs. From the center of these buds comes the fuzzy new growth, which is usually reddish purple; the tiny leaves are folded, each leaflet creased at its midrib and



The stag-horn sumac.
Photo by Verne Morton.

folded tightly against itself; as the leaves unfold, they are olive-green tinted with red, and look like tassels coming out around the old dark red "bob." When the sumacs are in blossom, we see in every group of them, two kinds; one with pyramids of white flowers, and the other with pinkish callow bobs. The structure of these two different flower-clusters is really the same, except that the white ones are looser and more widely spread. Each flower of the white panicle is staminate, and has five greenish, somewhat hairy sepals and five yellowish white petals, at the center of which are five large anthers. A flower from the bob is quite different; it has the five hairy sepals alternating with five narrow, yellowish white petals, both clasping the globular base, or ovary, which is now quite covered with pinkish plush, and bears at its tip the three styles flaring into stigmas.

a, *Pistillate flower from a "bob."* b, *Staminate flower from the greenish panicle.*

The velvet sumac is larger than the smooth species (*Rhus glabra*), and is easily distinguished from it, since the new wood of the latter is smooth and covered with bloom but is not at all velvety. The poison sumac, which is very dangerous to many people when handled, is a swamp species and its fruit is a loose, drooping panicle of whitish berries, very much like that of poison ivy; therefore, any sumac that has the red bob is not dangerous. The poison species has the edges of its leaflets entire and each leaflet has a distinct petiole of its own where it joins the midrib.

There is much tannin in sumac and it is used extensively to tan leather. The bobs are used for coloring a certain shade of brown. The famous Japanese lacquer is made from the juice of a species of sumac.

LESSON CCVI

The Velvet, or Staghorn, Sumac

Leading thought—The sumac is a beautiful shrub in summer because of its fern-like leaves; it is picturesque in winter, and its colors in autumn are most brilliant. Its dark red fruit clusters remain upon it during the entire winter. In June it shows two kinds of blossoms on different shrubs, one is whitish and bears the pollen, the other is reddish and is a pistillate flower, later developing into the seed on the "bob," or fruit cluster.

Method—Begin this study in October when the beautiful autumn color of the leaves attracts the eye. Observations to be made in the field should be outlined and should be answered in the field note-books. The study of the fruit and leaf may be made in the schoolroom, and an interest should be developed which will lead to the study of the interesting flowers the following spring. The sumacs in autumn make a beautiful subject for watercolor sketches, and their peculiar method of branching with their dark red seed clusters or bobs, make them excellent subjects for winter sketching.

Observations—1. Why is this called the velvet sumac? Why is it called the staghorn sumac? Look at the stems with a lens and describe the velvet. Can you tell this year's wood by the velvet? Is there any velvet on last year's wood? Is there any on the wood below? What is there peculiar in the appearance of last year's wood? What are the colors of the hairs that make the velvet on this year's growth? On last year's growth? What is the color of this year's growth under the velvet? Where are the leaves borne?

2. Look at the leaves. How many come off the stem between two, one of which is above the other? Is the midrib velvety? What is its color at base and at tip? What is the shape of the petiole where it joins the stem? Remove the leaf. What do you find hidden and protected by its broad base?

3. How many leaflets are there on the longest leaf which you can find? How many on the shortest? Do the leaflets have little petioles, or are they set close to the midrib? How does the basal pair differ from the others? Are the leaflets the same color above as below? Are the pairs set exactly opposite each other? Look at the three leaflets at the tips of several leaves and see if they are all regular in form. Draw a leaflet showing its base, its veins and its margin. Draw an entire leaf, and color it as exactly as possible.

4. Study the fruit. Pick one of the bobs and note its general shape. Is it smooth or bunchy? Sketch it. Remove one of the little bunches and find out why it is of that shape. Remove all of the seeds from one of last year's bobs and see how the fruit is borne. Sketch a part of such a bare stem.

5. Take a single seed; look at it through a lens and describe it. What are the colors? Cut or pare away the flesh, and describe the seed. What birds live on the sumac seeds in winter? How many kinds of insects can you find wintering in the bob? Find a seed free from insects and taste it.

Winter study of the Sumac—6. Study the sumac after the leaves have fallen and sketch it. What is there peculiar in its branching? Of what use to the plant is its method of branching? Break a branch and look at the end. Is there a pith? What color is the wood and pith?

