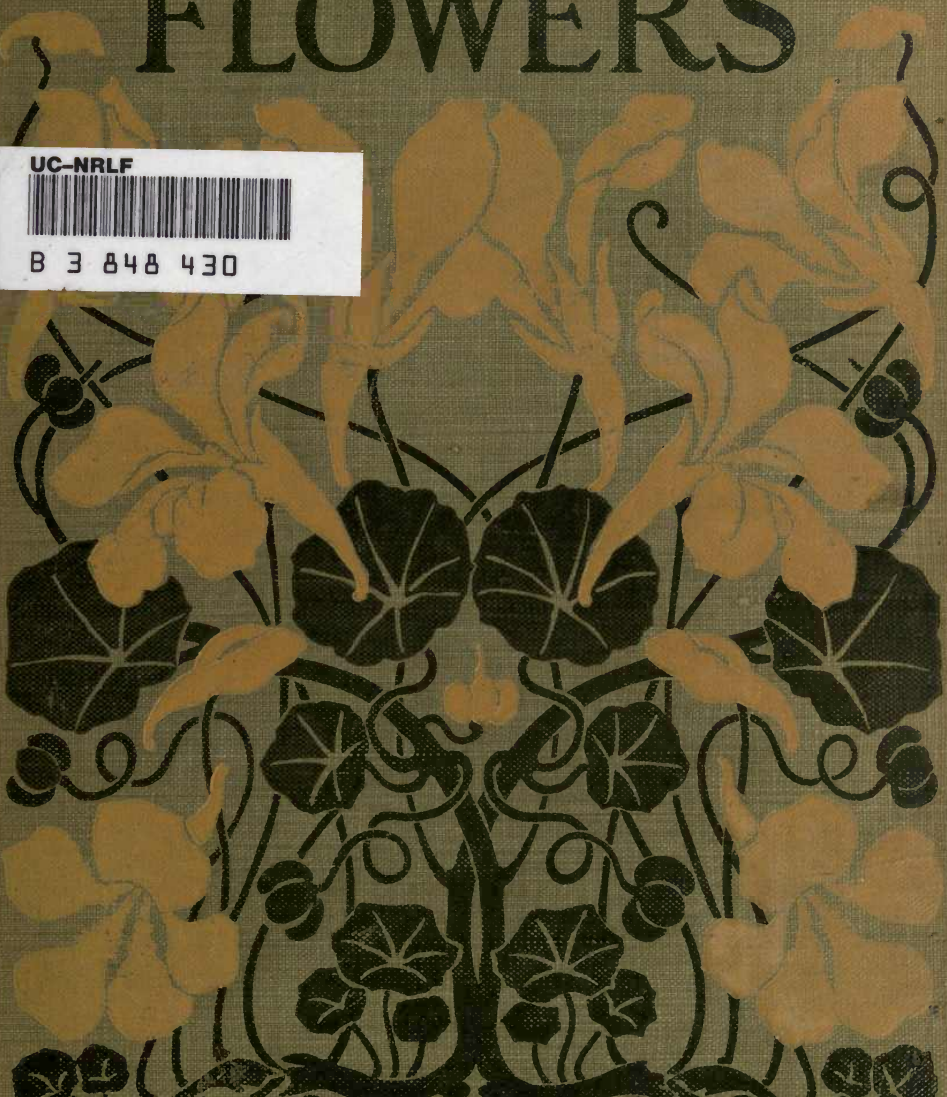
A FEW FAMILIAR FLOWERS



MARGARET·W·MORLEY

A FEW
FAMILIAR FLOWERS

HOW TO LOVE THEM AT HOME OR IN SCHOOL

BY

MARGARET WARNER MORLEY

MORNING-GLORY JEWELWEED
NASTURTIUM GERANIUM
HYACINTH

BOSTON, U.S.A., AND LONDON
GINN & COMPANY, PUBLISHERS
The Athenæum Press
1903

CONTENTS.

A WORD TO THE TEACHER.

It is with the hope of helping young teachers and those of more experience who are beginning to teach plant life that this little book is written.

It does not make much difference where we begin in studying nature. If we start with the seed, we end with the flower, and *vice versa*.

The best starting point depends upon the material at hand. Take whatever you have and make the most of it.

Select what seems to *you* the most obvious fact in the story of the plant you have, and build from that.

The bright flower, which first attracts attention and which is constantly being entered by winged messengers, is an admirable starting point in beginning the study of plant life, but it is not necessarily the only good one. Excellent results may be obtained by starting with the seed, the leaf, the stem, or, in fact, with any available part of the plant.

The main thing is to make the work charming, and wake up the mind of the pupil to the beauty and the astonishing activity everywhere manifest in living things.

In order to be clearly understood, the writer has been obliged to take some one starting point, and to proceed in a somewhat arbitrary, though not necessarily illogical, course. Also, to make a clear and vivid impression, the subject has been worked out in detail and partly in the form of dialogue between teacher and pupils.

The object has not been to give exact instruction as to how to teach, but rather to give an inspiration towards teaching nature's truths lovingly.

The method used is only one out of many methods that might have been adopted, and the flower as a starting point is only one out of many starting points that might have been chosen.

The value of such a book as this lies in what it *suggests*, in what activity it creates in other minds, rather than in the facts it states.

The plants selected, the morning-glory, nasturtium, jewelweed, and geranium, were chosen because of their size, abundance, availability, lateness of blooming, and because of their development in relation to insect fertilization. All these plants have large and showy blossoms, modified in form and in other ways for the visits of insects. At the same time, they are not so complex and difficult to observe and understand as are certain other familiar flowers.

The principal facts in flower life are thus in them easily discernible.

While there are sentimental reasons for beginning flower

work in the spring, there are also good reasons for taking up this work for the first time in the fall. Then the flowers are blooming out of doors, subject to more natural conditions, and are almost certain to be visited by insects, whose actions can be watched. The children, too, fresh from vacation, where in most cases they have lived more or less out of doors, are in sympathy with the wild life, and have unconsciously observed it. It takes the vacation into the schoolroom, in a sense.

For these reasons, and because of the difficulty often found of getting flowers in early spring in our climate, fall work has been here presented, though where the teacher prefers to begin work in the spring, the nasturtium and house geranium afford good material, as does also the hyacinth, which has been added purposely for spring work. The nasturtium can be planted in window boxes early in the winter, and the geranium can be obtained in full bloom in small pots for a small sum.

Where possible, the schoolroom windows should be kept bright with flowers. Window boxes are not much trouble, and, where the schoolroom is warmed by furnace, may be a source of great pleasure to both teachers and children.

Where the schoolroom is not warmed, window boxes can make bright the fall and spring weeks.

Some will ask why the sweet pea, which is so common, so attractive, and which blooms so late, has not been selected as one of the flowers studied.

The pea and bean are rather difficult for beginners, although in many respects they present admirable features for study. Because of their complexity, the dahlia and other showy fall flowers were rejected.

The object of studying flowers should be to present the great facts of plant life in a clear and interesting manner; not merely to attach labels to pieces of flowers, but to know of the life of the flower as a whole.

There are certain interesting things about plant life that everybody wants to know: where the bees find the honey, how they get it, what they do with it, how the pollen reaches the ovule, how the plant protects its pollen and adapts its form to the insects that visit it, etc.

These things are interesting. In a way they touch all life and elucidate it. These are the facts the child ought to have.

The minimum of interest and knowledge comes from merely pulling a flower to pieces and attaching difficult and meaningless names to the different parts.

The maximum of interest and knowledge comes from observing what use the flower makes of its parts and how the structure is related to the function. Having thus acquired a meaning, the flower parts become interesting and the descriptive terms are learned without difficulty.

Study a plant as you would a person, not on the dissecting table, but in its natural surroundings doing its life work.

It is easy to learn the history of many flowers without pulling them to pieces at all, and it is much more beautiful and satisfactory to work thus with young people.

Where children have had the care of flowers and love them, they do not like to tear them to pieces, and where they have not yet acquired this love, they are not helped to do so by treating the flower merely as a scientific "specimen."

Let the children find more than mere technical terms and forms of organs in their botany work. Let them find nature *beautiful* as well as wonderful.

No book can take the place of the teacher's individual planning. Children are not alike in different schools, nor in different classes of the same school; what might be admirable for one class of children might be unsuitable for another class. Each teacher should decide for herself how much to do and how to do it. This should be the test of her success: Do her children love the flowers, do they recognize in them a life akin to their own, have they an intelligent conception of the uses of the different flower parts?

If the teacher does her work well, the latest researches made by naturalists into the secrets of plant life may become the property of the child. Curiously enough, modern discoveries concerning the flower parts are the facts which appeal most strongly to the child and are most readily understood by him.

With a proper understanding of the fundamental facts

of plant life the young student has open to him the doors of intelligent interest in what is going on in the scientific world.

Of course, the more the teacher herself knows about plant life the better is she prepared to make the subject interesting to others. Information will come to her from many sources: the daily papers, the magazines and books, as well as from regular works on botany.

Delightful truths about plant life are constantly being presented to the public, and, among other things, Grant Allen's books on plants are particularly interesting and charming. His "Flowers and their Pedigrees" and his "Falling in Love and other Essays" contain much information that every teacher ought to have, and which cannot so easily be obtained in any other way.

Miss Newell's "Botany Readers," in two parts, Ginn & Co., are valuable aids to the teacher of botany, as they are mainly compilations from the great naturalists upon most of the interesting phenomena of plant life.

Extracts from Darwin, for instance, give in a few paragraphs the gist of his discoveries about movements in plants, fertilization, etc., which the student unaided could obtain from the original source only by reading many technical books. In a similar manner, most of the great botanical scientists have been applied to for their best and most interesting facts, translations from the German adding to the wealth between the covers of these little books.

In "Leaves from Nature's Story Book," Educational Publishing Co., Vol. II, will be found some interesting chapters on bees and wasps.

"Seaside and Wayside," D. C. Heath & Co., has in No. I some pretty bee stories for little folks, while No. III contains several interesting chapters on plant life.

"Flowers and their Friends," Ginn & Co., is a little book written to accompany the present volume. It contains stories and added facts about the plants here treated, and is intended to increase the interest of the children by giving them something to read about their plants as they study.

There is nothing in nature more delightful than the mutual helpfulness of plants and insects, and of the helpfulness of the different parts of plants to each other. Help the young people to feel this mutual helpfulness, and to know that it is as true and as important as the mutual "struggle for existence," about which so much has been written of late. In fact, so much stress has been laid upon the struggle that many people have come to hold the untrue and depressing view that all life is a carnage, as a result of their scientific study.

This is but half the truth; there is another side to life, and that is the side of *mutual helpfulness*.

Finally, this book is intended for teachers, not for children, and some things are told for the benefit of the teacher which would not be appropriate for the younger pupils. The teacher is expected to use her

discretion concerning the information she conveys to the children.

Use the plant work to brighten and elevate. Try to bring home to the developing mind a knowledge of the greatness and the beauty of life in all its forms.

A FEW FAMILIAR FLOWERS.

THE MORNING-GLORY.

Our first friend is the pretty vine growing over roadside hedges and stone walls, which the botany calls bindweed, but which is more popularly known as the wild morning-glory.

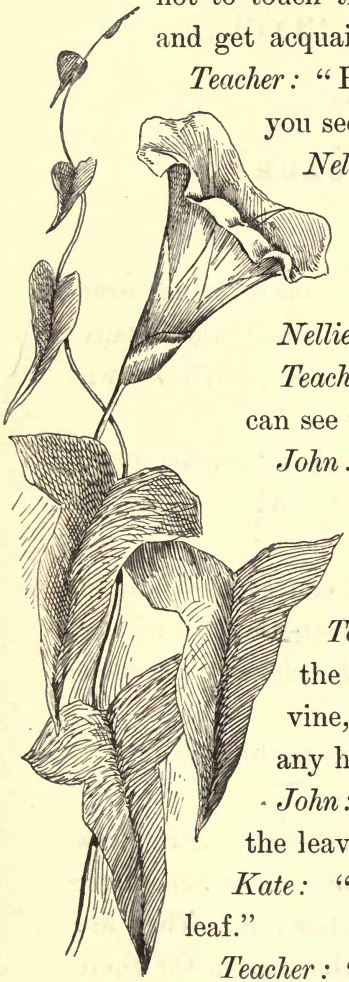
It bears a pink and white blossom about two inches long. Sometimes a wholly white variety is met with.

The cultivated morning-glory can be used almost as well, and the differences between the two will be noticed from time to time. Both belong to the same family.

The first thing to notice in our plant is the large and showy flower.

Suppose the teacher to have taken her little flock a short distance down the road on a sunny September day to where the flowers are blooming. They are less abundant than earlier in the season, yet there are several fine ones within reach.

It has been explained to the children that they are not to touch the flowers, only to look at them and get acquainted.



Teacher: "Here are our little friends. Can you see them, Nellie?"

Nellie: "Yes. I see six or eight."

Teacher: "Do you think you could see them from the turn in the road?"

Nellie: "I know I could."

Teacher: "What is the reason you can see them so far away, John?"

John: "They are so big."

Fred: "They are light colored. If they were green like the leaves we could not see them."

Teacher: "How they stand out in the sunlight! Look down under the vine, John, and see if you can find any hiding away."

John: "No, I can't find any under the leaves."

Kate: "Here is one partly under a leaf."

Teacher: "Yes, that one is not quite as easily seen as the others. But which do you think

the morning-glories like better, to hide away or to stand out?"

May: "I think they like to stand out."

[All the children agree with this.]

Teacher: "What holds them out in the light?"

Fred: "They have long stems."

Teacher: "So they have. Are their stems all the same length?"

Kate: "No, here is one with a stem twice as long as that one next it."

Teacher: "I wonder why."

John: "Oh, I know. That long stem starts under the leaves, and grows and grows so the flower can get out. The short stem is near the top."

Teacher: "Good, John. You know how to look."

Kate: "Oh, Miss A, a bee went into mine!"

Ned: "One's gone into mine, too."

Teacher: "What do you suppose the bees are after?"

[Some of the children may know that the bee gets honey from the flowers. If so, accept the fact without discussion; if not, say you will try and find out another time what the bee is after, and proceed.]

Teacher: "What shape is our morning-glory, Kate?"

Kate does n't know.

Anne thinks it is like a cornucopia. May says it is like a bell. George says it is something like a tumbler. Fred says it is like a funnel.

"I think it is like a bell held up by the handle," Lucy says; "there is the clapper inside and all."

Teacher: "What color is it?"

Several: "Pink and white."

John: "There is a pink part and then a white part."

Nellie: "The white parts run way down into the flower."

Teacher: "Let us count these white parts. How many are there, May?"

May: "There are five."

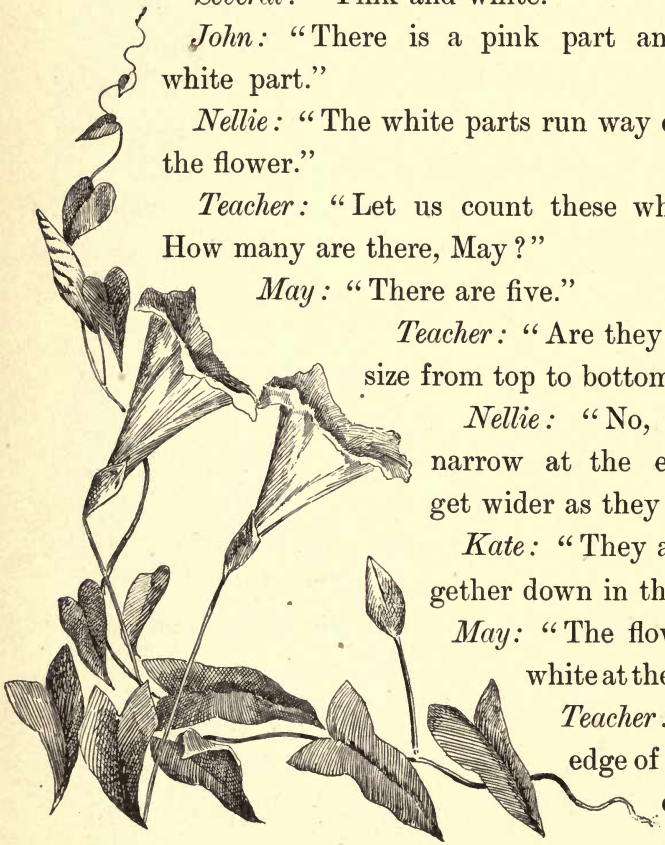
Teacher: "Are they the same size from top to bottom?"

Nellie: "No, they are narrow at the edge, and get wider as they go in."

Kate: "They all run together down in the flower."

May: "The flower is all white at the bottom."

Teacher: "Is the edge of the flower even?"



John: "No, it is sort of scalloped."

Teacher: "How many scallops has it?"

John: "It has five scallops."

Teacher: "Now let us see if the white goes down the middle of the scallop."

Children: "It does, it does."

John: "There 's another bee."

Teacher: "Now we will go, and to-morrow we will come again and watch the bees go into the flowers, and see where they go and what they get. Perhaps we can play we are bees and so find out about it."

[This finishes the general survey of the flower. The work may be done in one lesson or in two or three, according to the age and intelligence of the pupils.

Encourage the children to talk freely about the flower; do not put set phrases in their mouths.

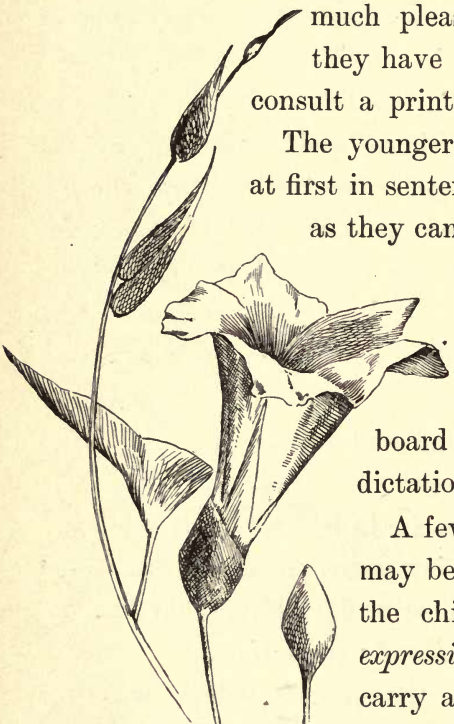
Have a good time, teacher and children together.

The main thing is to have a good time.

Get acquainted with the morning-glory in a pleasant, friendly way, and the scientific facts will take care of themselves.

If the children are able to write, have them write out what they have seen and talked about. It will be a good plan to have a blank book set

aside for the plant study. They can thus keep all they have done on their plant together, making a pleasant record of the term's work. It will be convenient to refer to, to refresh the memory, and much pleasanter to go to a book they have made themselves than to consult a printed volume.



The younger children will need help at first in sentence-making; but as soon as they can express themselves correctly in short sentences, let each child record his own thoughts, instead of copying from the blackboard or from the teacher's dictation.

A few short sentences at first may be very helpful in teaching the child the correct *form of expression*, but be careful not to carry arbitrary sentence-writing too far.

Remember the object is to train children to think for themselves and express their thoughts without help.

For young teachers who are having their first experience in the schoolroom, a few sentences ex-

pressive of what has been learned are appended. They are merely for illustration, and hundreds of others equally good can be formed.

Suppose the children are ready to write.]

Teacher: "Nellie, tell us one thing about our morning-glory."

Nellie: "It is bright."

Teacher: "What is bright?"

Nellie: "The morning-glory is bright."

Teacher: "I will write what Nellie has told us on the board."

[Writes: "The morning-glory is bright." Several of the children now read the sentence and then all write it. Similar sentences, as

The morning-glory stands up to be seen,

The bees come to the morning-glory,

The morning-glory likes the bees to come,

The morning-glory has white lines,

The morning-glory is pink and white,

may be obtained as a result of observation, and written in the same way.

As soon as possible, let the children write what they think, without copying.

After the children have talked and written about the flower, calling the bright part by the familiar name of "flower bell," "flower cup," or whatever

they please, tell them it has a very pretty name with a very pleasant meaning.

This name is "corolla," and means "a little crown, or garland."

Ask them who wear crowns. Kings and queens do, and May queens wear garlands of bright flowers. So our flower, with its pretty corolla, its "little crown," must be somebody very important; perhaps it is the queen of the whole plant.

Do not insist upon the use of the new word "corolla" to the exclusion of the more familiar terms "flower cup," "flower bell," etc., but add it to the other words. With a pleasant thought about the queen and her garland to help them, the children will soon find the new word as familiar as the old ones, and it will be adopted without any sense of strangeness, or any feeling that they are using a meaningless word.

After a flower part has been thoroughly looked at and the children *are acquainted with it*, then give the special name that distinguishes it.

Be sure, however, the new word is not given before the child is perfectly familiar with the part it applies to.

SUMMARY.

1. The flower is large and bright.
2. It stands up above the surrounding foliage.
3. Bees visit it.
4. It has a certain shape.
5. Its color is arranged in a certain way.

These are the facts for the teacher to have in mind when the children begin to look at the flower. Every one of them is of vital importance in the life of the flower, as will appear later.

Technical term, "corolla."

If it is impossible for the teacher to go to the flower with the children, she can talk to them about it so as to arouse their interest, and have them look at it out of school hours and tell her next day whether it stands up or hides under the leaves, and about the length of the flower stems; also about the form and color.

Or, with a good deal of ceremony, as though it were an important and honorable mission, one or more of the children may be despatched to the flower to look up the answers to these questions.