May or June Study of the Sumac—7. Where on the branch does the new growth start? How are the tiny leaves folded? Look over a group of sumacs and see if their blossoms all look alike. Are the different kinds of blossoms found on the same tree or on different trees? Take one of the white pyramidal blossom clusters; look at one of these flowers with a lens and describe its sepals and petals. How many anthers has it and where are they? This is a pollen-bearing flower and has no pistil. How are its tiny staminate flowers arranged on the stem to give the beautiful pyramid shape? This kind of flower cluster is called a panicle.

8. Take one of the green bobs and see if it is made up of little round flowers. Through a lens study one of these. How many sepals? How many petals? Describe the middle of the flower around which the petals and sepals clasp. Is this the ovary, or seed box? Can you see the stigmas protruding beyond it? What insects visit these flowers?

9. How can you tell the velvet or staghorn sumac from the smooth sumac? How can you tell both of these from the poison sumac?

10. To what uses are the sumacs put?

"I see the partridges feed quite extensively upon the sumach berries, at my old house. They come to them after every snow, making fresh tracks, and have now stripped many bushes quite bare."

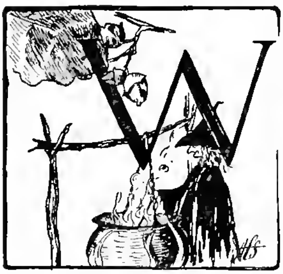
—Thoreau's Journal, Feb. 4, 1856.

THE WITCH-HAZEL

Teacher's Story

In the dusky, somber woodland, thwarting vistas dull and cold,
Thrown in vivid constellations, gleam the hazel stars of gold,
Gracious gift of wealth untold.

Hazel blossoms brightly glowing through the forests dark and drear,
Work sweet miracles, bestowing gladness on the dying year,
Joy of life in woods grown sere.



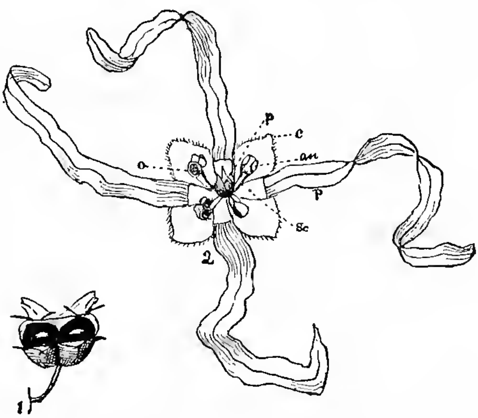
WITCH-HAZEL is not only a most interesting shrub in itself, but it has connected with it many legends. From its forked twigs were made the divining rods by which hidden springs of water or mines of precious metals were found, as it was firmly believed that the twig would turn in the hand when the one who held it passed over the spring or mine. At the present day, its fresh leaves and twigs are used in large quantities for the distilling of the healing extract so much in demand as a remedy for cuts and bruises and for chapped or sunburned skins. It is said that the Oneida Indians first taught the white people concerning its medicinal qualities.

The witch-hazel is a large shrub, usually from six to twelve feet high, although under very advantageous circumstances it has been known to take a tree-like form and attain a height of more than twenty feet. Its bark is very dark grayish brown, smooth, specked with little dots, which are the lenticels, or breathing-pores. If the season's growth has been rapid, the new twigs are lighter in color, but when stunted by drouth or poor soil, the new growth has a tint similar to the old. The wood is white, very tough and fibrous, with a pith or heart-wood of softer substance and yellow in color. The leaves are alternate, and the leaf buds appear at the tips of the season's twigs, while the blossoms grow at the axils of the leaves.

Witch-hazel.

The witch-hazel leaf is nearly as broad as it is long, bluntly pointed at its tip, with a stem generally less than one-half inch in length. The sides are unequal in size and shape, and the edges are roughly scalloped. The veins are straight, are depressed on the upper side but very prominent beneath, and they are lighter in color than the rest of the leaf. Witch-hazel leaves are likely to be apartment houses for insects, especially the insects that make galls. Of these there are many species, each making a diffeient shaped gall. One of the most common is a gall, shaped like a little horn or spur on the upper side of the leaf and having a tiny door opening on the under side of the leaf. If one of these snug little homes is torn open, it will be found occupied by a community of little aphids, or plant-lice.