Have the rest of the children listen to the report they bring back, and then they themselves look to see if it is correct. In this way it is possible to arouse in the whole class curiosity concerning the

flowers, and cause the children to look at them with interest.

If it is impossible for the teacher to go with the children to the flower, and impossible for many of the children to see the flowers growing, as in the city, then the flowers can be taken to school.

Each child should have a bottle or cup of water on the desk, in which the long stem of the flower can be put.

Then let the teacher describe as vividly as possible the vine growing over the hedges, or if it is the cultivated morning-glory, over the porch or fence. She can make the children fairly *see* the bright flowers growing up above the vine. Pictures are a help, too.

The principal thing is to have the child feel that the flower is *alive*, that it *does things*, is an individual like the rest of us.

While in some respects the bindweed affords better material for study, the morning-glory is almost as good, and often will be more easily obtained. The colored lines on the morning-glory are sometimes not quite as conspicuous as the white ones on the pink bindweed, but they are sufficiently noticeable and should always be dwelt upon, as they are important in the history of the flower.

The beauty of this work depends upon the skill of the teacher in leading the children to discover the important truths for themselves. She should never tell them what they can find out for themselves, *but should help them to find it out.*

Besides talking and writing, the children should frequently try to draw a picture of their flower.

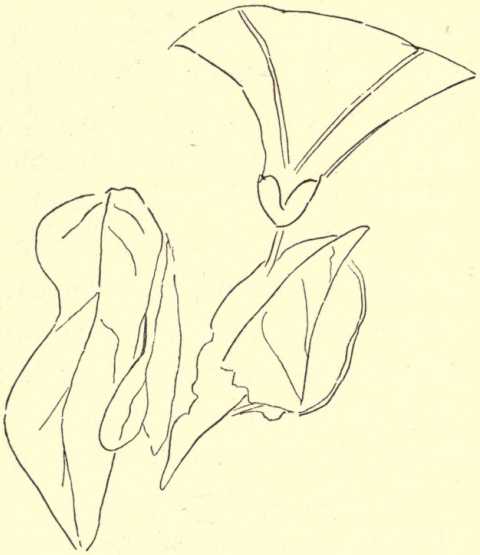
At every point in the work have the children do as much talking and writing and drawing as possible.

Let them have a drawing book on purpose for their plant work; or a few pages of drawing paper can be sewed into the note book, which in this case should have large enough pages to admit of a good-sized picture, at least as large as the natural object itself.

Let the drawing be as spontaneous as the talking and writing. Let the children try to make as good a picture of the flower as they can without fussing over it.

The pictures will be very crude; but in this case they are only used as another method of expression, and it does not matter how crude they are. Do not try to have them draw like the pictures in a book; let them draw just the way they want to.

Nothing fixes the form of an object so firmly as to try to draw a picture of it. Here is a wild morning-glory drawn by a boy nine years old.



While at first it may be well to talk of the "wild morning-glory," as that is its name to the child, as soon as it can be done easily and naturally, substitute the name "bindweed." Notice how the plant twines about the weeds and binds them together; for this reason it has its name.]

NECTAR AND NECTARY.

REVIEW what has already been learned, emphasizing the more important facts.

Then, if the work can be done out of doors, go and watch the bees enter the flowers.

On what part of the corolla do they alight?

Almost invariably upon the white lines. The children will soon discover this.

In the morning-glory, of course, the lines leading to the bottom of the flower are not white, but are different in color from the rest of the corolla.

Watch the bees go into the flowers. See where they go: down to the very bottom of the corolla. What do they go for?

Look down one of the lines into the bottom of the corolla. At its foot is a round opening.

Carefully insert the end of a slender, round, wooden toothpick into this opening. Turn it gently around once or twice. Then withdraw it and see a little moisture on the tip. Taste this; it is sweet. It is this sweet juice that the bee is after. She puts her long, slender tongue through the round opening and sucks out the juice; then she takes it home and makes honey of it.

The children will discover five of these little honey wells at the bottom of each flower cup. They are more easily distinguished in the bindweed than in the morning-glory, for in the latter the openings are partly concealed by fine white hairs.

Some of the children may know that the bees get honey from the flowers. If not, the teacher may say so. Do not tell the child what he can find out for himself; on the other hand, do not fall into the absurdity of never telling him anything. Tell him as much as is necessary to his understanding of the matter in hand. Wise telling is as valuable in teaching as is expert "developing" or drawing information from the child himself.

If the child knows that the bee sucks honey from the flowers, proceed without dwelling upon the habits of the bee. If he does not know, and has never tasted honey, show him, if possible, a piece of honey-

comb and let him taste the honey, telling him how the bee thrusts in her tongue and gets the juice to make this delicious, sweet honey from the flower; then proceed.

Since the insect is so essential to the life of the plant, this little digression is necessary: connect the insect life with the plant life at once. They will always remain associated in the child's mind, and this association will tend to the better comprehension of both.

A little later it will be well to study the bee more carefully, but at this point a due recognition of its honey-making habit may be sufficient.

SUMMARY.

1. Bees visit the flower to get honey.
2. The honey is kept at the bottom of the corolla.
3. There are five openings through which the bee can put her tongue to get honey.
4. The white lines on the corolla guide the insect to the honey.

The teacher should use her judgment as to how much to do in each lesson. The present book is divided into *subjects*, not *lessons*. One subject may require several lessons or it may be finished in one, according to circumstances.

Have the children tell about the flower and the bees in their own words, and, if able to write, write the story in their own way in their flower books.

If the children cannot go to the flowers, then provide them in the schoolroom as before. Tell in as graphic a way as possible how the bees go to the flower. Ask the children where they think the bees would find the best landing-place, on the lines or between them. Touch the flower with the tip of the finger and find it is *firmer* on the lines and easily bends between. Find the honey wells with the toothpick as before, and see that the lines lead to them.

Children's compositions tell perhaps better than anything else the kind of information they have been extracting from their work.

The following efforts at expressing what has been seen are offered for examination.

1. "The morning-glory has a flower something like a bell. Only it has five scallops. It is pink. There is a white path down the middle of each scallop. It gets wider as it goes in. At last they all run together. Then it is all white."

With the exception of the omission of too many nouns, a scientist need not be ashamed of the descrip-

tion. Something had been seen and accurately expressed in the child's own language.

When she notes its scalloped state, and says there is a white path down the middle of each scallop, she has done better than any botany I ever read.

Let us see what other children in the same class have written about the morning-glory.

2. "The morning-glory has white paths. It is pink, but the bees run in on the paths. I saw a big fly go down a path."

3. "The morning-glory has pink scallops. It is like a little bell, only it stands up. It has white paths down its scallops. Bees tumble down, and when they get to the end, their noses are in the honey pots."

4. "There are five wells of honey at the bottom. You can see them. The bees know it. The wells are at the end of the paths. They walk the paths and suck the honey through their noses."

5. "Bees go down the paths and suck out the honey. They put it in their combs. Then we eat it."

6. "Bees have little tongues to stick in the honey wells. They like to. They tumble all over the flower. The flower likes it."

7. "You can see five honey wells. Bees stick in their tongue. Teacher stuck in a toothpick. It

tasted sweet. Kate tasted it. Me and Tom did n't. She said it was sweet. She don't lie. It was there."

8. "The bees suck the honey. Flies suck the honey. Bugs suck the honey. Butterflies suck. Other things all suck. I pulled off a flower and sucked the end. It was sweet. It would be long to get enough."

9. "The bees like the honey. They can see the morning-glory. It is pink and stands up. It can't snuggle down; it sticks out so you can see. Its stem is short when it is on top. When it grows under bushes, stem is long. It must come up."

10. "The morning-glory stays on top. It climbs up the bushes. The flowers always stand out. It likes to be seen. It is pink to be seen. But has white. Bees run down to honey. It likes bees."

Since the flower owes its beautiful showy cup to the visits of insects, the relation between insects and flowers cannot be ignored. Besides, it is one of the most interesting and delightful flower facts to watch.

Who would not rather know that the bee goes down the paths to get honey out of the honey cups at the bottom of the flower than to know that the flower cup is called a "corolla" in the botanies, and that the corolla of the morning-glory is said to be monopetalous?

After the facts are known about the flower, then, and not before, the technical terms may be given without destroying the child's interest in the flower life.

When the children are familar with the "honey" in the flowers, tell them this sweet flower juice is called "nectar."

If they know anything about Jupiter and Venus and Minerva and Cupid and the other gods and goddesses, tell them nectar was the delicious drink of the gods on Mt. Olympus, and that it was passed around by the beautiful Hebe, goddess of youth and spring, until her place was taken by the beautiful boy Ganymede.

The flower honey was named "nectar" after this drink of the gods.

Wherever possible, relate the plant study to literature and to other subjects of study. Impress upon the young minds the great truth that all knowledge and all life are interrelated; that nothing exists by itself alone, but that each thing forms a part of one great whole.

The little cups that hold the nectar are called "nectaries," which means "nectar holders."

The lines or guides that show the bee the way to the nectar are the "nectar guides," or "pathfinders."

Have the children write in their books not only the descriptions of the flowers, but any observations they choose to make about them. Encourage references to mythology or history, or anything else suggested by the plant study. Make the little book a *literary* effort as well as a scientific treatise.

Have it illustrated by drawing, as far as possible.

THE STAMENS.

REVIEW the work already done. The review should precede each new lesson, as a rule, and should grow briefer each time.

That is, the attention should be more and more concentrated upon the *essential facts*, until finally they alone are mentioned. In this way the principal points of the work from the very beginning can be kept fresh in the mind and by constant repetition fastened there.

If the children have the privilege of watching the flowers out of doors they will not be long in discovering that the bees get something from them besides honey.

If they do not see it, the teacher can ask them to watch closely and see if the bee gets anything else. They will soon discover the white powder which dusts the bee's breast and legs, and which she gets from what one of the children called the "clapper" in the flower bell.

The bee can be watched as she climbs up the "clapper" and at the top gets this white dust, which

she rubs closely against the hairs of her breast or makes into little balls on her legs.

What does she do with it?

She takes it home and makes it into beebread to feed the young bees. She eats beebread herself sometimes, and so do the other bees that live in the hive. So this white dust is the bee's flour. We see that the bee gets both bread and honey from the flowers.

Now let us see just where Lady Bee gets her flour.

The children can watch her climb up the pillar in the middle of the blossom and at the top find the bags of flour.

The bee does not carry off the bags, but with her feet scrapes out the flour.

How many of these flour bags are there? There are five, each placed at the top of a slender white stalk.

These stalks, or poles, or stems, as the children may call them, are stacked about a central column, which is stouter and taller than they, and ends in a sort of roughish knob. It may be necessary to pick the flower from the vine in order to see these parts distinctly, though if the whole work can be done without picking it, that is by far the better way. The stamens can be studied in a corolla that has closed or fallen from the vine.

When the children are familiar with the idea and appearance of the bee flour, the teacher may tell them its name is "pollen" and that "pollen" comes from a Greek word meaning "fine flour."

When they are perfectly familiar with the little pollen bags, tell them they are called "anthers."

The stalk which holds the anther is a "filament." It is something like a thread, and "filament" means "a thread."

Anther and filament together form a "stamen."

SUMMARY.

1. Bees find flour as well as honey in the blossom.
2. This flour, or "pollen," is kept in five little bags at the top of slender columns, or "filaments," which the bees climb.
3. There is a stouter, longer central column, use not yet known.

If the children have the flowers in the schoolroom the teacher will have to work upon their imaginations to explain about the bee. She can "make believe" to good advantage here.

"Make believe" can be a valuable friend in teaching children — or anybody else.

Make believe the end of the little finger is the bee. Gently rub it against the center of the flower. See the white dust adhering to it. Find out, as

before, where this white dust comes from. The teacher will have to tell how the dust clings to the hairy body of the bee and how some bees roll it up into little balls on their legs. Pictures of bees will be a help here.

A short digression upon the habits of bees will be valuable at this point. It deepens the interest in both bee and flower.

If the teacher can procure some honey and bee-bread to show the children, it will add greatly to their pleasure.

Bees and flowers, let it be repeated, are so intimately related in reality that they should be closely united in the child's thought.

The interdependence of bees and flowers is a very beautiful thought to give the child. The bee cannot live without the flowers; from them it gets its food. Later it will be seen that the flowers are almost as dependent upon the bees as the bees are upon them.

They owe their lives to each other.

Nothing in Nature is isolated.

One form of life is always intimately connected with other forms and dependent upon them for existence. It helps others and others help it. This

great and important truth should be placed deep in the child's mind from the very beginning of his nature study. It cannot be too often insisted upon.

The pollen and the bees make delightful subjects for the children to write about.

It will not be necessary to interrupt the regular plant lessons very long at a time in order to do justice to the bee; occasionally, as opportunity offers, read and talk about the bees.

[Read "The Bee People."]

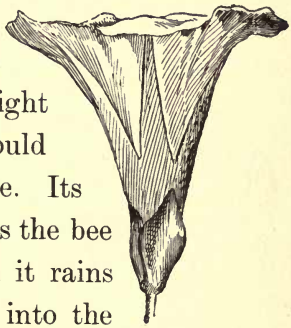
When the parts of the flower are known it is a great help to the memory to place them in tabular form. Schedule-making may perform an important office in education, but it should not be allowed to usurp the place of observation and description. It is a temptation to some minds to tabulate facts almost before they are learned; but with beginners, particularly with young children, the facts should not be memorized from the table, but the table should be formed from a knowledge of the facts.

When the stamens have been studied and talked about, their parts can be arranged in a concise and orderly manner in the form of a little table, which will help fix them in the mind.

And so with each set of organs as they are studied. But be careful not to do this too soon.

Stamen { anther — pollen.
filament.

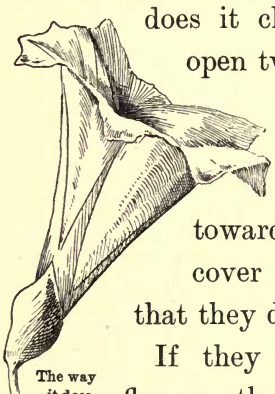
SOME HABITS OF THE FLOWER.



The way the flower does not stand.

NOTICE the attitude of the flower. Does it stand upright, looking up to the sky? No, it does not look straight up to the sky. If it did, the bee could not find so convenient a landing-place. Its face is turned a little to one side; thus the bee has a floor to light upon, and when it rains the water will be less likely to get into the flower.

At what time of day is the flower open? When does it close? Does the same flower open twice?



The way it does stand.

The children will notice at once that the flower opens in the morning and closes towards night. They can easily discover by marking several flowers that they do not reopen.

If they cannot watch the growing flowers the teacher again will have to tell them. The flowers in their bottles will close

and not reopen, and this makes a good starting-point for the teacher's story. She can tell them that the flowers on the vine close in the same way and soon wither and fall off.

Let the children open some of these withered flowers. They will find the fine stamens attached by their filaments to the inside of the flower.

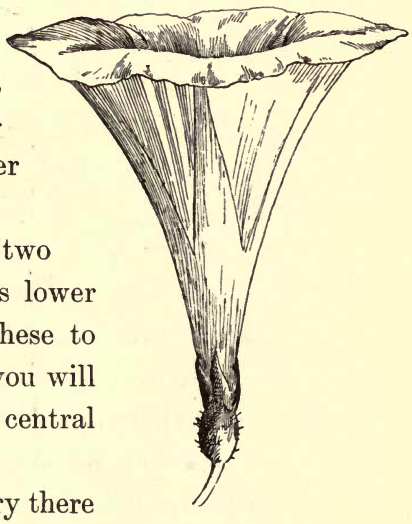
The anthers are withered and empty.

But what has become of the stout central column?

That is not in the withered flower.

Look on the vine and you will find it. When the rest of the flower fell off that remained on the vine.

Or, in the case of the plucked flower, it will be found attached to the flower stem.



MORNING-GLORY.

In the bindweed two green leaves cover its lower part. Gently push these to one side and within you will see the bottom of the central column.

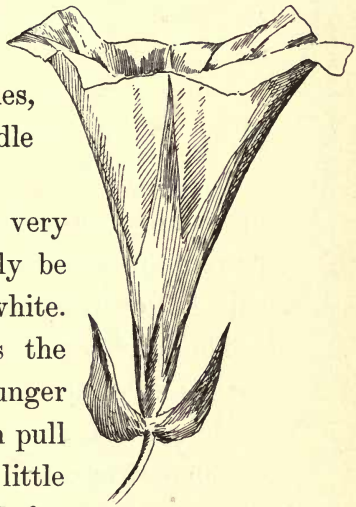
In the morning-glory there are no green leaves to conceal it.

This bottom is roundish and keeps on growing. Look for different stages of these roundish objects. It soon becomes evident that they are nothing more nor less than the young seed-pods. Or this pod may be called the nest that holds the eggs, for the seeds are the eggs of the plant.

Or it may be called the cradle that holds the seed-babies.

The children like this view of it, and it is true and good.

The seeds *are* the plant's babies, and they lie in this snug cradle rocked by the wind.[1]



BINDWEED.

At first the seeds are very, very small. So small they can hardly be seen. They are soft, too, and white.

These facts about the seeds the teacher can tell to the younger children instead of having them pull the flower to pieces to find the little seeds. The ovary is too small for little folks to work with to advantage, and all wanton or useless mutilation of the flower should be carefully avoided. Teach the children to respect the life of even a flower.

[1] See "Seed-Babies." Ginn & Company.

The older pods can readily be examined, and at this season of the year there will be ripe ones splitting open to let the seeds out. By examining these older pods the children can get at the principal fact of the ovary, — that it is the receptacle of the seeds.

SUMMARY.

1. Position of the flower.
2. The flower opens in the morning, closes in the afternoon, soon fades and falls, leaving the seed-pod on the vine to continue growing.
3. The stamens are attached to the inside of the corolla, and fall when it does.

If the children have the flowers in the schoolroom instead of seeing them in their natural position, the flowers can be left in the bottles of water until the cups fall off, when they can be examined as above.

The teacher should then supply seed-pods in different stages of development for them to look at.

Here, too, is charming material for the children to use in writing, and here is opportunity for profuse illustration.

Do not neglect the *drawing*. Children become very skillful in expressing themselves by means of pictures, even when they are not taught how to draw. Possibly it is better *not* to teach them; simply encourage them to try.

THE PISTIL.

When the flower cup fell off there remained the central column with the seed-cradle at its base.

What surrounds the seed-cradle?

The children will discover a little green cup with five divisions.

This clings closely to the seed-cradle, as though to hide and protect it.

Before the flower falls this green cup may be seen surrounding the lower end of the flower tube.

In the morning-glory this green cup is very noticeable; in the bindweed it is hidden by the two leaf-like "bracts" which have to be turned back to show it.

This little green cup is called the "calyx."[1] The word "calyx" means to conceal, to cover, and this green calyx conceals or covers the seed-cradle very nicely.

The five separate parts of the calyx are called "sepals."

[1] See Flowers and their Friends: "The Morning-Glory Calyx."

Here the teacher may call attention to the recurrence of the number five in the flower parts.

Ask the children what parts of the flower are in fives.

They will remember there were five pathfinders or nectar guides leading down to five honey pots or nectaries, five stamens with their flour bags or anthers, and now five parts to the calyx.

The flower seems to like the number five. A great many flowers like it, as they will learn later.

Look at the long column at whose base is the seed-cradle. This long white column has a sort of knob at the top.

SUMMARY.

1. The seed-cradle is surrounded by a green cup of five divisions: Calyx-sepals.
2. The flower has five divisions in several of its parts.
3. The seed-cradle is surmounted by a long column bearing a knob at the top.

A few lessons may now well be devoted to the beautiful care the plant takes of its seed-children.

In what part of the flower are the seeds?

They are right at the center, where they can best be surrounded and protected.

The central part with the seed-case at its base is the mother part of the flower.

Do you think the flower is glad to have the little seed-children at its heart?

What beautiful object has it put about them?

The bright corolla is there for the sake of the little seeds. The plant loves these seed-children so well, it wears this lovely bright crown for them.

And when the pretty corolla falls off there remains the stout green calyx, which we scarcely noticed before, to wrap them up.

The seed-children must grow now and be left in peace and safety to do it, so the bright corolla that told the bees and everybody that the little seed-children were beginning to grow falls off. The seed-children do not want the bees or other insects to touch them. In their little green house one would pass them by and not notice them among the green leaves.

After awhile their pods turn brown and look withered and dry, and nobody would think of picking them, and few insects would think of eating such dry, juiceless, dead things. All this time the little seed-babies are laughing in their sleeves, for they know they are not dry and dead, but as alive as can be.

The seed-pods in all their different stages can easily be procured in the fall of the year.

The story of the mother part of the flower with her seed-babies should be told and retold with all the charm and ingenuity of detail the teacher is capable of giving to it.

The children should tell it and write it until it is as familiar and dear to them as is the story of "Red Riding Hood" or of the "Sleeping Beauty."

The teacher can make motherhood lovely and charming, and develop a reverence for it in the flower life which will have an effect upon the child's thought of maternity throughout his whole life. Here is offered to the wise teacher a beautiful possibility and a grave responsibility.

With little children the facts of the plant's maternity can be given in the form of a story.[1]

Stories can be composed by the teacher, and the children themselves will oftentimes write very pretty stories about the mother part of the flower, and the tender care and love she bestows upon her seed-babies.

Sufficient time should be spent upon this subject to make it perfectly clear and familiar to the children.

Probably it will require several talks.