The witch-hazel blossoms appear at the axil of a leaf or immediately above the scar from which a leaf has fallen, the season of bloom being so late that often the bush is bare of leaves and is clothed only with the yellow, fringe-like flowers. Usually the flowers are in clusters of three, but occasionally four or five can be found on the same very short stem. The calyx is four-lobed, the petals are four in number, shaped like tiny, yellow ribbons, about one-half inch long and not much wider than a coarse thread. In the bud, these petals are rolled inward in a close spiral, like a watch-spring, and are coiled so tightly that each bud is a solid little ball no larger than a bird-shot. There are four stamens lying between the petals, and between each two of these stamens is a little scale just opposite the petal. The anthers are most interesting. Each has two little doors which fly open, as if by magic springs, and throw out the pollen which clings to them. The pistil has two stigmas, which are joined above the two-celled seed-box, or ovary. The blossoms sometimes open in late September, but the greater number appear in October and November. They are more beautiful in November after the leaves have fallen, since these yellow, starry flowers seem to bring light and warmth into the landscape. After the petals fall, the calyx forms a beautiful little urn, holding the growing fruit.

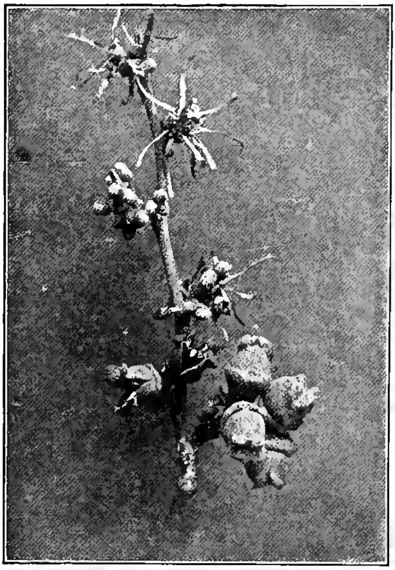


1, *A queer little face—witch-hazelnut ready to shoot its seeds.* 2, *Enlarged flower of witch-hazel showing the long petals;* p, *with dotted line the pistil;* an, *anther;* a, *anther with doors open;* c, *lobes of calyx;* sc, *scale opposite the base of petal.*

The nuts seem to require a sharp frost to separate the closely joined parts;, it requires a complete year to mature them. One of these nuts is about half an inch long and is covered with a velvety green outer husk, until the frost turns it brown; cutting through it discloses a yellowish white inner shell, which is as hard as bone; within this are the two brown seeds each ornamented with a white dot; note particularly that these seeds lie in close-fitting cells. The fruit, if looked at when the husk is opening, bears an odd resemblance to a grotesque monkey-like face with staring eyes. Frosty nights will open the husks, and the dry warmth of sunny days or of the heated schoolroom, will cause the edges of the cups which hold the seeds, to curve inward with such force as to send the seeds many feet away; ordinarily they are thrown from ten to twenty feet, but Hamilton Gibson records one actual measurement of forty-five feet. The children should note that the surface of the seeds is very polished and smooth, and the way they are discharged may be likened to that by which an orange seed is shot from between the fingers.

LESSON CCVII

The Witch-Hazel



Flowers and fruit of witch-hazel.
Photo by G. F. Morgan.

Leading thought—The witch-hazel blossoms during the autumn, and thus adds beauty to the landscape. It has an interesting mechanism by which it can shoot its seeds for a distance of many feet.

Method—This lesson divides naturally into two parts; a study of the way the seeds are distributed is fitted for the primary grades, and a study of the flower for more advanced grades. For the primary grades the lesson should begin by the gathering of the twigs which bear the fruit. These should be brought to the schoolroom—there to await results. Soon the seeds will be popping all over the schoolroom, and then the question as to how this is done, and why, may be made the topic of the lesson. For the study of the flower and the shrub itself, the work should begin in October when the blossoms are still in bud. As they expand they may be studied, a lens being necessary for observing the interesting little doors to the anthers.

Observations—1. Is the witch-hazel a shrub or a tree?

2. What is the color of the bark? Is it thick or thin, rough or smooth, dark or light, or marked with dots or lines? Is there any difference in color between the older wood and the young twigs? Is the wood tough or brittle? Dark or light in color?