[1] See Flowers and their Friends: "The Morning-Glory's Seed-Babies."

When the children are quite familiar with the idea of the central column with its enlarged base being the mother part of the plant, and after they have talked about it and listened to stories so as to get a sweet sense of the motherhood of their pretty flower, tell them the mother part of the plant is called the "pistil." Be sure they get the idea of motherhood firmly established before giving them this name; for, unfortunately, it conveys no pleasant meaning, the pistil being so named solely because of its external form, it being supposed to resemble in shape a pestle, or *pistillum*, as it is called in Latin, by which drugs are ground in a mortar.

The technical name of the little undeveloped seeds is better chosen, for they are called "ovules," "ovule" meaning "little egg," and these seedlets or ovules are the starting-point of the seeds, the eggs of the plant, from which the young plants will some day hatch out.

The cradle where the ovules lie is the "ovary."

The stalk that goes up from the top of the ovary is the "style," and the knob at the top is the "stigma."

Give these words one at a time, adding a new one only after the children are perfectly

familiar with those they already have, and use them as readily as they use their own everyday words.

Do not as a rule *insist* upon the use of the new words, but gradually and naturally substitute them for the old ones.

Learned in this way, scientific terms lose all their ugliness and difficulty.

Wherever possible, give the derivation of the new word used and its literal meaning. Make the botany lesson a language lesson as well.

Where the derivation is uninteresting or obscure, pass on without noticing it, merely giving the name arbitrarily. For instance, "pollen" means "fine flour." This is interesting, and to know it helps fix the word in the memory. On the other hand, the literal meaning of "pistil" is not particularly interesting, and does not fix in the mind an image of anything vital to the flower; so it would be as well, particularly with the younger children, not to notice its derivation.

The teacher herself should know the exact meaning of every word used. Most of them will be found in the glossary at the end of this book, or, failing that, in any good dictionary.

SUMMARY.

1. The seed-children : Their position at the center of the flower.

2. The mother part of the plant: *a.* The care she takes of the seed-children. *b.* The things she does for them.

3. Stories about the mother and the seed-children : Pistil — ovary, style, stigma.

SCHEDULE OF FLOWER PARTS.

Corolla.

Calyx — sepals.

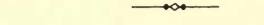
Stamen { anther — pollen. / filament.

Pistil { stigma. / style. / ovary — ovules.

The stem of the flower is called the "peduncle." It comes from the Latin *pedunculus*, a little foot, and forms the "foot" or support of the flower.

Introduce this word, not at the first lessons perhaps, but later when the children have grown familiar with the use of technical terms, and when occasion arises to speak of the flower stem.

FERTILIZATION.



THE children are now ready to be told the use the flower makes of the pollen it so generously bestows upon the bees for their beebread.

Review particularly at this point the story of the pollen, where the bees get it and how they get it.

Have the children notice again that the anthers are *below the stigma.*

The flower does not make the pollen for the bees alone. It makes it for its seed-children or ovules as well.

The ovules need the pollen. If they did not get it they would not be able to change into true seeds. For at first they are not perfect seeds, and without the pollen they would never come to be perfect, but would wither and die and soon fall from the vine.

The pollen wants to get to the ovules quite as much as they want to have it.

Pollen is made up of very small grains. These grains are so small that they can only be seen by means of a magnifying glass. But these tiny grains are alive. If a pollen grain can join an ovule, both

of them will live and form a seed. But if the pollen grain cannot join an ovule, both must die.

There is only one pathway from the outside world to the ovary where the ovule lies. The entrance to this path is in the stigma.

The style is hollow, or at least of such loose material that an object if small enough can pass through it.

So the first thing the pollen grain has to do is to find its way to the stigma.

How can it do this when it is placed *below* the stigma?

It cannot walk nor fly nor climb. If it were above the stigma it might drop down upon it. But as it is below the stigma, if it fell it would drop into the bottom of the flower cup and be farther away than before.

What is it to do?

The anther ripens and opens and the pollen grains cover the outside like fine white dust.

A bee enters the flower, and in doing so brushes her hairy body against the floury anther, and the pollen grains are rubbed off and carried about by her.

In passing from flower to flower the bee very often touches her body against the stigmas.

When the pistil is ripe the stigma is sticky, and when a pollen grain on the bee's body touches this sticky stigma it sticks fast. This is just what both pistil and pollen grain want.

Once on the pistil, the substance of the pollen grain passes down through the style to the ovary, where it unites with an ovule, thus giving it, as we may say, extra vitality. When the pollen has joined the ovule, the ovule begins to change into a seed. The ovule could not become a seed without it.

The union of pollen and ovule is called "fertilization."

When a flower has been "fertilized" it is able to perfect its seeds, and not otherwise.[1]

So now we understand why the flower loves the bee. She carries pollen to the stigma and so makes fertilization possible.

In order to entice the bee the flower makes a great deal of pollen that she may have food. It also secretes honey to coax her to visit it. Even the bright corolla was made by the flower to attract the attention of flying insects.

Bees are not the only insects that visit the morning-glory, but they are the ones that come oftenest and do it the most good. If the morning-glories are

[1] See Flowers and their Friends.

watched, many kinds of bees will be seen coming to them, some being too small to dust the stigma as they pass in and out of the flower.

Large flies, too, will be found visiting the flower for both honey and pollen, and fertilizing it the same as the bees do.

Some kinds of small flies light on the stigma and crawl down to the anthers to eat the pollen. They of course aid in fertilization, as they carry the pollen of one flower to the stigma of another.

Beetles, too, are sometimes seen in the morning-glories, eating the pollen and even the anthers.

It will be found that many insects visit our flower in the course of a day.

Only a few grains of pollen are needed by the flower itself, but to insure the contact of a few with the stigma, it is necessary for the flower to produce a great many; so thousands of grains are formed in order that the insect may not fail to give the flower what it needs. Sometimes the insect enters and leaves a flower without touching the stigma at all; but as many insects visit the same flower in the course of a day, some of them will be sure to fertilize it, since there is such an abundance of pollen that even the last comer will be sure to get dusted by it.

SUMMARY.

1. The pollen is necessary to the formation of seed.
2. Its method of getting to the ovule.
3. Its abundance.

In connection with this work the teacher may add that the flower prefers the pollen of a stranger plant; that is why the anthers are below the stigma. It is not desirable that the pollen fall upon and fertilize its own stigma. It is better for pollen to be brought from another flower. The insect in flying from flower to flower is very apt to dust the stigma with pollen from another morning-glory. This kind of fertilization is called "cross-fertilization," and makes stronger seeds than those that result from the fertilization of a plant by its own pollen, a process known by the name of "self-fertilization."

It is not impossible for the morning-glory to fertilize itself, as the uppermost stamen reaches nearly to the stigma sometimes, and the moving of the flower in the wind may lodge grains of pollen upon the stigma. In some cultivated flowers the stamens reach above the stigma, or sometimes enclose it. Also when the corolla falls it may happen that a few grains of pollen will touch the stigma and so fertilize it; but this happens only

when the flower has not already been cross-fertilized, for after it is once fertilized, pollen has no further effect upon it.

You see this flower has a chance to become fertilized in case the insects fail it, for no matter how much it may desire cross-fertilization, it is better for it to be self-fertilized than not fertilized at all.

At her discretion the teacher may tell the children that the stamen is the father part of the plant, just as the pistil is the mother part.

The stamens help care for the seed-children so they can become strong seeds.

If skillfully done, there is no such beautiful introduction to sex life as is offered by the world of flowers.

The teacher can impress upon the young minds a sense of beauty and reverence for motherhood and fatherhood that will tend to keep the heart pure and the mind rightly attuned to understand the great and beautiful mysteries of sex life that are later to unfold.

Make the birth of these seed-children a *beautiful* mystery.

Right here among the flowers *lay the foundation for right thinking in regard to the most important function of life.*

The subject of inheritance may here be discussed.

If the seeds grow on a vine bearing purple flowers and round leaves, the vines that come from these seeds will probably have round leaves and purple flowers. That is, the children of the vine will resemble the parent vine.

The seeds remember and make new vines just like the parent vines.

But sometimes the seeds from a round-leaved, purple-flowered vine may grow into a vine having leaves of another shape and flowers of another color.

How can you account for this?

You must know that the seed-children inherit their nature from father as well as from mother. Now if the pollen or father part came from another vine with different leaves and flowers, the seeds would be partly like the father and partly like the mother; just as the children in a family take after the mother sometimes, and sometimes after the father.

Reproduction and inheritance are the two most important factors in the development of life.

Every one now knows that plants as well as animals increase by sexual reproduction.

Flowers contain both male and female organs, and have a sort of family life. The stamens are the male part of the flowers and the pistil the female part.

The stamens and pistil in the same flower stand in the relation of brothers and sisters to each other. Just as it is not desirable for brothers and sisters in the higher life to intermarry, so it is not desirable in plants, and they, as a rule, employ some device to prevent it.

In the case of our morning-glory, the position of the stamens with regard to the pistil is the plan used.

Most plants will accept their own pollen rather than not set seeds at all, and for a few generations self-fertilization, or intermarriage as it would be called in the higher life, in many plants seems to do no harm.

A few plants are so constructed that they cannot possibly fertilize themselves, and others again are so formed that they cannot be fertilized except by their own pollen.

Cross-fertilization, however, seems necessary at least occasionally, in most species, to preserve the vigor of the plant.

Suppose a flower were to receive pollen from a different species, what then would happen?

If a lily were dusted with rose pollen, for instance, we might expect as a result seeds which would grow into strange lily-rose plants. But this, as we know, does not occur. A flower cannot be fertilized by the pollen from a flower of a different family.

It affects it no more than if it were so much dust.

The subject of reproduction is one of the most important facts of plant life, and too much skill cannot be exercised in conveying it to the child.

Of course he will not understand it fully, nor is it necessary he should.

Let him get clearly fixed the idea that the pollen unites with the ovule to form the seeds; that both pollen and ovules are *alive* and anxious to grow; that they cannot grow without union with each other; that both have the power of transmitting the characteristics of the plant they came from.

Here are involved the two greatest factors in the development of life, — reproduction and inheritance.

Since sexual reproduction is the method of all the higher life, whether plant or animal, that it be rightly understood and reverenced is one of the most important matters in the life of every individual.

Where more beautifully, simply, and easily can this great subject be introduced to the child than through his study of flowers?

Later, when it becomes necessary to explain to him certain facts in animal life, reference to the flower life with which he is already familiar will make vastly more easy the more difficult subject.

So, although the child cannot yet understand fully the meaning of the relation of the pollen to the ovule, make him familiar with the general facts, for the sake of the future.

At this point a general review of all the flower parts is valuable.

They are now seen from a new and valuable point of view.

The bright corolla is a signal to the bees. It also folds about and protects the pollen from the wind and rain, and little crawling insects that might creep in and steal the honey without fertilizing the plant. Only large insects would be likely to rub off the pollen and brush it against the stigma.

So the corolla is unfolded for the sake of the seed-children.

The pollen is liked by the bees, but the plant produces it primarily to help the seed-children to grow.

The nectar is made to attract the bees, that they may come and do a service to the seed-children by carrying pollen to the stigma. So really the flower makes nectar for the sake of its dear seeds.

The pistil holds the seed-children and takes care of them.

The calyx surrounds and protects the ovary where the seed-children lie.

Thus every part of the flower is made for the sake of the dear little seed-children.

We enjoy the beauty of the flower, and enjoy it all the more because we know about it and its beautiful love for the helpless little seeds.

The flower is the way it is for its own sake. It was not made beautiful to please us.

But we have the power to see that the flower is beautiful and to love it because it is. That is one of the greatest powers there is.[1]

The work so far has been chiefly for beginners in plant study, and to give information to the young teacher.

It can be adapted to the youngest children, or, following the same method, can be amplified to suit older pupils.

Just how much it is wise to teach a class of children about one flower should be decided by the teacher. Do not weary the child with an accumulation of facts he cannot understand. On the other

[1] See Flowers and their Friends: "This is the Flower so Bright and Gay."

hand, give him enough to stimulate curiosity and hold his interest.

Let all, old and young, *begin* plant study alike, with the *life story* of some one plant.

Is it not much better at the beginning to study carefully and at length one object, and so become *acquainted with it*, than to pass hurriedly over a number?

It may take the whole fall to study the morning-glory properly, including leaf, root, and stem.

But if that is done, *many of the essential facts of plant life are known and understood*, and any other plant will be more easily and quickly understood in consequence.

With pupils over twelve the teacher, if she desires, can go more into detail in the structure of the flower.

But she should always, as far as possible, relate the structure to the function.

Never study structure as an end.

It is always a means to an end, or else a survival of something that was useful to the object in some past period of its life.

Let us continue with our flower and see what still remains for the older pupils to learn from it.

The *nectary* is at the bottom of the corolla; the

nectar is secreted by a yellow gland which forms a band about the ovary in the bindweed, and is in the form of a less conspicuous greenish band in the morning-glory.

A gland is a growth which has the power to select out certain things from the sap of the plant. The nectar gland separates out from the rest of the sap the sugary juice which forms the nectar.

The five openings to the nectary are formed by the way the filaments are shaped and placed.

Let the pupils examine carefully to see how the filament, attached near the base of the corolla by its *back*, flares out in an over-arching edge on either side, and how the edges of two filaments just touch, leaving a little channel below them.

Notice what a clever and efficient method this is of forming the tubes that open into the nectary.

In the morning-glory the openings to these tubes are more or less obscured by fine white hairs.

What is the use of these hairs? Certainly they prevent ants and other small insects from crawling in to steal the honey.

If possible, have the children see both the bindweed and the morning-glory all through the work. They are so nearly identical that they will not con-

fuse the mind, and the slight differences only add to the zest of examining them.

Why is the entrance to the nectary reduced to five small holes? Why would it not be as well for the filaments to grow flat against the corolla, and so leave an open space all around, instead of humping up and filling the opening all but these little holes?

Some of the pupils will see that the desire of the flower is to keep its honey for the larger insects which have a proboscis long enough to enter through the holes into the nectar-filled space below, and who because of their size can scarcely enter a flower without brushing the stigma and the stamens, and so fertilizing the plant.

Insects too small to fertilize the flower only do it harm if they enter; for they steal the honey, and so prevent visits from larger insects able to effect fertilization. Where there is a protection against them, as in the case of the fringe of hairs, they will not be tempted to enter it as a rule, as they cannot reach the honey through the small openings. The proboscis of the larger insects is strong enough to push these hairs aside. In the morning-glory small bees often take the honey without fertilizing the flower, but the morning-glory cannot hope to protect itself against *all* misfortunes.

The *anther* is placed at the very end of the filament. Such an attachment of anther to filament is called "innate," meaning "born on."

Examine the anther and find the two bags or boxes where the pollen is stored. Each of these bags forms a little dark room or "cell," like a prison cell.

The word "cell" comes from the Latin *cella*, and means a "small, close room."

There is another meaning to the word "cell" which of late has assumed great importance, but the original meaning of a small, dark room is the one here referred to.

The pupils will discover that each anther cell opens by a lengthwise slit.

Notice that the anthers open on the side looking away from the pistil. Such opening is called "extrorse," meaning "turned to the outside."

Why is the opening to the anthers extrorse?

It will be seen that opening thus the insect which is obliged to pass between them and the corolla on its way to the nectary cannot do so without rubbing off the pollen.

The opening of an anther is called its "dehiscence." "Dehiscence" comes from the Latin word *dehiscere*, meaning "to gape," and any one noticing how the

open anthers gape apart will acknowledge the name to be appropriate.

The line along which the anther opens or "dehisces" is the "line of dehiscence."

Notice that the line of dehiscence in the morning-glory anther is on the back.

The stamens and stigma are placed low in the corolla. They do not stand out beyond it; they are said to be "included."

What is the advantage of this position?

The pollen is protected by the corolla from the rain, and from being blown away by the wind. Water spoils the pollen of most plants.

From youngest to oldest the pupils should be drilled in recording their observations and reflections. The material for compositions increases in abundance and attractiveness as the subject expands, and the older pupils no less than the younger should keep their written records of the plant study. Have as much drawing as circumstances permit, and see that circumstances permit a good deal!

THE PISTIL.

THE stigma of the bindweed will be seen to consist of two oblong divisions or "lobes." These slender lobes are thought to resemble lines, and for this reason are called "linear." The stigma of the morning-glory has three round lobes bunched together into a little head. Such a stigma is called "capitate." "Capitate" comes from the Latin *caput*, a head, and means "head-like."

We remember that the little boxes or bags in the anther that held the pollen were called "cells," and that the word "cell" comes from the Latin *cella*, and means a small, close room. A prison room is a cell, an anther room is a cell, and if we cut across the ovary of a morning-glory, we shall find it composed of from three to six little seed-rooms, or cells, with one ovule in each cell, while in the bindweed there are only two or three cells, each containing two ovules.

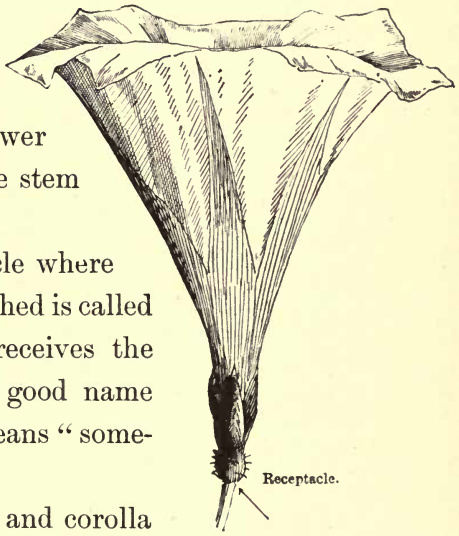
Because the ovary is thus composed of three parts, it is "compound."

The stigma is also compound, because it has more than one lobe.

The pistil as a whole is called compound when any of its parts are.

Con or *com* in Latin means "together," and "compound" comes from a Latin word — *componere* — meaning "to place together."

Where a flower part is made up of two or more parts placed together, that part is said to be compound.



Notice the way the flower parts are attached to the stem or peduncle.

The top of the peduncle where the flower parts are attached is called the "receptacle." It receives the flower, so receptacle is a good name for it. "Receptacle" means "something that receives."

See whether the calyx and corolla are attached to the receptacle above the ovary or below it.

Careful looking will show the corolla attached *below* the ovary, although the stamens grow forward about the style and conceal the ovary when one looks down into the flower cup. It is plainly seen that the calyx is attached to the receptacle below the ovary.

So the ovary is attached *above* the calyx and corolla.

The one that is above is the superior. So the ovary is said to be "superior" because it is attached above the calyx and corolla. This position of the ovary is important in classification.

It is readily seen that many of the so-called "technical terms" of botany are only common words very accurately used, and a knowledge of the exact meaning of these words adds to the general vocabulary of the pupil, and tends to encourage accuracy in the use of words.

For obvious reasons, the calyx and corolla are called "floral envelopes," while stamens and pistil are called "essential organs."

The morning-glory, as well as the bindweed, is a "perfect" flower because it has both kinds of essential organs, and so can perfect its seed.

It is "complete" because it has everything a flower can have: calyx, corolla, stamens, and pistil.

Sometimes the calyx and corolla are called the "perianth"; this comes from a Greek word, meaning "with flowers all around."

Either the calyx or the corolla may also be called a perianth. A perianth, then, is any floral envelope,

whether calyx or corolla, or both together. It is a good word to become familiar with for future use.

A circle of flower parts is called a "whorl." The sepals form a whorl, the petals form another whorl, and the stamens yet another. A whorl means a circle of like parts about a center, and comes from the old English word *whorvil*, meaning "the whirl of a spindle." When a spindle is whirled rapidly about, it describes a circle that looks a little like a circle of flower parts.

It may not be necessary to give all the technical terms above given. The ones most essential to the understanding of books on botany have been selected, but many of them may be introduced later if desirable in connection with flowers hereafter studied, the amount of work done with the first plant studied depending upon the age and development of the children.

THE BUD.

HAVE the children look at the buds in different stages of growth.

In the bindweed the two leaves, or bracts, below the calyx entirely cover up and hide the bud when it is small.

Finally it peeps out.

In the morning-glory there are no bracts; the calyx alone conceals and protects the bud.

Notice how the bud is rolled or twisted shut.

A flower rolled up this way is said to be "convolute" in the bud.

"Convolute" means "rolled together."

The calyx, too, is not yet open. It is tightly closed about the bud. But it is not convolute. Instead of being rolled shut, the sepals overlap each other like the shingles on a roof.

In this way they are able thoroughly to protect the tender bud.

What name do you think is given to flower parts that overlap in this way? They are said to be "imbricated" in the bud.

"Imbricated" is a very interesting word. It comes from the Latin word *imber*, meaning "rain." Now why should they use a word made from one meaning rain to describe the overlapping of the sepals? Let us examine this.

There is another Latin word derived from *imber*. It is *imbrex*, and means "a hollow tile," "a gutter tile," to carry off the rain from a roof.

But there is another Latin word — *imbricatus*, which means "covered with tiles." So we see how a word meaning rain gives rise to one meaning a protection from rain. And because the sepals are overlapped like the tiles on a roof, and protect, they are said to be imbricated.

Draw the buds and write about them.

Let the older pupils see which way the bud twists. It always twists from left to right. Twist it that way, and you shut it tighter. Twist it from right to left, and you loosen and partly open it.

Why should all the morning-glory buds twist from left to right?

It is the result of inheritance, though why the original plant formed this habit we do not know. Doubtless there was some good reason for it, and some day we may find out what it is.

Look at a bud which is partly unfolded; notice

the position of the nectar guides about the bud. The nectar guides, we remember, are stiffer and stronger than the rest of the corolla. See that the flower is folded so as to bring the firm part — or nectar guides — *on the outside of the bud.* They are wound about the more delicate part of the corolla which is folded up inside, and so form a protection to the bud. Thus they serve two purposes.

We will now leave the morning-glory flower, though we have by no means exhausted it.

We have become acquainted with the most obvious facts of its life, and found them interesting.

The older pupils are just as interested in the *life* of the flower as are the younger ones.

They find the mere naming of parts just as tiresome, and, in the end, it is as barren of results.

If the structure and meaning of the flower are learned first and the names afterwards, the interest continues.

There is pleasure in thinking about the flower and what it does and how it does it.

The new names, given with their meaning, one at a time as they are needed, are remembered without difficulty.

This is the natural way of learning new words. It is the way the child begins to talk. He sees a

horse and calls it a horse. He learns the name of the cow, the cat, the dog. He learns by looking at them that a cow has ears, eyes, legs, and horns.

When he knows about the legs of a cow he recognizes legs in any other animal. Nobody thinks of putting before him a cow, a bird, a bat, a monkey, and telling him to compare and classify the positions of their legs. After a while, when he knows a bird, a bat, and a monkey, he delights in comparing their legs, and finding the forelegs of the bird are its wings, of the monkey its arms, etc.

Just so in studying a flower. Let the young student thoroughly learn some one flower with the words descriptive of its parts, as a result of actual looking and knowing.

When the pupil is thoroughly familiar with this flower, let him take another and study that, finding many parts like those in the first one and some new facts.

It will not be long before he will have become acquainted with the ordinary forms of plant life. For instance, he finds innate anthers in his morning-glory. In another flower he will find the anthers fastened along their whole length, or "adnate." In another he will find them fastened in the middle and swinging in the breeze, or "versatile."

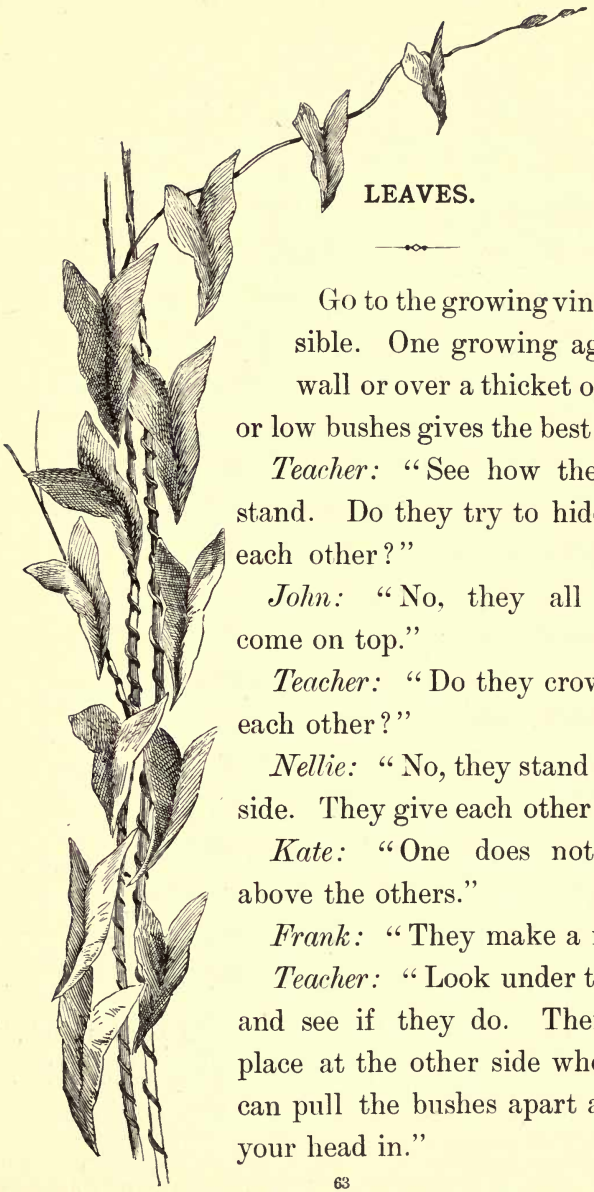
After he has become acquainted with flowers containing the different kinds of attachments of anthers, *then* let him classify anthers as innate, adnate, and versatile, *not before.*

In other words, do not study *anthers,* as is so often done, but study whole flowers.

Let the child learn to know his flowers little by little, as he knows the rest of the world about him.

Keep the flower intact.

Do not try to classify before the pupil has the facts in his possession necessary to classification.



LEAVES.

Go to the growing vine if possible. One growing against a wall or over a thicket of weeds or low bushes gives the best results.

Teacher: "See how the leaves stand. Do they try to hide under each other?"

John: "No, they all try to come on top."

Teacher: "Do they crowd over each other?"

Nellie: "No, they stand side by side. They give each other room."

Kate: "One does not stand above the others."

Frank: "They make a roof."

Teacher: "Look under the vine and see if they do. There is a place at the other side where you can pull the bushes apart and get your head in."

Fred: "Oh, Miss A, there is nothing but *stems* under the bushes — no leaves at all!"

Kate: "Let me look. That 's so. And the leaves of the bindweed and all the other leaves on the weeds are on top."

Nellie: "I see some little bits of plants down below and a few leaves, but they are most all on top."

Teacher: "What holds the leaves up in the air?"

Fred: "The stems do."

Teacher: "Are the stems all the same length?"

May: "Oh, no; some are long and some are short. The long ones start underneath and grow till they get to the top. The short ones start near the top and do not have to grow so long."

Teacher: "Bravo, May! You could not have told it better. Why do you suppose the leaves all want to be on top?"

Ned: "They want to be seen."

Teacher: "Whom do they want to have see them?"

Ned (laughing): "I don't know. The flowers stood up to be seen, so I thought at first the leaves did."

Teacher: "What made you change your mind?"

Ned: "It would n't do the leaves any good to have the bees come."

Nellie: "I think they like to be in the sun."

Teacher: "Let us see what happens to leaves that are not in the sun."

[They hunt in the dark corners under the bushes and find a few pale specimens. The teacher then shows them some plants or branches she has found in the cellar or under the porch in the dark.]

Teacher: "What is the difference between these and the leaves that get plenty of light?"

Frank: "These are not so green."

May: "Those cellar plants are not green at all; they are yellow."

Teacher: "Nearly all plants need light. They cannot grow green and strong without it. They also need air. They cannot live without air any more than we could. Look about some time and see how all the leaves on all the plants grow so as to be in the light. They do not crowd each other; they grow in such a way as to help each other. Look at our vine again. Which way do the leaves point?"

John: "They point down."

May: "Not *exactly* down, but a little to one side."

Teacher: "How much do they overlap each other?"

Fred: "They do not overlap very much. A good many do not overlap a bit."

Teacher: "Why do you suppose they turn to one side as they do?"

Fred: "I think they do not want to overlap each other."

Nellie: "They wish to help each other."

Teacher: "What helps the leaves to get in the right place?"

May: "The stems do. They grow long or short to put the leaves in the right place."

SUMMARY.

1. The leaves stand up in the light and air.
2. The stems grow different lengths, so as to bring the leaves all on about the same level.
3. The leaves stand side by side.
4. They point down and do not overlap.
5. Their position gives them the greatest amount of light and air.

Why do people train morning-glory vines over their porches?

Because of the pretty flowers and because of the fine screen they make to the front of the porch. They make a good awning.

Draw pictures of the leaves as they are grouped, and write about them.

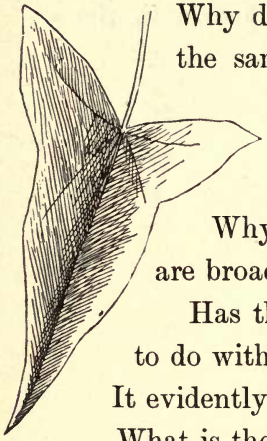
Of course, if it is impossible to go to the vine, the vine will have to be taken to the schoolroom.

Detach it close to the ground, and let it lie in water for some time; it will not then wilt so quickly.

Place the cut end in water, and pin the vine against the wall as nearly as possible in the position in which it grew.

The teacher may now describe in a graphic way the appearance of the vine in its natural state until the children form a picture of it in their minds. Have specimens of leaves or plants grown in the dark.

SHAPE OF THE LEAF.



See how the leaves stand so as to fill up all the vacant spaces.

What makes the leaves all point the way they do, not directly down, but a little sideways generally?

Why do they not all lie side by side pointing the same way?

They would then overlap each other. They do not want to do this, for they like all the air and light they can get.

Why would they overlap? Because they are broader at the top.

Has the shape of the leaf, then, something to do with its position on the vine?

It evidently has a great deal to do with it.

What is the shape of the bindweed leaf?

Try to draw it. Such a leaf is said to be "halberd-shaped," or "hastate."

"Hastate" comes from the Latin *hasta*, which means "a spear."

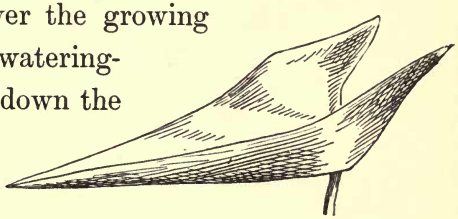
The leaf is thought to resemble the head of a spear or halberd. The halberd is an old-time battle-axe, with a head shaped a little like this leaf.

Is the leaf flat?

No, its two halves slightly approach each other, forming a channel, or gutter, down the middle.

What is the use of this gutter when it rains?

If sand be poured over the growing vine, or water out of a watering-pot, it will be seen to run down the channel and drip off the point of one leaf to another.



Finally it is all shed on the ground a short distance away from the stem of the plant.

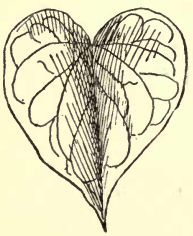
In this way the rain is collected in one place instead of being scattered over a larger space.

This is an advantage when only a little rain falls in the summer, for then the roots get more.

SUMMARY.

1. The shape of the leaf decides the way it shall grow so as to get the most air and light and rain.

2. The shape of the leaf is described.

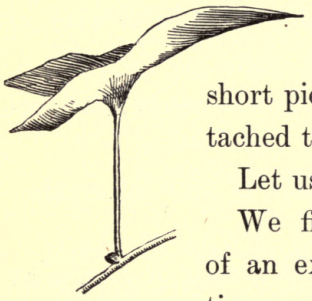


In the morning-glory the leaf is rounder, and is heart-shaped, or "cordate," at the base. But it stands so as to fit in the vacant spaces in the same way, and is shaped so as to shed the rain.

The position of leaves to each other and to the plant stem is an important and interesting subject, and the teacher will find a chapter upon it in Balfour's little book entitled "Flower, Fruit, and Leaf."

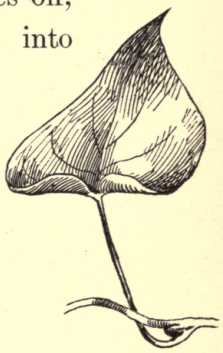
LEAF PARTS.

If the children cannot examine the growing plant, each child should have a piece of the stem, with a leaf attached, in a glass of water on the desk. Do not pull the leaves off, but cut the vine into short pieces, with a leaf attached to each piece.



Let us look at a leaf.

We find it is made up of an expanded green portion, or "blade," and a stem, or "petiole."



Draw the leaf.

"Petiole" comes from the Latin *petiolus*, meaning "a little foot."

"Petiole," meaning "leaf stem," and "peduncle," meaning "flower stem," both come from the Latin word which means a foot, or support.

What is the use of the petiole? It supports the blade of the leaf and holds it out in the air and light.

What shape is this petiole?

It is rounded beneath and flat above, with a little channel along the flat upper side. What is this channel for?

Does it help convey the rain to the leaf?

See how the petiole is attached to the vine.

The place where the leaf comes out is called the "node." "Node" means "knot," or "swelling," and the stem of our plant is usually a little thicker at the place where a leaf comes out.

The morning-glory and bindweed vines have but one leaf at each node.

The space between two nodes is an "internode." "Inter" means "between."

Where there is but one leaf at a node, the arrangement is said to be "alternate," because one leaf comes, and then after a space another.

"Alternate" means "one and then another."

The petioles of the leaves do not all grow on the same side of the vine.

Then how do the leaves manage to stand side by side on the same plane?

If they are not faced the right way when they start from the vine, the petiole *turns*, so as to bring its leaf on the upper side.

The bindweed generally grows against a wall or

a fence or over bushes, and so only one side of it is towards the light. All the leaves turn to this side.

The petiole not only grows the right length to hold the leaf up to the light and air, but it turns about in such a way that the leaf is brought into the right position for its best good.

SUMMARY.

1. Parts of the leaf: Blade, petiole.
2. The petiole: Its shape, position on stem.
3. Node.
4. Internode.
5. Alternate arrangement of leaves.

Draw the leaf in its right position on the stem. Write about it.

POSITION OF THE FLOWER IN RELATION TO THE LEAF.

Look at the place where the petiole joins the vine. The flower starts from the same node, or a little green bud is there.

Oftentimes both flower stem and green bud start from the place where the petiole is attached.

Where is the green bud?

It is between the petiole and the vine, close to the upper side of the petiole.

This little niche between the petiole and the vine where the flower stem and the green bud come out is the "axil" of the leaf. "Axil" comes from a word meaning "shoulder-joint," and here is used to mean the "arm-pit," or under side of the shoulder-joint.

The bud comes out of the axil, or arm-pit, of the leaf.

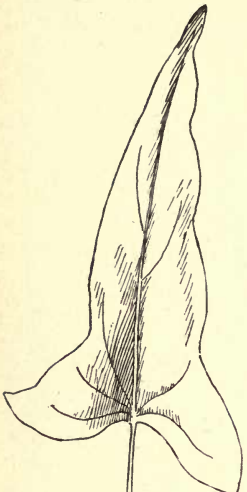
A bud or flower growing from an axil is said to be "axillary."

SUMMARY.

1. Axil.
2. Axillary growths.

The flower bud likes to grow near the leaf. It is able to get food easier there. The sap that goes into the leaf can easily flow into the parts that lie in the axil of the leaf. So we find flower buds and new branches starting from the axils of the leaves. The little green bud will probably grow into a short branch. Such branches may be seen on the lower and older part of the vine.

Draw the leaf with the bud in its axil. Write about it.



THE BLADE.

LET each child have a leaf.

What is the use of the petiole?

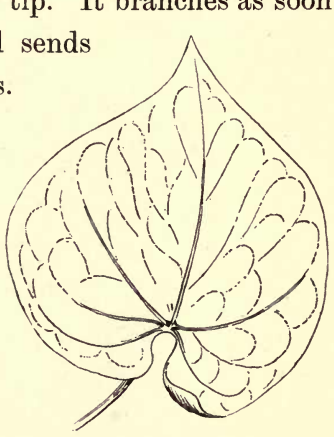
It is to hold the leaf up in the air and turn it towards the light.

What is the use of the leaf blade?

Let us first see how it is made.

Is it all alike? No, it has a softer green part and a stiffer framework.

The petiole seems to run through the blade or the leaf clear to the tip. It branches as soon as it enters the blade, and sends the branches along the sides.



Hold the leaf against the light, and see how the branches keep on branching until a fine network is formed.

When a man builds a house he makes a framework of strong beams to fasten the walls to. A ship has stout ribs to keep it firm. A person has bones for the same purpose.

The stiff branches which are given off from the petiole and form the framework of the leaf are called "ribs."

If a leaf had no ribs it would be blown to pieces by the wind and broken by being jostled against things.

So the petiole runs into the leaf blade and branches out to hold it firm.

A "skeletonized" leaf shows beautifully the branching of the framework. Such leaves are often seen on the sidewalks in the fall, and in the woods.

The more delicate parts have disappeared, and only the tougher woody part remains.

The rib that runs through the middle of the leaf blade from the petiole to the opposite point is called a "mid-rib." The rest are "side ribs."

All the large ribs in the morning-glory start from the same place, — the point where the petiole enters the leaf blade.

They branch off something as the fingers do from the palm of the hand; so our leaf is said to be "palmately ribbed," or "palmately *veined*." Sometimes the branches of the petiole that form the framework of the leaf are called "veins" instead of ribs.

In fact, they are a combination of ribs and veins,

for they give firmness to the leaf, and also help convey the juices of the plant through the leaf.

Because the small branches of the veins cross in all directions, forming a network, our leaf is said to be "net-veined."

The way a leaf is veined, or ribbed, is called its "venation."

SUMMARY.

1. The leaf blade:

   Its parts { framework. / softer green part.

2. The framework:

   Ribs, or veins { mid-rib, or vein. / side ribs, or veins.

3. Palmately veined.
4. Net-veined.

Draw the leaf with its veins. Write about it.

THE GREEN PART OF THE LEAF.

The space between the ribs is filled by the green part of the leaf. This is softer and more delicate than the framework.

It is called the "parenchyma" of the leaf.

Why do you suppose it has this long name?

There is a somewhat funny meaning attached to it. "Paren'chyma" comes from a Greek word meaning "to pour in beside."

It is just as if the framework of the leaf had been laid flat on something, and the green part poured in all around it!

The parenchyma is a very important part of the leaf.

It absorbs food from the air, and so enables the plant to grow. It does some of the eating for the plant, and the roots do the rest. So the leaves and roots work together to supply food for the growth of their plant.

The leaves cannot stay green unless they have sunlight. If they are kept in a dark place we know they turn white, and the plant finally dies.

The leaves breathe as well as eat. They are the lungs of the plant.

They take in pure air just as we do and breathe out impure air.[1]

The leaves eat for the plant, they breathe for it, they shed the rain down on the roots, and they make a shade to prevent the ground below from drying up too fast.

The plant cannot grow without leaves. If it loses its leaves it cannot eat, and so dies.

SUMMARY.

The green part (parenchyma) of the leaf and its work.

Write as much as possible about the work done by the leaf.

The older pupils will be interested in the exact work done by the parenchyma. It contains the green coloring matter of the plant as well as other valuable plant materials. The green coloring matter is called "chlorophyll." The word "chlorophyll" comes from the Greek, and means "leaf-green."

It is the chlorophyll which does the eating for the plant. It consists of little green grains lying close together, and has the power to eat only when under the influence of sunlight.

[1] See Flowers and their Friends: "Chlorophyll."

There is a very curious story connected with the food the chlorophyll eats. This food is carbon dioxide, or carbonic acid as it used to be called. Carbon dioxide, like many other gases, is invisible. It is always found in the air we breathe. It is an impurity, and if it collected in too large quantities, would destroy us. If it were not for our friends the plants, it is probable the carbon dioxide would smother us, we are constantly breathing it out in such large quantities.

But this gas which would become injurious to us if not removed from the air is just what the plants need to live on. By eating it they purify the air for us to breathe.

But this is only one chapter in the story of how leaves eat.

Carbon dioxide is composed of carbon and oxygen. Carbon in itself is a solid, and oxygen is a gas which is necessary to our lives. We breathe it in with every breath we draw, and without it could not live at all.

Thus, free oxygen is necessary to our lives, while oxygen combined with carbon in the form of carbon dioxide is harmful to them.

Now see what our friends the plants do for us.

They take up the carbon dioxide out of the air and

pull it to pieces. They separate it into carbon and oxygen. They do not care for the oxygen, so they return that to the air for us to breathe.

Thus we have to thank the plants for taking the impure carbon dioxide out of the air and giving pure oxygen back to the air.

Since all animals breathe out carbon dioxide and breathe in and use pure oxygen, a great quantity of impurity is constantly being thrown into the air and a vast amount of oxygen taken from it.

So the plants make animal life possible by keeping the air pure.

But animal life repays the plants by giving them the carbon dioxide they need and without which they would starve.

The plant gets its chief supply of carbon from the carbon dioxide of the air, and carbon is the principal element in the composition of the plant. Most of its hard parts are made of carbon.

So you see the plant has its friend the animal to thank for the food it eats.

Animal could not live without plant, nor plant without animal.

SUMMARY.

1. The plant needs carbon as food; this it gets from the carbon dioxide in the air.

2. The chlorophyll of the plant breaks up the carbon dioxide, takes the carbon, and sets free the oxygen.

3. Carbon dioxide is injurious to animal life, while oxygen is necessary to it.

4. Hence, men and all animals are dependent upon the plant life for the air they breathe, and consequently for their existence.

5. But, on the other hand, animals breathe out carbon dioxide, which the plant needs as food.

6. Hence, the plant is dependent upon the animal for its existence.[1]

Since nearly all of the hard part of the plant is made of carbon, the leaves have to work very hard to supply it.

The plant cannot use pure carbon. It combines the carbon with hydrogen and oxygen to form starch and other substances. But, curiously enough, it cannot use the oxygen it separates from the carbon dioxide. *That* it sends back to the air, and takes water which the roots have sucked up and breaks it up into hydrogen and oxygen, for water is composed of hydrogen and oxygen.

The plant makes over the starch into stems and leaves and wood and bark.

It needs a few other things, such as potash, soda, magnesia, silica, and iron, which it gets from the earth through its roots, but it is largely

[1] See Flowers and their Friends: "Skin Cells, Chlorophyll." This subject furnishes fine material for composition.

made from the materials it finds in the air and in water.