3. Do the leaves grow opposite each other or alternate? On what part of the plant do the leaf buds grow?

4. What is the general shape of the leaf? Is it more pointed at the base or at the tip? Are the leaves regular in form, or larger on one side than the other? Are the edges entire, toothed or wavy? Are the petioles short or long? Are the veins straight or branching? Are they prominent? Are the leaves of the same color on both sides?

5. Are there many queer-shaped little swellings on the leaf above and below? See how many of these you can find? Tell what you think they are.

6. Do the flowers grow singly or in clusters? What is the shape and color of the petals, and how many of them are there in each blossom?

Describe the calyx. If there are any flower buds just opening, observe and describe the way the petals are folded within them.

7. How many stamens? With a lens observe the way the two little doors to the anther fly open; how is the pollen thrown out? What is the shape of the pistil? How many stigmas?

8. Does each individual flower have a stem or is there a common stem for a cluster of blossoms? Do the flowers grow at the tips or along the sides of the twigs? When do the witch-hazel flowers appear and how long do they last?

9. Make a drawing of a witch-hazel nut before it opens. What is the color of the outer husk when ripe? Cut into a closed nut and observe the extreme hardness and strength of the inner shell.

10. Where are the seeds situated? Can you see that the shell, when partially open, ready to throw out the seeds resembles a queer little face? Describe the color and marking of the seeds; are they rough or smooth? How far have you known the witch-hazel to throw its seeds? Study the nut and try to discover how it throws the seeds so far.

References—Tree Book, Rogers; Our Northern Shrubs, Keeler; Familiar Trees and Their Leaves, Mathews; Field, Forest and Wayside Botany, Gray.

THE MOUNTAIN LAUREL

Teacher's Story

AS a child I never doubted that the laurel wreaths of Grecian heroes were made from mountain laurel, and I supposed, of course, that the flowers were used also. My vision was of a hero crowned with huge wreaths of laurel bouquets, which I thought so beautiful. It was a shock to exchange this sumptuous headgear of my dreams for a plain wreath of leaves from the green-bay tree.

However, the mountain laurel leaf is evergreen and beautiful enough to crown a victor; in color it is a rich, lustrous green above, with a yellow midrib, the lower side being of a much lighter color. In shape, the leaf is long, narrow, pointed at each end and smooth-edged, with a rather short petiole, The leaves each year grow on the new wood, which is greenish and rough, in contrast with the old wood, which is rich brownish red. The leaves are arranged below the flower cluster, so that they make a shining green base for this natural bouquet.

The flowers grow on the tips of the branching twigs, which are huddled together in a manner that brings into a mass many flowers. I have counted seventy-five of them in a single bunch; the youngest flowers grow nearest the tip of the twig. The blossom stems are pink, and afford a rich background for the starry open flowers and knobby closed buds. The bud of the laurel blossom is very pretty and resembles a bit of rose-colored pottery; it has a five-sided, pyramidal top, and at the base of the pyramid are ten little buttresses which flare out from the calyx. The calyx is five-lobed, each lobe being green at the base and pink at the point. Each one of the ten little buttresses or ridges is a groove in which a stamen is growing, as we may see by looking into an opening flower; each anther is "headed" toward the pocket which ends the groove. The filament lengthens and shoves the anther into the pocket, and then keeps on growing until it forms a bow-shaped spring, like a sapling with the top bent to the ground. The opening flower is saucerlike, pinkish white, and in form is a five-pointed star. At the bottom of the saucer a ten-pointed star is outlined in crimson; and bowed above this crimson ring are the ten white filaments with their red-brown anthers stuffed cozily into the pockets, one pocket at the center of each lobe, and one half-way between; each pocket is marked with a splash of crimson with spotty edges. From the center of the flower projects the stigma, far from and above the pollen-pockets.

Diagram of flower of laurel.

p, pocket; st, stamen.

Each laurel flower is thus set with ten spring-traps all awaiting the visit of the unwary moth or bee which, when seeking the nectar at the center of the flower, is sure to touch one or all of these bent filaments. As soon as one is touched, up it springs and slings its pollen hard at the intruder. The pollen is not simply a shower of powder, but is in the form of a sticky string, as if the grains were strung on cobweb silk. When liberating these springs with a pencil point, I have seen the pollen thrown a distance of thirteen inches; thus, if the pollen ammunition does not strike the bee, it may fall upon some open flower in the neighborhood. The anthers spring back after this performance and the filaments curl over each other at the center of the flower below the pink stigma; but after a few hours they straighten out and each empty anther is suspended above its own pocket. The anthers open while in the pocket, each one is slit open at its tip so that it is like the leather pocket of a sling.