The animal cannot feed upon earth and air and water. Only the plant can do that. So in order to get food the animal eats the plant. If it were not for the plant the animal world would die of starvation.

So man is dependent upon the plant for food also. He eats the plant itself, or else he eats animals which have obtained their food from the vegetable kingdom.

Leaves breathe as well as eat for the plant.

The chlorophyll is not necessary to the breathing power of the plant.

It breathes by means of any and every part of its living structure.

It takes in the air from all living parts of its surface, uses the oxygen and gives out the carbon dioxide, just as we do when we take air into our lungs and give it out again.

Thus two processes are always going on in a living plant, — eating and breathing. The green part of the plant eats, and so destroys carbon dioxide. It uses the carbon and returns the oxygen to the air. Other tissues in the plant take up oxygen and give out carbon dioxide. These contradictory processes are going on side by side all the time.

If the plant breathes out carbon dioxide the same as animals do, why does it not make the air impure?

In so far as it breathes out carbon dioxide, it *does* make the air impure. But the quantity of carbon dioxide it eats is so much greater than the amount it breathes out that the result on the whole is to purify the air.

SUMMARY.

1. Eating
   - The plant takes in carbon dioxide.
   - Uses the carbon.
   - Gives off the oxygen.
2. Breathing
   - The plant takes in oxygen from the air.
   - Gives off carbon dioxide.
3. The plant also gives off water and other wastes.

Excellent composition material resides in the subjects just treated.[1]

[1] See Flowers and their Friends.

NAMES OF THE PARTS OF THE BLADE.

DRAW a picture of a morning-glory or bindweed leaf.

In order to talk about the different parts of our leaf blade, it will be convenient to name them. Let us call the part next the petiole the "base" of the leaf.

The base of the morning-glory leaf is cordate. The bindweed leaf is halberd-shaped.

The point of the leaf opposite the petiole is the "apex."

The apex of the morning-glory leaf is sharp or pointed, and so we call it "acute."

The apex of the bindweed leaf is long, pointed, and tapering. It is a sort of long-acute apex, so we call it "acuminate."

The edge of our leaf we will call its "margin."

Look at the margin of the morning-glory or bindweed leaf and see if itis toothed or cut or jagged; if not, if it is smooth and unbroken, we will say it is an "entire" margin.

SUMMARY.

1. Base : Halberd-shaped, hastate, or cordate.
2. Apex : Acuminate, acute.
3. Margin : Entire.

We see how the leaves of closely related plants take different forms. Sometimes we find different forms of leaves on the same plant. In our bindweed we remember the two leaf-like bracts that covered the calyx. These are leaves changed in form in order the better to do their work. Such a small changed leaf is called a "bract," and this particular kind of bindweed — there are several kinds — which bears bracts to protect the seed-pod is called the "bracted bindweed." When we want to be very accurate in speaking of our bindweed, we must call it the bracted bindweed.

Is the leaf the same color on both sides?

It is much darker on the upper side.

This is probably because the sun shines more directly upon it and makes its green matter (chlorophyll) more active.

The leaf has a very fine down on both sides. This can be seen by holding it to the light and looking across it. This down would help protect it from cold, just as the animal is protected by its

coat of fur or hair. It also protects it from too great evaporation. The water cannot escape so readily from the interior of the plant through this coating of hairs. It also keeps the leaf from getting wet by rain or dew, and so having its breathing pores stopped up.

SUMMARY.

1. Color of the leaf.
2. Covering of down.

Composition work.

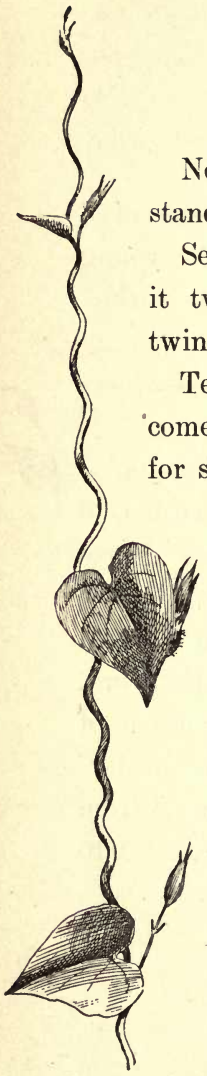
VERNATION.

HAVE the pupils look at the growing end of a morning-glory or bindweed vine. Find the young leaves which have not yet opened. See how they are folded together.

They are folded along the mid-rib with the faces of the two halves touching each other.

The young leaves are very tender. Being folded close in this way is a protection against both cold and heat, and also prevents the water from evaporating too rapidly from the tender tissues.

The way the leaves are folded in the bud is called their "vernation." "Vernation" is a Latin word, meaning "renewing of youth." The vernation of the morning-glory and bindweed is "conduplicate," which means "doubled" or "folded together," from the Latin *con*, "together," and *duplicare*, "to double."



THE PLANT STEM.

NOTICE how weak and slender it is. It cannot stand alone. But it can twine about a support.

See if you can determine in which direction it twines. Why do you suppose it always twines from left to right?

Tell the children how, almost as soon as it comes out of the seed, the plant begins to look for something to hold to.

How does it do this?

The slender tip of the vine moves about in a circle from left to right. It keeps on moving in a wider circle as long as it can stand up or until it touches something it can twine about. If it cannot find anything it lies down on the ground, but its growing tip stands up and keeps on circling about. It will grow quite long sometimes before it finally reaches a support. When it does, up it goes, twining around and around, and always from left to right. Look at the growing vines and see how they have found their support. Trace a

vine back to its root. You will have to go several yards sometimes to find the root end of a bindweed.

The bindweed often twines about the weeds in its way and binds them closely together, and for this reason it has received its name.

Encourage the older pupils to watch the tip of a growing vine out of school and note the rapidity with which it turns about its support. It takes too long to do this in class, and, of course, where the plants have to be studied in the schoolroom, it is impossible —except in the case of living plants in window boxes.

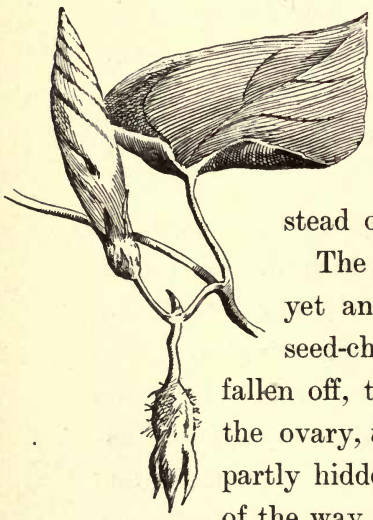
Both bindweed and morning-glory belong to the Convolvulus family, and this family gets its name from the twining habit of the stems of its members, "convolvulus" coming from the Latin word *convolvere*, meaning "to roll around."

The stem of the plant is a very important part. It contains the channels through which the sap passes, and also the long, strong, woody fibres that give stiffness and strength to the whole structure. The petiole is but a branch of the stem; fibres of delicate wood run from the stem into the petiole; from that they pass on into the blade, where they branch and branch again to form the framework of the leaf. This framework, as we know, is filled in with a softer tissue, the parenchyma, which, among other things,

contains the chlorophyll grains. So we may look upon a leaf as a part of the stem which has undergone certain changes.

The vine knows how to twine and look for a support. The petiole also knows how to turn about. We have seen it turn to bring the leaf blade up to the light and air.

The peduncle, like the petiole, is also a branch from the stem. In some morning-glories it bears a pair of diminutive transformed leaves, or bracts. It, too, knows how to turn so as to bring the flower out into the sunlight, where the insects can see it. It always stands, too, so as to hold the open mouth of the flower a little to one side instead of holding it up to the sky.



The morning-glory peduncle makes yet another turn for the sake of the seed-children. After the corolla has fallen off, the peduncle, which still bears the ovary, *turns down* so that the seeds are partly hidden under the leaves and are out of the way. So we see how even the stem does something to help care for the seed-children.

Draw and write.

THE ROOT.

THE best time to procure the root is after the plant has been withered by frost. Its work as a plant is done. It has matured the seed so that new plants for next season are provided for, and now that the winter is at hand the plant fades and changes.

Emphasize the fact that it *changes*. Do not say it *dies*. Tell the children how the material in the plant undergoes changes; that the morning-glory vine will soon disappear, but it is not lost, and it has not stopped being useful. All the good materials that made the vine will soon alter their form; some of them will escape into the air in the form of gases, and some will sink into the earth in the form of rich juices and minerals. All these things, gases, minerals, and juices, will finally find their way into new plants and help make them. If some plants did not change in this way there could be no new plants growing. The new plants need the materials of the old ones.

So our morning-glory grows, bears seeds, changes into gases, minerals, and fluids, and becomes a part

of some other plant. Perhaps part of the mother vine goes to help its own seeds grow next year.[1] Plants that grow from the seed, bear fruit, and disappear all in one season are called "annuals"; that means yearly plants. They come up from the seed anew each year.

If the root of the bindweed is studied, the underground portion of the plant will be found to run a long distance, as though it were an underground stem, which is what it really is.

Examine this underground portion. See that the long, slender stem is divided into *nodes*. There are no leaves at the nodes, only small, undeveloped buds. The color of this long underground portion is white instead of green. It is in reality an underground stem. You know it is a stem because it has nodes. The roots grow out of this stem. They are small and have tiny branches. You can see them scattered along the underground stem.

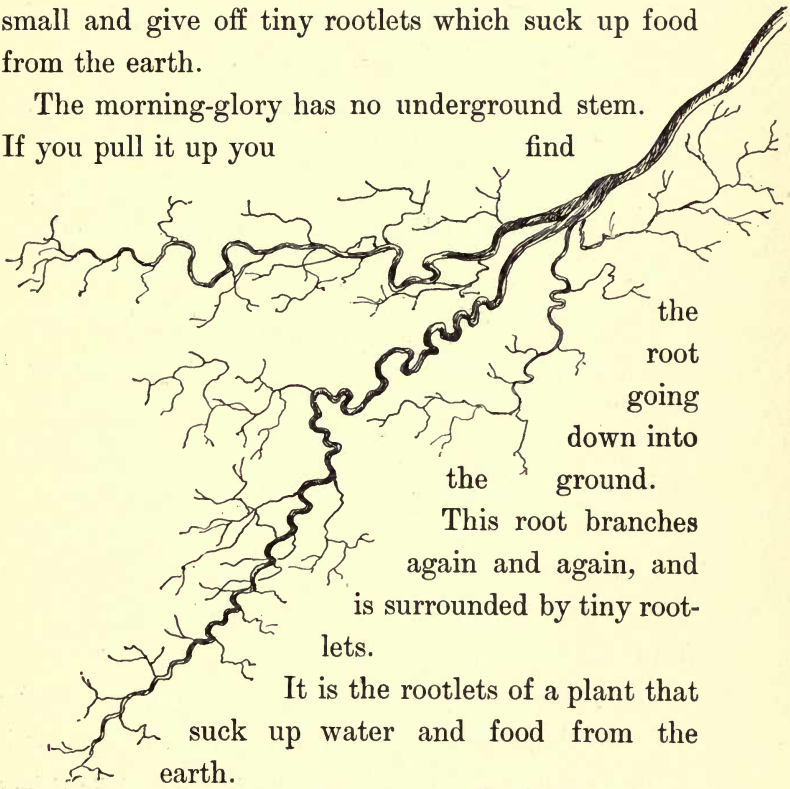
[1] See Flowers and their Friends: "What becomes of the Flowers?"

Thus we see that roots *sometimes* grow out of stems.

Underground stems are not green because the sun cannot get to them.

The roots usually start from the nodes. They are small and give off tiny rootlets which suck up food from the earth.

The morning-glory has no underground stem. If you pull it up you find the root going down into the ground.



This root branches again and again, and is surrounded by tiny rootlets.

It is the rootlets of a plant that suck up water and food from the earth.

The main part of the root or underground stem does not suck up nourishment at all. It is a support

for the rootlets, a storehouse for food materials, and an anchor to the plant.

The roots have to be strong and firmly fastened in the earth, or the plant would be blown away or torn up by passing animals. The main roots anchor the plant and keep it in one place, so the rootlets can have quiet to do their work in.

The little rootlets do all the underground eating for the plant.[1]

The roots of our two plants look like threads or "fibres," and for this reason are called "fibrous" roots.

The rootlets suck up water, and the older pupils will remember that water contains hydrogen and oxygen which the plant separates, joining the hydrogen and oxygen to the carbon the leaves take in, and thus forming starch.

Starch, as we know, is a combination of hydrogen, oxygen, and carbon. The hydrogen and oxygen come from the water by way of the roots, the carbon from the air by way of the leaves.

The leaves do not, as a rule, absorb water. The roots do that. So it is better to moisten the earth around our plants than to pour the water over the leaves, though it is good to do both.

[1] See Flowers and their Friends: "Root Cells."

Moisture is given off by the leaves, although they do not usually take it in. If the leaves are wet and the air about them moist, they do not part with their moisture so readily.

So wetting the leaves of a plant keeps it fresh because it prevents the leaves from parting with their moisture.

Evaporation takes place slowly in moist air.

On a hot, dry day leaves often wilt and hang down because they have parted with so much moisture.

Evaporation takes place rapidly in dry air, particularly if the air is also warm.

All parts of the morning-glory and bindweed plants contain a milky juice which has a bitter taste.

Is this to prevent its being eaten by insects and animals?

Draw the roots and underground stems, and write about them.

FRUITS.

WATCH the ovary after the corolla has fallen. Draw it.

Notice how it enlarges and how the calyx persists.

Find the seed-pods in several different stages, from the little green body left when the corolla falls, to the ripe seed-case. Draw them.

In the bindweed the two bracts that cover the lower end of the flower and the calyx turn brown and look dead and withered. You have to look closely to find the seed-pods at all.

In the morning-glory the pods turn down after the corolla falls. Sometimes there are three or four pods in a cluster, where the flowers have bloomed one after the other. These turn down out of the way, and are not as obscure as those of the bindweed. You can readily see their clean-cut outlines with the calyx lobes standing out from them. As they ripen the calyx lobes turn back and expose the smooth brown pod.

BINDWEED.

This pod with its seeds is the "fruit" of the plant.

The developed ovary of any plant is its "fruit."

Children think only of apples and pears and other edible and juicy seed-cases as fruits. *The seed-bearing part of a plant is a fruit, no matter what its shape or consistency.*

MORNING-GLORY.

The morning-glory fruit splits open, the outer case falls off and lets out the black seeds.

There remain on the vine the inner partitions to the ovary. They divided the fruit into three or more little rooms. There were one or two seeds in each room.

Because the fruit contains several rooms or cells, we know it is compound.

The fruit of a morning-glory is a "pod."

The splitting open of the pod is its "dehiscence." "Dehiscence," we remember, comes from *dehiscere*, "to gape."

Any dry, dehiscent fruit is called a pod.

The seeds are shaped like the "quarters" of an orange, so that they may fit into the space. The partitions between the cells of the ovary are transparent. One can look through them as though they were little windows.

The seeds are shaped like little wedges. They are

the shape that best enables them to fill up *all* the space in the ovary.

There is a little mark at one end where they grew to the ovary cell.

One division of an ovary is often called a "carpel." So our morning-glory fruit has three carpels.

When the fruits are thoroughly ripe they split open, or dehisce, in three places, the outside falls off, and the seed-children fall to the ground, where they lie all winter, kept warm and safe under the dead leaves that cover the ground.

Draw the fruits and seeds, and write about them.

The children should gather a quantity of seeds and put them away in boxes or bottles with labels, for winter use.

While thus concentrating the attention upon one flower and becoming acquainted with its life and structure, it is not necessary to ignore all other flowers. The children will bring other flowers to school, will notice them in their walks, and will ask about them.

Encourage this interest as much as possible.

Be interested in the corollas and stamens and pistils of all the flowers the children bring. Wonder with them about the coming of the insect, and try

to discover where it finds the honey. But do not let this interfere with the regular work of the class.

Keep to one plant until as much has been learned about it as circumstances permit.

In giving technical terms explain the literal meaning of the words as far as the children are able to comprehend.

The older pupils will be interested in the Latin words and prefixes from which the technical words are derived.

As much attention as possible should be paid to the meaning and the right use of words.

Train the child to speak and write with accuracy concerning the things he sees.

This does not mean that he is to be confined to conventional methods of expression.

Encourage him to tell about the plants in his own words, and to use such words as best express exactly what he means.

Nature study should be one of the best aids to language work. It can be used as nothing else can to develop accuracy, freedom, and beauty of expression.

A good unabridged dictionary is indispensable to every schoolroom. The teacher should consult the dictionary for the meaning of every word, technical

or otherwise, with which she is not familiar. She should implant in the older pupils a genuine love for the dictionary!

The teacher and her pupils will constantly discover new and interesting things about the flowers studied, which will not be mentioned in this or any other book. The beauty of this work is that it never comes to an end. New vistas are always opening.

No one knows all there is to know about even our little morning-glory.

There is opportunity for every one to make discoveries.

Life, too, is constantly changing. The details which are true of morning-glories in Rhode Island may not be true of morning-glories in Illinois — nor of Rhode Island morning-glories at some future time.

So the teacher must not be discouraged if her morning-glories are not exactly like those described in flower, leaf, stem, root, or seed; and she must not try to make her specimen fit into anybody's description. Let her frankly say, "My plant is not like that," and accept it the way it is.

What the teacher herself discovers in plant life is just as true and just as good as what the books say.

Each teacher should be at heart an original investigator.

As many schools are not equipped with magnifying glasses, only such facts as can be discovered from simply watching the plant have been used.

A vast amount of valuable information can be gleaned from the plant world by means of the instruments with which nature has provided every one.

Having studied one plant carefully and somewhat in detail, the same general plan may be followed for any plant.

A GENERAL PLAN OF WORK FOR ANY FLOWERING PLANT.

In blooming plants the bright flower is the first thing one naturally notices. Therefore it is a good plan to begin with that.

1. Notice the conspicuousness of the flower, conspicuous generally from *color* and *position*. It wants to be seen.

2. The visit of the insect comes next in order. It sees the flower and goes to it. Why does it visit the flower? Most people know it goes for honey. Find the nectar and the nectary, if there are any.

3. How do the shape and color of the corolla favor the insect's visit? This leads to a preliminary study of petals and sepals and their markings.

4. The insect goes for something besides nectar. Notice the fine flour, or pollen. This leads to the study of the stamens.

5. Examine flowers that are fully opened or that have withered on the plant, and also that which is left after the flower falls. This leads to the study of the pistil.

6. Reconsider stamens, petals, sepals, in relation to the pistil.

In studying the leaf notice:

1. The general arrangement of leaves with regard to each other.

2. The value of the petiole in holding and keeping the leaf in the right position.

3. Shape of leaf and influence this has upon its position in regard to other leaves.

4. Position of leaf on stem.

5. Venation.

6. Work done by leaves.

7. Vernation.

In studying the plant stem consider:

1. The work done by the stem and its adaptability to this work.

2. Any peculiarity in color, shape, or in its covering of down, hairs, etc.

In studying the root consider:

1. Its size and shape in regard to the work it has to do.

2. Any peculiarities which it may show.

In studying the fruit consider:

1. Form, structure, and position of fruit as related to the development of seeds.

2. Seed-coverings.

3. Dehiscence or other methods of freeing seeds.

In this way the different parts of the plant become infinitely better known than if they were merely pulled to pieces and the different organs labeled.

Each organ is seen to have a distinct duty to perform in the interest of the plant. There are order and reason in the structure of the flower and in every part of the plant. Everything in it means something.

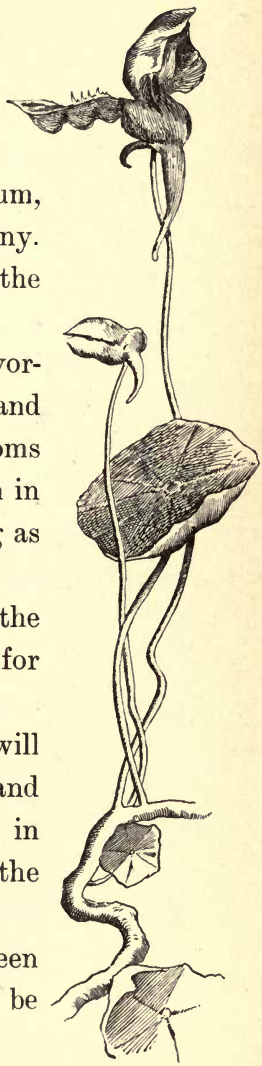
There has been a foundation laid for intelligent interest in the scientific discoveries and problems of the day.

Even the little child can understand the vital facts of plant life, a knowledge of which is the result of modern scientific investigation.

Treat flower, leaf, stem, and fruit alike from the point of view of function. Everything is the way it is because of the work it has to do.

Set the child to inquiring of everything in nature why it is as it is. What is the meaning of the different forms living things assume?

THE NASTURTIUM.



Our next plant is the garden nasturtium, or *Tropæolum*, as it is called in the botany.

It may not be possible for all to get the morning-glory.

The nasturtium has become such a favorite it can be obtained almost anywhere, and is easy to raise as a house plant. It blooms until the coming of frost, and if grown in boxes can be taken in and kept as long as necessary.

If the seeds are planted early in the winter the plants can be in bloom for spring work.

In this case the bee and its work will have to be described by the teacher and imagined by the children, as it will be in any case where the work is done in the house.

Where the morning-glory has been studied first, the nasturtium should be compared with it at every step.

This will make a good deal of the work on the nasturtium merely a rapid review, as many essentials are alike in all flowers, and thoroughly to know one is to know a good deal about all.

The nasturtium will be treated, as a rule, as though the morning-glory had already been studied.

Where it has not been, it will be advisable for the teacher to read the chapters on the morning-glory, so that she may use the same method in knowing and naming the organs of the nasturtium.

For the sake of brevity, the word "morning-glory" will be used, meaning both morning-glory proper and bindweed, unless reference should be made to differences between the two, when the one meant will be designated.

GENERAL APPEARANCE OF THE FLOWER.

SUPPOSE the teacher to stand before the bed of nasturtiums with the children about her.

They have come to look at the flowers, but are not to pick them.

The teacher questions, as in the morning-glory, about the appearance of the flowers.

It is decided that they can be seen a long way off because they are so large and bright, and because they stand up on long stems.

Teacher: "Do they *all* stand up away from the leaves?"

Kate: "No, but they are so bright you can see them under the leaves."

John: "The leaves are not so very thick. You can see between them."

Teacher: "What other flower do we know about that stands up so as to be easily seen?"

Children: "The morning-glory."

Ned: "This is brighter than the morning-glory."

John: "It does n't stand out so far, I think."

Nellie: "It does n't need to. You can see it easier, it is so red."

Teacher: "Why do you suppose it is so bright?"

[This question will not be asked here if the morning-glory has not been studied. See chapter on Morning-Glory.]

Kate: "It is bright because it wants the bees to see it and come."

Teacher: "Do the bees come?"

Ned: "Yes, here 's one in my flower."

Teacher: "Is it a big bee or a little one?"

Kate: "It 's a big bumblebee."

Teacher: "Watch it, and see where it goes."

John: "It has gone clear in as far as it could crowd."

Teacher: "What do you suppose it is after?"

Children: "Nectar."

Teacher: "Let us see if we can find where the nectar is kept."

John: "There is a round hole way back in my flower."

Teacher: "Put a toothpick gently in and see where it goes."

John: "It goes down into that long horn at the back of the flower."

Teacher: "Now take it out and look at the point."

John: "It is quite wet."

Teacher: "Taste it."

John: "It is sweet."

Teacher: "What, then, do you think it is?"

John: "I think it is nectar."

Teacher: "How does it compare in quantity with the nectar of the morning-glory?"

Nellie: "There is a great deal more."

Teacher: "What is the long horn?"

Jennie: "It is the nectary."

Teacher: "What a cunning place to store the nectar!"

Nellie: "It is like a cornucopia."

Teacher: "'Cornucopia' means 'horn of plenty,' so I think that a pretty good name for it. Sometime we will read the story of the cornucopia.[1] Where do we see cornucopias, James?"

James: "On the Christmas tree, full of candy."

Nellie: "The flower is the bee's Christmas tree."

Teacher: "The cornucopia on our flower is called a 'spur,' because it sticks out like the spur on a horseman's heel or on the leg of a rooster. I do not think that is as pretty a name as cornucopia."

John: "Let us call it cornucopia."

Teacher: "So you may; only let us sometimes say 'spur,' so we may not forget that is also its name."

[1] See Flowers and their Friends: "The Tropæolum."

Teacher: "How many openings are there to the nectary of the nasturtium?"

Kate: "Only one."

Teacher: "Who remembers how many the morning-glory has?"

Children: "It has five."

May: "I think I know why the nasturtium has so much more nectar. It is because it is all in one place. In the morning-glory it is in five places."

Let the children try to draw the flower. Also have them write about it, or, if they cannot write, have them tell the story of the flower over and over.

Take as much time as is necessary to make the work easy and pleasant; do not crowd too much into one lesson. Have a separate writing book for the plant study. [See Morning-Glory chapter.]

SUMMARY.

1. The bright and conspicuously placed flower.
2. Its general shape.
3. Entrance of the bee.
4. Finding of the nectar.
5. The nectary, its position, shape, and opening.

THE COROLLA.

REVIEW previous lessons. As a rule, the review should precede each new lesson. The necessity for constant review cannot be too strongly insisted upon.

The review naturally grows briefer as time goes on, until only the principal facts are mentioned.

Have the review sometimes given in the form of a story. Spare no pains to make the children *love* the work. Let one child tell all he can about the flower cup, another about the bee, etc.

After the review let the teacher ask the children if they like to look at the flower, and why.

They will say they do, because it is pretty, bright, like sunshine, etc.

Ask them to smell of it. It smells sweet.

How do the bees find the flowers?

They see them because of their bright color, and probably they smell them as well.

Teacher: "Watch a bee go into the flower. See what a fine little room it makes for Madam Bee. Look at the roof of this flower house; of how many pieces is it made?"

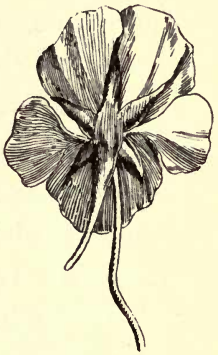
Tom: "It is made of two pieces."

Teacher: "Shall I tell you what these pieces are called? They are called 'petals.' How many petals make the floor?"

John: "Three."

Kate: "One, and the other two make the sides."

Teacher: "How many petals are there altogether?"



Children: "There are five."

Nellie: "There are five big ones. There are some little ones between the big ones."

Teacher: "Turn the flower around and look at the back of it. You see what you call the little petals are on the outside."

John: "They cover the cracks between the petals."

Teacher: "So they do. Look at this bud, John. What do the outside parts do for it?"

John: "They cover it all up. You can just see the end of the flower sticking out."

Teacher: "Who remembers what this outside covering to the morning-glory bud is called?"

Children: "The calyx."

Teacher: "What is the difference between this and the morning-glory calyx?"

[The children will remember that that was green, and see that this is colored a little like the flower. Also that this is larger than that, and not so regular in shape.

They will also notice that, like the morning-glory calyx, it has five sepals.

The nasturtium calyx is large and bright to help the petals make the flower showy.

But, like the morning-glory calyx, it is less delicate than the corolla. It is tough and strong to protect the corolla.

The teacher now asks what they will call the bright part of the flower as a whole.

They tell her the corolla, and that "corolla" means "little garland," or "crown."]

Teacher: "Is the corolla all grown into one piece here?"

Children: "No, it is separated into five petals."

Because it has several distinct petals this corolla is said to be "polypetalous." "Poly-" means "many," so "polypetalous" literally means "many petals."

Does this polypetalous flower make as good a place for the bee as the morning-glory?

Almost as good, because the petals overlap and are stiff, and so make a sort of cup for the bee to go into.

If the morning-glory has been studied, ask if its corolla is divided into several petals. It is not. All of the corolla is grown together into a tube. Such a corolla is said to be "gamopetalous," because "gamo-" means "union," and there is here a close union of the corolla into one piece, with no separate petals.

What do both calyx and corolla do for the flower? They protect the tender essential organs, and they make the flower conspicuous.

They are the floral envelopes. They may also be called the perianth.

SUMMARY.

1. Flowers fragrant to attract bees.
2. Corolla composed of petals; terms, polypetalous and gamopetalous.
3. Colored calyx.
4. Floral envelopes, or perianth.

Do not forget to have as much writing and drawing in connection with the flower study as possible.

If the children have studied the morning-glory, or are old enough to do so intelligently, have them form a schedule of the flower parts at this point.

Floral envelopes, or perianth { calyx — sepals. / corolla — petals.

SHAPE AND COLOR OF THE PETALS.

ARE the petals all the same shape? It will readily be noticed that the two upper ones are broader, and the three lower ones have long, slender stems.

We call the stem of a petal a "claw."

Let us see how the two upper petals come to make such a fine tight roof.

The children will notice that their edges overlap, the petals are so broad. But back in the flower the claws are slender, and there would be a crack between them if it were not for the topmost sepal. This covers up the crack. The two side sepals bring the roof well down at the sides.

The two upper petals grow fast to the sepals.

The rain cannot come through this roof.

The flower does not like the rain to get inside, for it mixes with the nectar and wets and spoils the pollen.

If the flower grew upside down the rain could easily come in. There are openings in the floor. It

is not necessary for the floor to be tight enough to keep out rain.

The petals grow between the sepals. They are therefore "alternate" with them.

The three lower petals have a sort of fringe on the claw and on the petal where it joins the claw. This fringe is called a "beard."

Of what use is this beard to the flower?

It might help keep out the rain, and it might prevent ants and other small insects from crawling in and stealing the nectar.

The flower likes the bees to come, but does not like the ants.

Some child will probably suggest that that is why the lower petals have such slender claws. It would not be easy for a small insect to walk in. It would be likely to get in the cracks of the floor.

Notice how the flower stands.

Does the opening into the corolla look up to the sky or to one side?

The flower is so attached to the peduncle that the opening looks out to one side. The roof is above. In this way the stamens are protected from the rain.

Recall a similar position in the morning-glory

flower. The corolla is not held with the opening looking straight up to the sky. We remember it was turned a little to one side.

Draw the flower in its proper attitude.

Are the nasturtium petals all colored alike?

The upper ones have brighter spots of color and they have brown lines.

These brown lines run into the honey spur, or nectary.

They guide the bees to the nectar. What other nectar guides have we seen?

The white (or colored) paths in the morning-glory are nectar guides, or pathfinders.

SUMMARY.

1. Shape and position of petals.
2. Claw.
3. Nectar guides.

THE CALYX.

Teacher: "Look at the calyx and tell me how many sepals it has, John."

John: "It has five sepals."

Teacher: "Are they separate or grown together?"

John: "They are separate."

Kate: "I think they are grown together."

Nellie: "They are separate at the ends and grown together at the bottom."

Teacher: "Is Nellie right about this?"

[The children examine carefully, and decide that she is right. At the bottom the sepals are all grown into one.]

Teacher: "What do we call the morning-glory corolla because it has no separate petals, John?"

John: "We call it gamopetalous."

Teacher: "What shall we call the calyx when the sepals are grown together into a single piece?"

John: "We might call it gamosepalous."

Teacher: "That is right. We call our calyx gamosepalous if the sepals are grown together ever so little, so as to make the lower part of the calyx one. If the sepals were all separate, what should we call the calyx?"

John: "Polysepalous."

Teacher: "That is right. What kind of a calyx has the morning-glory?"

Nellie: "It has a polysepalous calyx."

Teacher: "Good. Now look at the spur. What part of the flower makes the spur?"

Fred: "I think it is the calyx."

Teacher: "How does the calyx make a spur?"

Fred: "Some of the sepals are grown together to make it."

Teacher: "Which sepals have grown together to make the spur?"

George: "The three upper ones have."

Teacher: "Are there any color lines on the calyx?"

Fred: "Yes, on the upper sepals. They finish out the nectar guides of the petals."

Teacher: "What other part of the flower do the sepals resemble?"

May: "They resemble the petals."

Teacher: "What part of the plant do the morning-glory sepals resemble?"

John: "They are like little green leaves."

Teacher: "What are the uses of the sepals to the nasturtium?"

Kate: "They help make it bright."

John: "They help form a roof to keep out rain."

May: "They help make a floor."

Nellie: "They protect the bud."

Write about the calyx.

SUMMARY.

1. Shape, position, and use of sepals.
2. Gamosepalous.
3. Polysepalous.

With the older pupils the teacher may speak of the "cohesion" and "adhesion" of flower parts. If physics has been studied, it will be remembered that like molecules cohere, as, for instance, the molecules in a piece of wood. Unlike molecules when they remain together are said to "adhere," as when two pieces of wood are held together by glue. The glue adheres to the wood. So when different parts of the same flower whorl grow together they are said to "cohere."

When one sepal grows to another sepal, as in the case of the monosepalous calyx, the sepals are said to cohere. If petals grow together they are said to cohere, and so of the parts of any flower whorl.

But if the parts of different flower whorls grow together they are said to adhere. Thus, if petals and sepals grow fast to each other, they are said to adhere, as in the case of the upper petals and sepals of the nasturtium.

In the morning-glory the older pupils found the nectar gland growing about the ovary. In the nasturtium it occupies the tip of the spur, and the nectar flows into and partly fills the roomy spur.

It will interest the older pupils to know why the spur is so long.

Can the bee's tongue reach to the bottom of this long spur?

It cannot. Even the large bumblebee cannot reach clear down. Then why has the flower developed such a nectary?

Usually the flower is constructed to agree with the shape and size of the insects that fertilize it.[1]

No doubt this is true of the nasturtium, and in spite of the frequency with which the large bees are

[1] See Flowers and their Friends: "Tongues and Tubes."

found in it in our gardens, it evidently is not a bee flower.

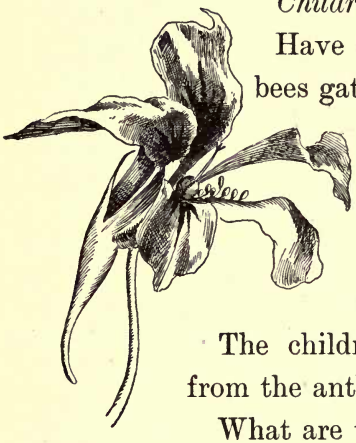
We must remember the nasturtium does not grow of itself in our climate. It is not wild with us. It has been brought from South America, where it no doubt is visited by insects with very long tongues, or else by humming birds, and so has developed a long spur.[1]

Humming birds sometimes visit it here. Their long bills can reach deep into the nectary. But our bumblebees are able to get some of its nectar, and they are very fond of it, being effectual instruments in fertilizing it.

[1] See Flowers and their Friends: "The Tropæolum."

THE STAMENS.

Teacher: "What do you think the bee finds in the flower besides nectar?"



Children: "She finds pollen."

Have the children watch the bees gather the pollen if possible. See them collect a little ball of dark-colored pollen on the hindmost legs.

Where does the bee get the pollen?

The children will say she gets it from the anthers.

What are the anthers a part of?

They are a part of the stamens.

Teacher: "Where in the nasturtium do we find the stamens?"

John: "They are on the floor."

The children will find there are eight of them.

They do not stand up as in the morning-glory.

They lie flat on the floor, but the anthers of some turn up.

Why do they lie flat on the floor?

Evidently so as not to obstruct the opening to the nectary. They also help make a firm floor, or landing-place, for the insect.

See if the anthers are all ripe and shedding their pollen at the same time.

Only part are. Some have not opened yet, others have shed all their pollen, while still others are shedding it.

Have the children discover for themselves that only the ripe anthers stand up. The unripe and overripe lie down out of the way.

Why do the ripe anthers stand up?

In order that when a large insect enters the flower it may brush against them.

When the anther gets ripe it opens, or "dehisces," and sheds its pollen.

The stamens think of each other; they do not wish to get in each other's way, so when they are not shedding pollen they lie down flat out of the way of the nectary, so the bees can come to the ripe stamens.

The teacher tells the children to press the three lower petals down out of the way and look at the stamens carefully.

Teacher: "How many of them seem ripe and fresh and full of pollen?"

Kate: "Only one of mine. Two of them look withered and five have not opened."

John: "One of mine looks fresh. All of the others look withered and lie down."

Teacher: "How many find just one anther full of fresh pollen?"

Several do.

Teacher: "How many find more than one?"

A few do.

Teacher: "How many find *all* the anthers ripe and fresh and covered with pollen?"

Jennie thinks she does, but Lucy shows her how the fresh ones look, then she says hers are all withered.

If the children are old enough, and if there is abundance of material, the ripening of the anthers can be watched for a few days, and the *order* in which the stamens open one at a time can be noticed.

Why do the stamens open one at a time and continue to shed pollen for several days instead of all opening together and finishing their work in a few hours, as is the case with most of our wild flowers?

If the stamens opened all at once the pollen might be injured by a heavy shower, where the water beat in and soaked the anthers. Does the *Tropæolum*,

then, bloom in its native country during a rainy season?

Teacher: "Why are the stamens of the nasturtium on the floor?"

Lucy: "So the bee will have to touch the pollen when she goes in."

Nellie: "It is easy for her to get the pollen."

Teacher: "Is this like morning-glory pollen?"

John: "No, it is red."

Teacher: "Do the bees gather it?"

If the children can watch the flowers out of doors, they will see the bees with the red pollen on their legs and bodies. If not, the teacher will have to tell how they collect it.

If they have seen the bees in the morning-glories, they can tell for themselves.

Have the children look at the filaments of the stamens.

They are short and stiff. They do not stand up straight, but curve so as to bring the anther in the right place. If the children can do so, have them form a schedule of the parts of the stamen.

$$\text{Stamen} \begin{cases} \text{anther} — \text{pollen.} \\ \text{filament.} \end{cases}$$

Have the children spend as much time as possible in drawing the flowers. Also have as much writing

as possible; the nasturtium stamens form a very attractive subject.

SUMMARY.

1. The stamens.
2. Their position, number, method of ripening.

If she pleases, the teacher may here compare the position of the morning-glory stamens with that of the nasturtium stamens.

In both cases the object is the same, — to place the stamens in such a position that the insect cannot reach the nectar without coming in contact with the pollen.

There are five openings to the nectary of the morning-glory, so the stamens stand erect, stacked about the central column; and whichever way the insect enters, it will be likely to touch the circle of anthers.

In the nasturtium there is only *one* opening to the nectary; therefore the stamens are all put in front of that opening and so placed that the insect is obliged to pass over them to reach the nectar.

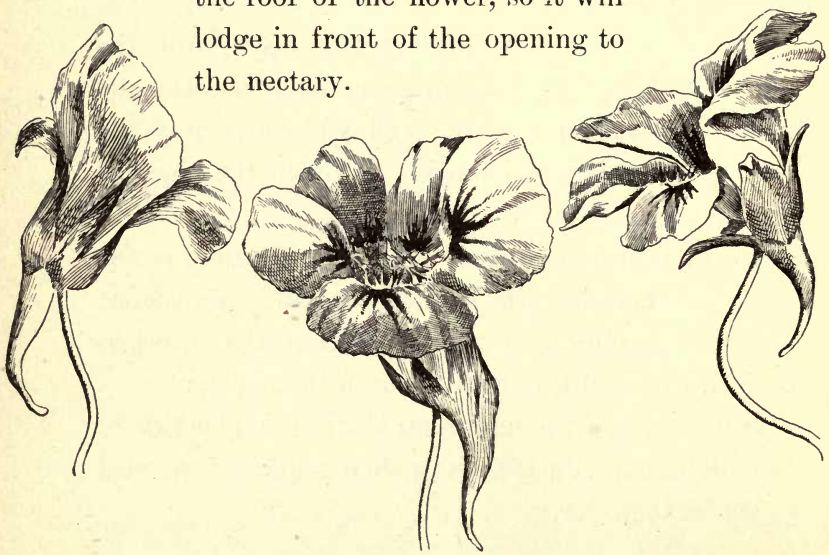
In the case of the humming bird, the under side of the bill becomes dusted with pollen, and this is carried to the next flower.

If it is impossible to go to the growing flowers where the bees have access to them, the flowers may be used in the class room.

The teacher should then have the children place their flowers in water, with the stem supported in just the position the flowers assume when growing—that is, with the open face of the flower directed out instead of up, as in the illustrations, the spur hanging down.

Then the teacher may tell how the bright flowers stand out in the open spaces above or between the leaves, and how the bees come to them.

Then she may tell the children to make believe the little finger is the bee, and to slide it in under the roof of the flower, so it will lodge in front of the opening to the nectary.



Teacher: "Now take out the finger and look at it."

Ned: "Mine is all yellow."

All the children find their fingers yellow.

Teacher: "What do you suppose has made your fingers yellow?"

Kate: "I think it is pollen."

Teacher: "Is it like the morning-glory pollen?"

Tom: "That was white and this is red, but it stains the fingers yellow. It is floury, like the morning-glory pollen."

Teacher: "You are right, it is the pollen."

The teacher now asks the children to tell her what the bee does with the pollen.

If they have studied the morning-glory, they are able to tell her it is the flour of which the bees make beebread, and that they carry it to the hive attached to the hairs of the body or rolled into little balls on the legs.

[See first chapter on the Morning-Glory.]

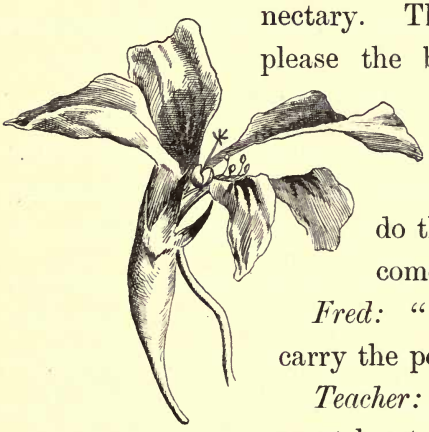
Such a lesson can be made very charming, though of course nothing can take the place of the real bees and the natural growth of the flowers.

Have the older pupils notice that the attachment of anther to filament is *innate*, the same as in the morning-glory.

The anthers have two cells each. These cells open, or dehisce, by a lengthwise slit at the side instead of at the back, as in the morning-glory. The pollen gushes out and lies on the *front* of the anther in the best position to be rubbed off by a passing insect.

THE PISTIL.

LEAD the children to notice how all the stamens bend back so as not to stop up the opening to the nectary. They are anxious to please the bee and make her glad to visit the flower.



Teacher: "Why do they wish the bee to come?"

Fred: "They want her to carry the pollen."

Teacher: "Where do they want her to take it?"

Nellie: "To the little seed-children."

Teacher: "Let us look for the seed-children. What part of the flower holds them, Jack?"

Jack: "The mother part holds them."