After the corollas fall, the long stigma still projects from the tip of the ripening ovary, and there it stays, until the capsule is ripe and open. The five-pointed calyx remains as an ornamental cup for the fruit. The capsule opens along five valves, and each section is stuffed with little, almost globular seeds.

The mountain laurel grows in woods and shows a preference for rocky mountain sides or sandy soil.

Another of the common species is the sheep laurel, which grows in swampy places, especially on hillsides. The flowers of this are smaller and pinker than the mountain laurel, and are set below the leaves on the twig. Another species called the pale, or swamp, laurel, has very small flowers, not more than half an inch in breadth and its leaves have rolled-back edges and are whitish green beneath. This species is found only in cold peat-bogs and swamps

LESSON CCVIII

The Mountain Laurel

Leading thought—The laurel blossom is set with ten springs, and each spring acts as a sling in throwing pollen upon visiting insects, thus making sure that the visitor will carry pollen to other waiting flowers.

Method—Have the pupils bring to the schoolroom a branch of laurel which shows blossoms in all stages from the bud. Although this lesson is on the mountain laurel, any of the other species will do as well.

Observations—1. How are the laurel leaves set about the blossom clusters to make them beautiful? What is the shape of the laurel leaf? What are its colors above and below? How do the leaves grow with reference to the flowers? Do they grow on last year's or this year's wood? How can you tell the new wood from the old?

2. Take a blossom bud. What is its shape? How many sides to the pyramid-like tip? How many little flaring ridges at the base of the pyramid? Describe the calyx.

3. What is the shape of the flower when open? How many lobes has it? What is its color? Where is it marked with red?

4. In the open blossom, what do you see of the ten ridges, or keels, which you noticed in the bud? How does each one of these grooves end? What does the laurel blossom keep in these ten pockets? Touch one of the ten filaments with a pencil and note what happens.

5. Take a bud scarcely open. Where are the stamens? Can you see the anthers? Take a blossom somewhat more open. Where are the anthers

Mountain laurel.

Photo by Verne Morton.

now? From these observations explain how the stamens place their anthers in the pockets. How do the filaments grow into bent springs?

6. Are the anthers open when they are still in the pocket? Look at an anther with a lens and tell how many slits it has. How do they open? Are the pollen grains loose when they are thrown from the anther? How are they fastened together? Does this pollen mass stick to whatever it touches?

7. What is the use to the flower of this arrangement for throwing pollen? What insects set free the stamen-springs? Where is the nectar which the bee or moth is after? Can it get this nectar without setting free the springs? Touch the filaments with a pencil and see how far they will sling the pollen.

8. Describe the pistil in the open flower. Is the stigma near the anthers? Would they be likely to throw their pollen on the stigma of their own flower? Could they throw it on the stigmas of neighboring flowers?

9. How does the fruit of the laurel look? Does the style still cling after the corolla falls? Describe the fruit-capsule. How does it open? How do the seeds look? Are there many of them?

10. Where does the mountain laurel grow? What kind of soil does it like? Do you know any other species of laurel? If so, are they found in the same situations as the mountain laurel?

"A childish gladness stays my feet,
As through the winter woods I go,
Behind some frozen ledge to meet
A kalmia shining through the snow.

I see it, beauteous as it stood
Ere autumn's glories paled and fled,
And sigh no more in pensive mood,
'My leafy oreads are all dead.'

I hear its foliage move, like bells
On rosaries strung, and listening there,
Forget the icy wind that tells
Of turfless fields, and forests bare.

All gently with th' inclement scene
I feel its glossy verdure blend;—
I bless that lovely evergreen
As heart in exile hails a friend.

Its boughs, by tempest scarcely stirred,
Are tents beneath whose emerald fold
The rabbit and the snowbound bird
Forget the world is white and cold.

And still, 'mid ruin undestroyed,
Queen arbor with the fadeless crown,
Its brightness warms the frosty void,
And softens winter's surliest frown."

—From "The Mountain Laurel" THERON BROWN.