Teacher: "What do we call the mother part?"

Frank: "The pistil."

Teacher: "Where is the pistil in our flower?"

Nellie: "There is a green berry in the bottom of my flower with a little white brush growing out of the top."

Tom: "It looks more like an anchor than a brush."

The children should here examine some old and therefore partly faded flowers.

The pistil is large and conspicuous. The style stands up, the three *linear lobes* to the stigma stand apart.

In the newly opened flower it is difficult to see the pistil. The style is small and short, and the stigma lobes lie close together. The stamens quite conceal the pistil. Until the stigma lobes separate and the pistil stands up, the pistil is not ripe, and cannot use the pollen that may fall upon it.

Let the children examine their flowers and discover that the stigma is not open until nearly or quite all of the stamens have shed their pollen, and that meantime the small, half-grown pistil lies down under the stamens.

When the flower is nearly done shedding pollen, the pistil comes up. It grows larger and longer and stands up where the ripe anthers stood in front of the opening to the nectary, and its three lobes are wide open.

No bee could go in without touching it.

The spur is full of honey. There is not much, if any, pollen left, but there is plenty of delicious nectar, and the bees visit it as eagerly as ever.

Why does the stigma wait until the anthers have shed their pollen?

Does it not wish to receive pollen?

It wishes it of all things in the world, for without it its seed-children would perish. But it does not want its own pollen; it wants pollen from another flower. It knows the bee will be dusted with other pollen when she comes to it for nectar, and that going to the nectary she will brush against the now ripe and sticky stigma with its three lobes standing wide apart, and leave some of this pollen upon it.

Like the morning-glory, the nasturtium does not make pollen for its own use. It makes it for the use of its neighbors, the other nasturtiums, and sends it to them by its messengers, the insects and humming birds. It first fills its spur with honey to entice these visitors for the benefit of its neighbors, then makes honey to call the insects with their pollen-dusted bodies to come and give pollen to its pistil.

What happens as soon as the pollen touches the stigma?

The children, if the morning-glory has been studied, will be able to tell how the pollen grain sends down its tube to the ovule,[1] and how, as soon as it has received the gift from the pollen, — or been fertilized, — the ovule begins to develop into a seed.

Tell in connection with this stories of the mother part of the plant and her care of the seed-children.

Do not forget the writing and drawing.[1]

SUMMARY.

1. The pistil is the flower's reason for enticing the bee.

2. The ovary: *a.* The style, short at first, grows longer. *b.* The club-like stigma when ripe opens into three linear lobes.

3. The pistil ripens after the anthers, and when ripe stands up in front of the nectary.

SCHEDULE OF ESSENTIAL ORGANS.

Stamen { anther — pollen.
filament.

Pistil { ovary.
style.
stigma — lobes.

As the petals and stamens fade and expose the ovary, notice that they are attached to the peduncle *below* the ovary. Thus the ovary, like that of the morning-glory, is superior.

[1] See Flowers and their Friends.

Help the older children to understand clearly the meaning of "superior" as applied to the ovary, as it will save them much trouble in their future botany work.

Since the nasturtium is so modified as to make cross-fertilization by means of insect or bird visits almost a necessity, what will happen when the plants are grown in the house, where no insects or humming birds approach them?

A few belated pollen grains may be shaken or blown against the stigma from its own anthers, and so occasionally seeds will set; but for an abundant crop of strong seeds, artificial fertilization will have to be resorted to.

If the children have studied the morning-glory, they will be prepared to understand why the pollen must be put upon the stigmas, and it will be great fun for them to convey the pollen of one plant to the ripe stigma of another upon a pencil point, the end of a toothpick, or by means of a small, clean paint brush. They can play they are the bees.

If they have not studied the morning-glory, when they find the pollen and learn the use the bee makes of it, have them fertilize the plants as above, and tell them the reason for it.

If convenient, a few unfertilized plants may be set

aside, and the results in the two instances watched, those that have been artificially cross-fertilized bearing more seeds than those that have not. The nasturtium does not illustrate this point as clearly as the geranium, as it is more often self-fertilized.

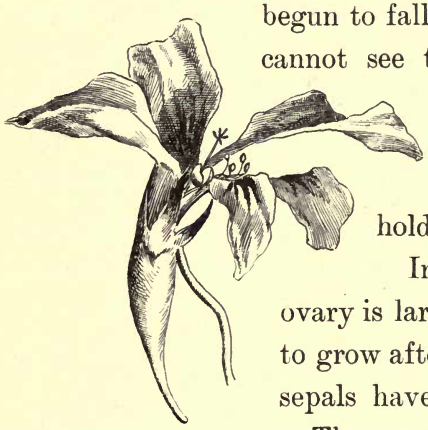
We have now found two ways by which flowers secure cross-fertilization.

In the case of the morning-glory, the structure of the flower was such as to secure it, the stamens standing below the stigma so that the pollen would not naturally come in contact with it.

In the nasturtium, stamens and pistil are close together, and self-fertilization would be inevitable if it were not for the difference in time at which the stámens and pistil mature. The stamens mature first; the flower is therefore said to be "protandrous," or "proterandrous"—"proterandrous" being formed from two Greek words and meaning "before" and "male," that is, the male part of the flower, or the anther, maturing before the pistil.

OVARY AND FRUIT.

If the children can see the growing plants, then look at and make pictures of flowers which have begun to fall to pieces. If they cannot see the growing plants, the teacher must supply such flowers, as well as stems holding each a fruit.



In the old flower the ovary is larger, and it continues to grow after all the petals and sepals have fallen.

The ovary is divided into three parts; it is therefore compound.

The pistil is compound: it has a compound ovary and a three-parted, or compound, stigma.

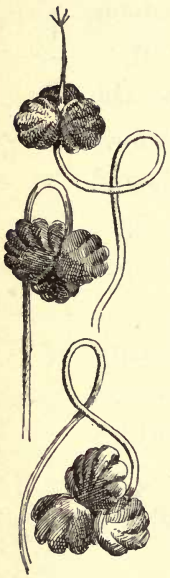
Each division of the ovary is a single cell which contains one seed.

One cell of an ovary or a fruit is often called a "carpel."

"Carpel" comes from a Greek word meaning "fruit."

The fruit is merely the developed ovary. Sometimes the nasturtium fruit has but two carpels, as one fails to develop, and once in a while but one will be matured. Since the carpels of the nasturtium are almost separate from each other and stand apart like lobes, they are sometimes called lobes.

The calyx does not remain to protect the nasturtium ovary, as it does in the morning-glory. It falls when the corolla does; consequently the nasturtium fruit has no covering of sepals.



But the peduncle does its best to care for it. What does the peduncle do for the morning-glory when the flower cup falls?

It turns down, we remember, so as to hold the seeds under the leaves and out of the way.

The nasturtium peduncle does more than this. It *curls up*. Sometimes it makes three or four turns, like a bed spring, and so draws the fruit way down out of sight under the leaves.

It sometimes turns about in a very fantastic way in order to carry the fruit beneath the leaves.

Have the children draw pictures of the fruits and their twisting stems.

This carrying of the fruit below the leaves protects it from being dried up by the sun, and also makes room for other flowers.

If all the fruits stood out as the flowers do, there might not be room enough for the buds to develop. The fruits care for the other flowers and get out of their way.

When the fruit is thoroughly ripe it is brown and looks shriveled. It is smaller than the green fruit. It finally separates from the peduncle and falls to the ground in three parts. The cells separate from each other as well as from the peduncle.

The fruit does not dehisce, so we cannot call it a pod.

SUMMARY.

1. Ovary: Compound, three-celled, one seed in each cell, or carpel, or lobe.
2. Fruit.
3. Twisting of peduncle.

Charming compositions can be written at this stage of the work.

THE LEAF.

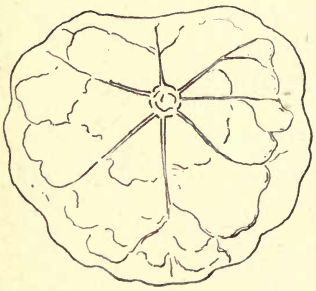
Look down upon a bed of nasturtiums. See how the large leaves form a sort of loose canopy above, while underneath and close to the stems are many little leaves.

The stems of the large outer nasturtium leaves grow very long sometimes, so all the place underneath is lighter and more airy than in the space beneath the morning-glory vine.

Notice that the largest and finest leaves are on top.

The leaves are round like a shield, with the petiole fastened near the middle of the back.

Because of their shape the leaves are called "peltate," from the Latin word *pelta*, a shield.



They are held up like a collection of shields by their long petioles.

The shields are not quite round, and the petiole is not attached directly in the center, but more to one side. For these reasons the

leaf is larger and heavier on one side, and consequently hangs down somewhat instead of standing horizontally. If the leaves were horizontal, there could be but few of them. Standing sidewise as they do, they do not interfere so much with each other.

The petioles of the nasturtium are long and flexible, and the leaves are balanced so as to move easily in the wind.

Draw the nasturtium leaves.

The seeds were brought from South America and planted, and the nasturtiums grow for us. But they have to grow just as they did in their own country — at least at first.

If our climate does not suit them as they are, in course of time they may possibly change to suit the climate.

If the seeds are not gathered in the fall and taken care of, they die.

This country is too cold for them; they cannot lie under the leaves all winter and start to grow in the spring the way the morning-glory seeds do.

We cannot understand the nasturtium as well as we could if we saw it in its own home.

We do not know just what its natural surround-

ings there are, nor how its new surroundings affect the habits of the plant.

SUMMARY.

1. Shape of the leaves ; position.
2. Home of the plant.

THE PETIOLE.

EXAMINE the petiole. It is long and cylindrical, shaped like a pencil, a wire, or a rubber tube.

It curves about a good deal. It brings its leaves to the light.

Some nasturtiums climb by twining the leaf stalks, or petioles, about things the way the morning-glory vine does.

Other nasturtiums seem to have partly lost that habit. The only remains of it are the queer turns and curves it makes with no apparent purpose.

Notice the attachment of the petiole to the vine. One leaf grows from each node. Like the morning-glory, the nasturtium has alternate leaves.

The peduncle starts from the axil of the leaf. Leaf buds also start from some axils.

The petiole of the leaf is not tough like the morning-glory petioles. It is crisp and juicy. Such a stem is called "succulent," from the Latin *succus*, juice.

There is a stinging taste to the juice of the nasturtium.

The morning-glory juice was milky and bitter.

The nasturtium juice is said to be "pungent." "Pungent" comes from a Latin word meaning "to prick." When any part of the nasturtium plant is crushed by the teeth, it causes a prickling sensation in the mouth and at the back of the nose.

The word "nasturtium" itself has reference to its pungent quality.

"Nasturtium" has a very funny meaning. It comes from two Latin words, *nasus tortus*. "Nasus" means "nose," "tortus" means "convulsed," so "nasus tortus" means "convulsed nose."

Whenever we bite a nasturtium we have a "convulsed nose," and this should make us think of what its name means.

SUMMARY.

1. Shape of petiole.
2. Axillary growths.
3. Consistency of petiole.
4. Pungent quality of plant juices.

The nasturtium is a very pretty plant to draw, flowers, leaves, and fruits making good subjects for a sketch.

THE LEAF BLADE.

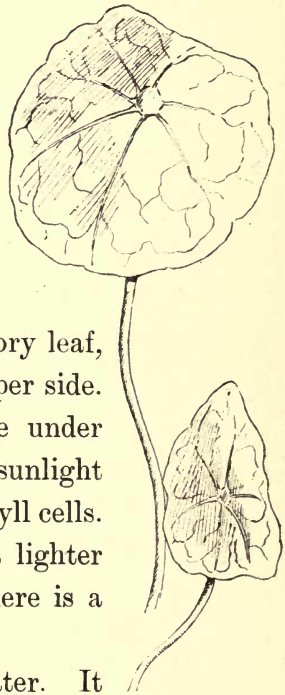
GIVE each child a leaf with a long petiole.

Notice how the veins come out of the petiole and branch about in the leaf blade.

Hold the leaf up to the light and see the network of fine veins.

Draw the leaf.

The venation is palmate and therefore net-veined. It is similar to that of the morning-glory.



Look at the *color* of the leaf. It is lighter green than the morning-glory leaf, and lighter on the under than the upper side.

Leaves are usually lighter on the under side, where they do not get so much sunlight and consequently have fewer chlorophyll cells.

Notice that the nasturtium leaf is lighter in color than most other leaves. There is a good reason for this.

Hold a nasturtium leaf under water. It glitters like a metal leaf on both sides. Take it from the water, it comes out *dry;* the water has not made it wet.

The reason for this is that the nasturtium leaf is covered by a fine coating of wax on both sides. This wax coating protects the stomata, or breathing pores, from the entrance of water from the outside.

The water cannot run into the pores of the leaf. Since both sides of the leaf are coated with wax, you would expect to find stomata on the upper as well as the under side, and this is the case.

Since the leaves are so well protected against moisture, you would expect them to live where they were subject to it. Recall the stamens, opening one at a time, and lingering for several days. Both these facts lead us to surmise that the nasturtium in its native home has to contend with water either in the form of showers or of heavy dew.

The position of the leaf blades on the petiole lead us to suspect the nasturtium lives in a hot climate, as well as one where there is frequent rain or heavy dew. From such facts as these we can often learn many things about the habitat of an *exotic*, as we call plants not native to our country. We must be careful, however, not to come too quickly to a conclusion, as we need to know *all* the reasons for certain structures before we are able to say certainly what they mean in certain cases.

By studying the structure of an exotic and so

finding out what were its conditions in its native country, we can learn what to do for it to make it live with us.

If the children have studied the morning-glory, question them about the use of the ribs, or veins, about the use of the parenchyma and the meaning of the word.

[See lesson on Morning-Glory Leaf.]

Keep vividly before the mind of the child the use, or function, of each part.

SUMMARY.

1. Venation: Palmate veined, net-veined.
2. Color.
3. Appearance under water.

VERNATION.

THE young leaves of the nasturtium are so small that it is difficult to determine how they are folded in the bud. The older pupils, however, can readily distinguish their vernation. The tiny young leaves have both margins rolled in towards the mid-rib, and, small as they are, they enfold a still younger and smaller bud. The tiny leaf flattens out while still close to the plant stem, and as it grows larger the petiole lengthens and brings it out into the open.

In this way it is protected by the older and larger leaves until able to care for itself.

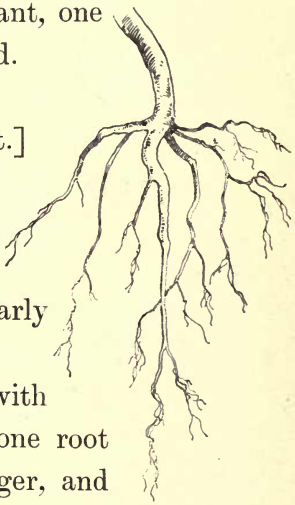
Its mode of vernation is "involute," meaning "to roll in."

THE ROOT.

TAKE up a root when the frost has touched the leaves; or, in the case of a house plant, one of the plants will have to be sacrificed.

Does the plant *die?*

[See lesson on Morning-Glory Root.]



The nasturtium root, it will be observed, is made up of fibres branching in all directions. It is a fibrous root. The rootlets are scattered irregularly over the surface of the roots.

The root is small in comparison with the rest of the plant. Sometimes one root no larger round than a man's finger, and giving off three or four small branches, will supply a plant that covers a bed several feet across.

The plants lie close to the ground, and some hold fast by their leaf stalks, so there is not so much need of a stout, long root to anchor them. Other parts of the plant perform the office of an anchor. On stone walls the stems and leaves twine about and fasten the plant securely.

Sometimes a stem lying on the ground will give out rootlets at the nodes.

In the bindweed were found nodes on the underground part. Here are found roots springing from the stems above ground.

Roots and stems are very closely related.[1]

Draw the roots.

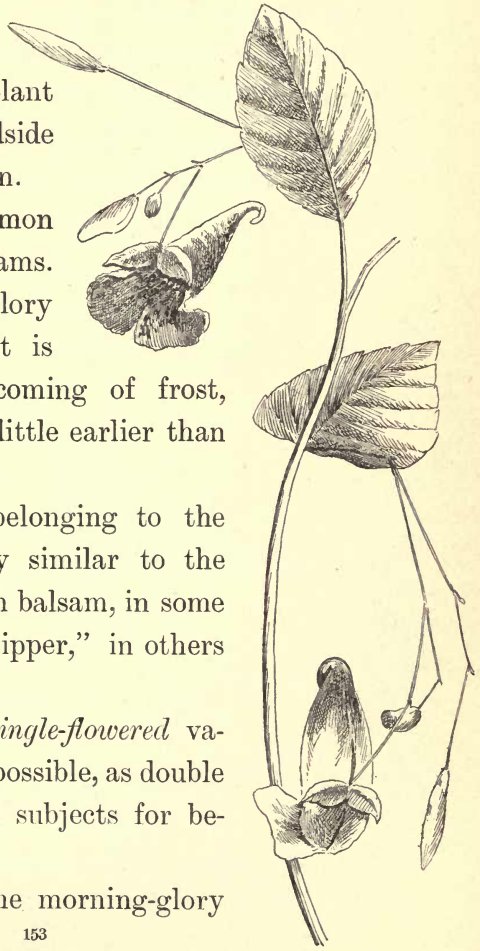
Gather a quantity of ripe seeds and put them away for winter use.

Another name for the nasturtium is *Tropæolum*. It comes from a Greek word meaning "trophy," and is so named because the foliage is supposed to resemble a group of shields.

The nasturtium belongs to the geranium family. It has many points in common with the geranium.

[1] See Flowers and their Friends: "Root Cells."

IMPATIENS, JEWELWEED, TOUCH-ME-NOT, LADY'S EARDROP, BALSAM, SNAPWEED.



SUCH are the various names by which this plant that grows by the roadside in damp places is known.

It is extremely common near brooks or small streams.

Like the morning-glory and the nasturtium, it is obtainable until the coming of frost, though it disappears a little earlier than the others.

A cultivated plant belonging to the same species, and very similar to the jewelweed, is the garden balsam, in some places called "lady's slipper," in others "snappers."

If this is used, the *single-flowered* variety should be taken if possible, as double flowers are never good subjects for beginners.

As in the case of the morning-glory

and nasturtium, go to the growing plant if possible. The wild plant is difficult to transport any distance, as it wilts almost as soon as picked.

Compare this plant at each step with others that have been studied.

Like the nasturtium, the jewelweed belongs to the geranium family, so it will be doubly interesting to compare it with the nasturtium.

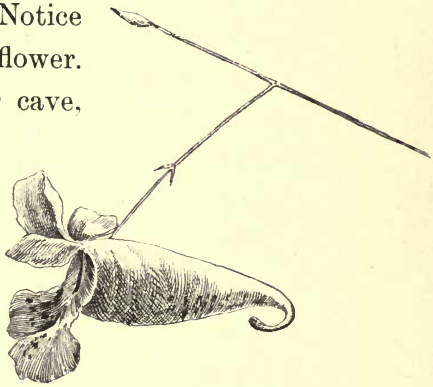
Suppose the teacher to stand by the roadside with the children, beside a mass of jewelweed.

GENERAL APPEARANCE.

As before, notice the bright color of the flowers. They are yellow, some varieties spotted with dark red.

They swing on their slender stems. They are balanced at the very end of the peduncle.

The bees are busy in them.



Watch the bees go in. Notice the size and shape of the flower. It is like a little den or cave, and just large enough for a bumblebee's body to squeeze in.

Teacher: "How do you suppose the bees find the flowers?"

Ned: "They can see them, the flowers are yellow, and there are so many of them."

Nellie: "The flowers hang down under the leaves, but you can see them just as plain!"

Tom: "The leaves are sort of scattering, they are not close together, they do not hide the flowers."

The bright color of the flower is always the most noticeable fact. It is also one of the most important facts in the economy of the flower.

The bright color no doubt attracts insects, and thus secures cross-fertilization to the flower. The relation of insect to flower is one of the most important facts of plant life, as we have already learned.

For this reason the bright color of the flower and the visits of insects deservedly receive much attention and first notice.

As has been said before, *the bright flower is the most conspicuous thing about the plant, and is what every one first notices.*

Hence, have the children talk about it in all their flower-study until they unconsciously unite bright colors with the visits of insects in their thought of flowers.

Watch the bee go into the flower. She goes in as far as she can. She fills the whole flower cavity. A large bee cannot get her hind legs in.

Teacher: "Why does the bee go into the flower?"

Fred: "She goes for nectar and pollen."

Teacher: "Where do you think this flower keeps its nectar?"

John: "It must be far back, the bee crowds so far in."

Jane: "There is a little spur at the back of the flower. It turns down."

John: "The nasturtium keeps its nectar in a spur."

Teacher: "How are we to find out?"

Belle: "Let us make believe the toothpick is a bee and see if it can find the nectar."

Frank: "There is an opening into the spur back in the flower."

Teacher: "You may put the toothpick in the opening and see if it finds honey."

[Frank does so. He turns the toothpick around carefully two or three times. The end is moist and tastes sweet.]

Teacher: "Where is the nectary of the jewelweed, Jane?"

Jane: "It is in the spur."

Teacher: "Why does the flower keep nectar in its spur, Tom?"

Tom: "It wants the bees to come."

Teacher: "How many ways can the bees get to the nectary?"

Fred: "Only one way."

Teacher: "Why does the flower want the bee to come?"

Fred: "It wants it to carry pollen to the stigma."

Teacher: "Why do you suppose the flower has but one opening to the nectary?"

Nellie: "It wants the bee to come just the right way to rub off the pollen onto the stigma."

Teacher: "Where is the pollen?"

[The children are puzzled. There are no stamens to be seen.]

Teacher: "Make believe your finger is a bee. See if it is dusted with pollen when you take it from the flower."

[The children gently press the end of the little finger into the flower cavity. They find white pollen adhering to it.]

Teacher: "In what part of the nasturtium flower were the stamens?"

Ned: "On the floor."

Teacher: "Are there any stamens on this floor?"

[Not a sign of one can be seen. Suddenly somebody discovers what seems to be a large pollen-covered stamen *hanging down from the roof.*]

Teacher: "What part of the bee touches the pollen?"

George: "The *back* of the bee."

Teacher: "What part touched the nasturtium pollen?"

May: "The breast of the bee."

Teacher: "So our jewelweed has planned just the opposite way to get its pollen carried."

Have as much writing and drawing as possible.

SUMMARY.

1. The bright color of the flowers.
2. The bees entering for nectar.
3. The spur.
4. The position of the pollen.

If the children cannot go to the flowers they will have to be supplied, the teacher using every device to make the visit of the bee seem real.

Generally where the flowers are supplied they will be the garden balsam. The whole stalk should be picked and put in water. Give each child a stalk if possible; if not, distribute as many as possible about the room.

The garden balsam flowers are not as simple as the wild flowers. The petals are larger, and more or less obscure the plan of the flower. Still, the single flowers show very well the essential facts. The peculiar appearance and position of the stamens are the same in both.

Humming birds are particularly fond of the jewelweed. Where these flowers bloom in profusion, humming birds will be found. The children will be

delighted to see them poise before the airy, swinging flowers and thrust in their long bills.

If not frightened, the humming birds become very tame, going from flower to flower with the greatest unconcern, although a person may be standing close to them.

If the children cannot see the humming birds, the teacher may tell about them.[1]

The name of the flower should be noticed.

Why is it called "jewelweed"?

It is sometimes called "lady's eardrop."

Probably it has received both names for the same reason. It is like a jewel worn in the ear.

People used to wear earrings a great deal, and often these were in the form of pendants that swung from the ear and looked not unlike this little flower.

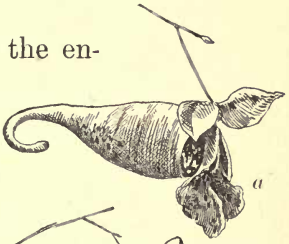
The other names for the jewelweed may be discussed later. All parts of this plant afford charming material for children's compositions.

[1] See Flowers and their Friends: "Jewelweed Stories."

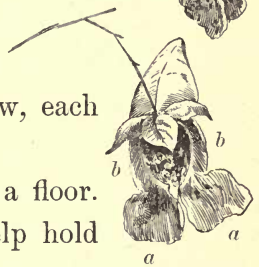
THE COROLLA.

EXAMINE the spotted cave the flower makes for the support of the bee.

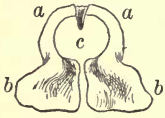
There is a sort of little porch at the entrance to the flower (*a*).



This porch is made of two irregular petals, one on either side. These petals are narrowed above, each forming a blunt claw (*b*), by which they are attached to the peduncle. Below, each forms a broad blade (*a*).



These broad blades meet to form a floor. They are yellow and showy, and help hold up the bee.

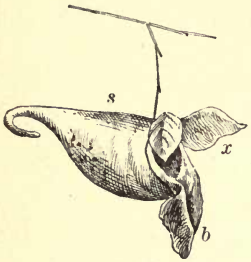


The opening (*c*) between the claws of these petals is only large enough to admit the body of a good-sized bee.

Look at a bud and see how the two petals are all covered and protected by the other parts of the flower. These other parts are the *sepals*, although they too are yellow. Recall the fact that the nasturtium sepals were yellow.

Let us look at these sepals.

Over the porch made by the petals (*b*) is a hood, or roof (*x*).

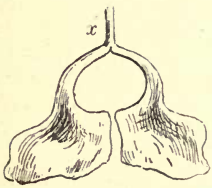


It is one sepal, though it looks like two grown together, which is probably just what it is. Back of the porch made by the petals is a sac (*s*), or the children may call it a little cave. This is a sepal which has grown into this strange form.

It and the porch together make the snug cave into which the bee crowds to get the nectar, which is in a little spur at the farther end of the sac. In fact the sac may be likened to a large spur with a tapering end.

How is the spur of the nasturtium formed?

It is formed by the sepals growing together.

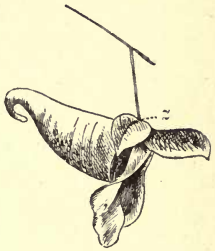


This spur is also formed by a sepal.

The claws of the petals join together on top (*x*) where they are attached to the receptacle.

The sepal which forms the cave is also attached to the receptacle at the same place. It is attached by the upper front edge of its roof. The sepal which forms the roof of the porch is also attached at the same place.

Over the back of the porch roof, just where it joins the cave, or sac (*z*), are two more sepals. They are arranged like tiles on a roof, over the space between the sepals that form the porch roof and the sac at the back.



So there are four sepals and but two petals to this odd flower.

Since the sepals and petals are so alike in color and function that they cannot be distinguished as sepals and petals by the beginner, the term "perianth" is a very convenient term to use in reference to the floral envelopes of the jewelweed.

[If this is the first flower studied, read chapters on Morning-Glory and Nasturtium for hints upon obtaining knowledge of flower parts.]

Is the flower gamopetalous or polypetalous?

It is polypetalous, as the two petals are distinct.

It is also polysepalous, as each of the four sepals is distinct.

Sepals and petals are very much alike.

Fig. *A*.

They all work together to form a place where the bee may enter, and where she cannot enter without conveying away the pollen. For the pollen is suspended from the roof at the point where the petals and sepals are attached to the

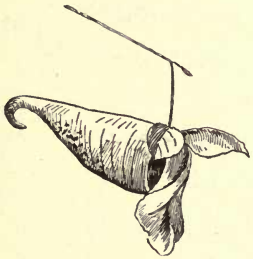
receptacle. It can be seen by turning back the hood, or porch roof (*x*), a little. (Fig. *A*.)

The flower is so small that a bee could not enter without touching the pollen.

Think of the skill displayed by the flowers to secure what they want.

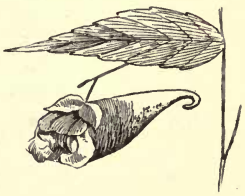
In the nasturtium no large insect could enter without walking over the pollen on the floor. Here none can enter without touching its back against the pollen on the roof.

What chance do you think the rain has to get into this flower?



It would be impossible. As the flower swings on its delicate peduncle, the opening is directed a little *down;* this adds to its security against rain. In some varieties the peduncle droops so as to bring the flower under the leaf, the leaf thus acting as an additional roof, or screen.

In the garden balsam the petals are larger than in the jewelweed. Each is evidently formed by the union of two petals into one. There is a trace of this two-petal state in the wild flower, but it is hardly evident enough to attract the attention of young students, unless they



have also seen the garden balsam. Originally there must have been four petals, but these finally united into two.

If possible, supply the children with both kinds of flowers, the jewelweed and the garden balsam, that they may see the slight differences between these nearly related varieties.

The garden balsam comes to us from India.

How do you suppose two plants so widely separated in their homes came to be so much alike ?[1]

The upper sepals in the garden balsam, those that cover the cracks between the porch cover and the cave, are *very* small,—so small that they will not be noticed at first. The sepal that forms the porch cover, on the other hand, is much larger and as bright in color as the petals.

While the jewelweed is yellow, the garden balsam is white, pink, or red.

There are four sepals, but the evident union of two to make the sepal which covers the porch shows the plan of five to have been the original plan of the flower.

The growing together of the two sepals that form the porch cover is an advantage in making a tight

[1] See Flowers and their Friends : "Jewelweed Stories."

roof. It also is a saving of material. More nourishment can thus go to form seeds.

The hint of two petals having united to form each of the two existing petals points to a time when the balsam had four petals. Why did it not have five? Probably it did. Four petals proving enough, the fifth disappeared.

Four petals being really more than the flower needed, the two petals on each side finally united to form one.

The balsam has greatly changed to adapt itself to the visits of the bees.

Its sepals have done so much to help that its petals have partly disappeared because they were not needed.

The older pupils will be interested in this, and in the explanation that flower parts disappear when not needed from lack of nourishment. Flowers are constantly changing. Suppose some petal which had become non-essential to the flower should fail in a certain plant to develop. The nourishment that would have gone to that petal, let us suppose, goes to the rest of the flower instead, and makes the rest of the flower, including the ovules, richer in food material and stronger.

These strong seeds would have the best chance to

grow in the crowded earth. They would crowd out the weaker plants. If their seeds inherited the peculiarity of having one petal less, there would soon be a new variety of flower, and the old kind might wholly disappear.

In some such way natural selection is always operative, changing the life on the earth into new forms.

The balsams are the result of much progressive growth. They are no longer simple polypetalous flowers. They are very complex.

Like the nasturtiums, they have used many clever devices to procure the pollen they want and to care for the welfare of their seed-children.

Notice the tiny bracts on the peduncle.

PISTIL AND STAMENS.

WHERE is the pistil in our jewelweed?

In some of the flowers, instead of a pollen-covered knob hanging from the roof, there will be seen a little green spike.

Look at an older flower; at a peduncle where the flower has fallen off.

This little spike is surely the pistil.

It contains the ovules, and at the end opposite the peduncle is a tiny sticky point, or stigma.

There is no style.

The stigma sits right down on the ovary instead of being held away from it by a style.

It is said to be "sessile." "Sessile" comes from a Latin word meaning "to sit."

So the pollen is in one flower and the pistil in another.

We now see why the jewelweed is so carefully constructed with reference to the coming of the bee.

If the bee does not come, the pistil cannot be fertilized, for there are no anthers in the flower with the pistil.

Let us look a little more carefully. Let us look at a great many flowers before deciding about the stamens and pistil.

Here is something strange. The knob bearing the pollen is falling from this flower, and *beneath it is a pistil!*

Is it true, then, that underneath the stamen knob in each flower there is concealed a pistil?

A careful examination proves this to be the case.

Let us look at the stamen knob that has fallen off.

It has five stems.

What does this mean?

Open a bud and what do you see?

Five anthers lying close together!

Closer examination shows these anthers to lean towards each other and to be slightly grown together. When they open to let the pollen out, one can no longer distinguish the five anthers; they look like an irregular, pollen-covered knob.

The filaments are short and thick, but are separate, or "distinct," as we say of parts not grown together.

Because the anthers lean towards each other and are so close together, we say they are "connivent," and because they are grown together, we say they "cohere."

Which ripens first, anther or pistil?

Evidently the anthers do; hence, the flower is protandrous.

When the anthers have shed the pollen they all fall off together. They had formed a little hood over the unripe pistil; it was all covered up by them, so nothing could get to it.

The pistil was *behind* the anthers in a sort of little box they formed over it.

When the stamen hood falls off there stands the pistil, ripe and ready for pollen.

Thus we see that although pistil and stamens exist in the same flower, the pollen cannot fertilize its own pistil.

After the stamen group has fallen, bees in search of honey dust the exposed stigma with pollen from other flowers.

Before the stamens fall, the bees carry the pollen they have ripened to other flowers that are ready for it.

The flowers help each other. They all provide pollen, although no flower can benefit by its own pollen.

Recall the fact that the nasturtium flowers are also protandrous. The nasturtium pistil is not hidden by the stamens, but it fails to mature until after the pollen has been shed.

SUMMARY.

1. Position of pistil.
2. Position of stamens and their relation to the pistil.
3. Five stamens with connivent and slightly cohering anthers.
4. Mutual helpfulness of flowers.

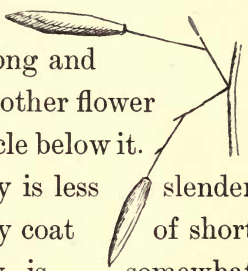
In connection with the study of the pistil, dwell upon the care the plant takes of its seed-children.

Dwell upon the mother-love of the plant and tell stories illustrating it. Remember to have as much drawing and writing as possible all through the work.

For schedules, see chapter on Morning-Glory.

OVARY AND FRUIT.

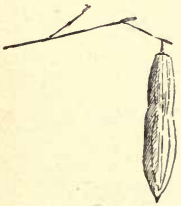
After the group of stamens has fallen, the flower continues to produce nectar, and thus attracts the bees and other friends to the ripe stigma. After a time the petals and sepals fade and fall, leaving the ovary to continue its growth.



The ovary is green; it grows long and slender. It is superior, as all the other flower parts were attached to the receptacle below it.

In the garden balsam the ovary is less slender and is covered with a soft, heavy coat of short hairs. The wall of the ovary is somewhat fleshy and succulent. Perhaps in the hot climate of India, where the balsam acquired its present form, it needed the downy covering to prevent too great evaporation from its succulent tissue.

The jewelweed fruit is smooth, or "glabrous." "Glabrous" comes from the Latin word *glaber*, which means "smooth."



The ripe fruit is a pod which dehisces lengthwise into five parts, or "valves." When ripe, each valve *suddenly* curls up.

It separates at the receptacle end and begins to curl up there. Its sudden forcible curling up or snapping motion shoots the seeds long distances.

In this way the seeds often find new places to occupy. Plants have many devices for conveying their seeds to new places.

If you touch the ripe jewelweed or balsam pods, they snap open. For this reason the plant has received the name "impatiens" in the botanies. *Impatiens* is a Latin word, and means "impatient."

For the same reason the plant is sometimes called "touch-me-not" and "snapweed."

The valves burst away from a central part to which the seeds are attached. They burst away with such force that the seeds are loosened and thrown long distances.

The central part to which the seeds are attached is called the *placenta*.

What did the nasturtium do to protect its seed-children? Its peduncle curled up and carried the ovaries below the leaves, for their own sake and for the sake of the other flowers.

The jewelweed also does something special for its seeds; it shoots them to new places, where they may have a better chance to take root.

Both nasturtium and jewelweed belong to the

geranium family. This family seems particularly skillful in taking care of its seeds.

SUMMARY.

1. Superior ovary.
2. Fruit a pod with five valves.
3. Method of dehiscence.
4. Reason for this.
5. Placenta.

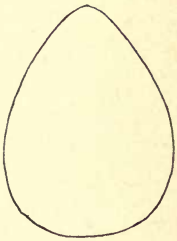
THE LEAF.

NOTICE how the leaves stand upon the growing plant. They do not get in each other's way.

There is one leaf at each node, consequently the leaves are alternate.

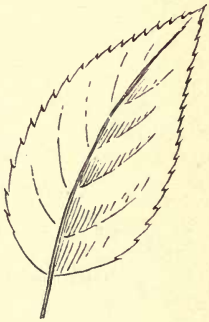
The petioles are short.

Let us look at the shape of the leaf.



If we were to cut an egg in two lengthwise, the cut surface would be very much the shape of this leaf, so we will say it is egg-shaped, or "ovate."

Is the margin entire?



It is not. It is toothed; the teeth are like those of a saw, and so we will call the margin "serrate," which means "saw-like," from the Latin *serratus*. Each tooth on our leaf is tipped with a little soft point.

Draw the leaf.

The leaf is rather light green in color, and lighter on the under side than on the upper.

Plunge it in water. See how it glistens on both sides like a silver leaf. This glistening surface is not wet by the water.

Recall a similar condition in the nasturtium leaf. This, like that, has its stomata protected from water by a waxy substance.

Because of its silvery appearance when under water, the jewelweed in some places is called "silver leaf."

The jewelweed grows in damp places, where it is wet by the dew nearly every night. The dew wets the under side of the leaf quite as much as the upper, for dew does not *fall*, as many suppose; it *settles about an object.*

SUMMARY.

1. Position of leaves, alternate.
2. Shape of leaf, ovate.
3. Margin, serrate.
4. Appearance under water.

Have the jewelweed book as profusely illustrated at every chapter and as full of interesting and well-told facts as possible.

VENATION.

NOTICE how the mid-rib runs through the leaf from base to tip. It does not branch into several veins like the morning-glory and nasturtium leaves. It gives off branches along its whole length. The mid-rib and its side branches look not unlike a feather in structure. For this reason it is said to be "feather-veined." Hold the leaf up to the light and see that it is also net-veined.

SUMMARY.

1. Feather-veined.
2. Net-veined.

Review what has already been learned about the parenchyma of the leaf and its work; also the work done by the veins.

Draw the leaves at every lesson if possible.

THE PLANT STEM.

The main plant stem grows three or four feet high; it is smooth, or glabrous, and at first glance appears to be round. Look more carefully and find that it is *angled*, and that the angles are rounded. The nodes are swollen and conspicuous. The internodes are long, and the stem is somewhat succulent, containing a watery, bitterish juice.

Follow one of the angles, or edges, of the stem. It does not rise up straight, but twists around towards the right in a spiral manner.

The stem seems to be trying to turn around on its own axis. It does not twine like the morning-glory stem nor like the petioles of the nasturtium, but, like the nasturtium, it seems *inclined* to turn about.

The succulent nature of the jewelweed stem reminds us of the nasturtium; although the juice lacks the pungent quality of the nasturtium, it is bitterish in taste.

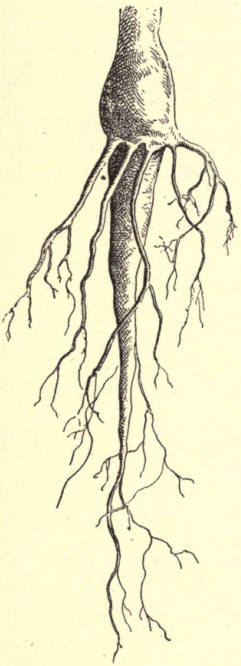
SUMMARY.

1. Height.
2. Surface.
3. Shape.
4. Spiral growth.
5. Succulence.

The jewelweed grows in swampy tangles. Near the ground, and sometimes for three feet above, there are no leaves, only stems. On the topmost branches above the tangle the leaves show themselves. The plant is straggly in appearance, and makes a fine showing above the other low-growing plants of the swamp.

THE ROOT.

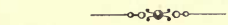
THE root is not very large; it is not unlike the nasturtium root in appearance. It is very loosely attached to the moist earth and can easily be pulled up. The position of the plant in the thick undergrowth protects it from being blown or torn away, so the root is not obliged to form a very good anchor.



Review uses of roots.[1]

[1] See Morning-Glory and Nasturtium chapters; also Flowers and their Friends: "Jewelweed Stories."

THE SCARLET GERANIUM.



This also is a fall flower, blooming freely until the coming of frost. It can, however, be grown in pots in the house and used in winter or spring.

Small pots containing blooming plants can generally be obtained of the florist at small cost.

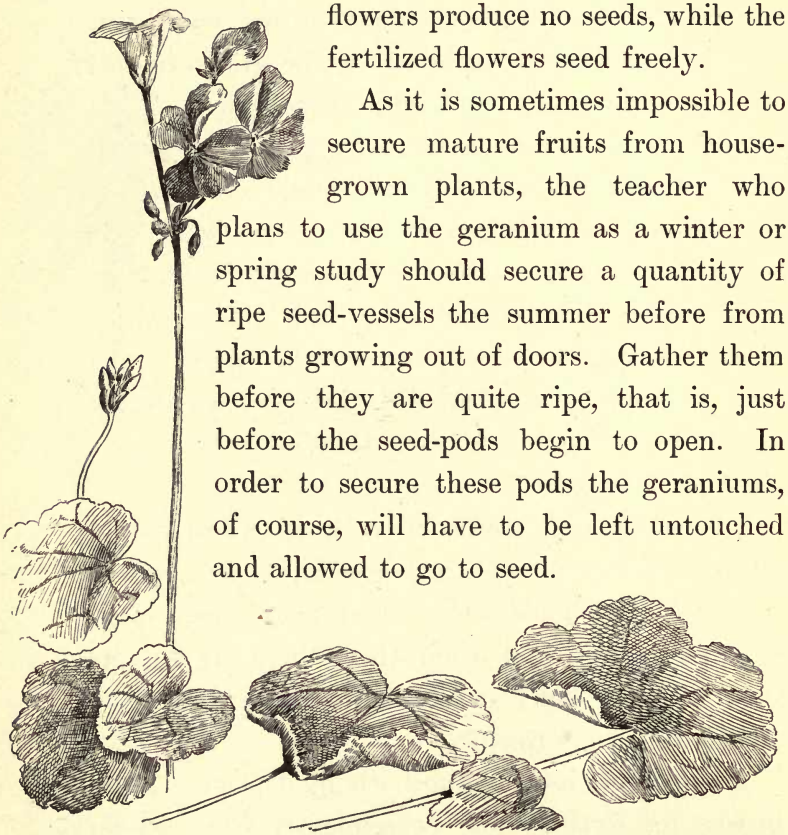
Although in many respects a very good plant to study, the house geranium, or "pelargonium," as the botany calls it, is subject to certain defects which make it less satisfactory to begin with. After one or more plants have been studied, these defects are not a hindrance; on the contrary, they are very instructive and interesting.

In some plants, particularly those grown out of doors, the flowers mature perfectly, as do also the fruits. But in house-grown plants the stamens often have no anthers, and often where there are anthers there is no pollen; consequently no seeds can set and no fruit be formed.

The pelargonium is almost wholly dependent upon insects for fertilization; consequently when grown

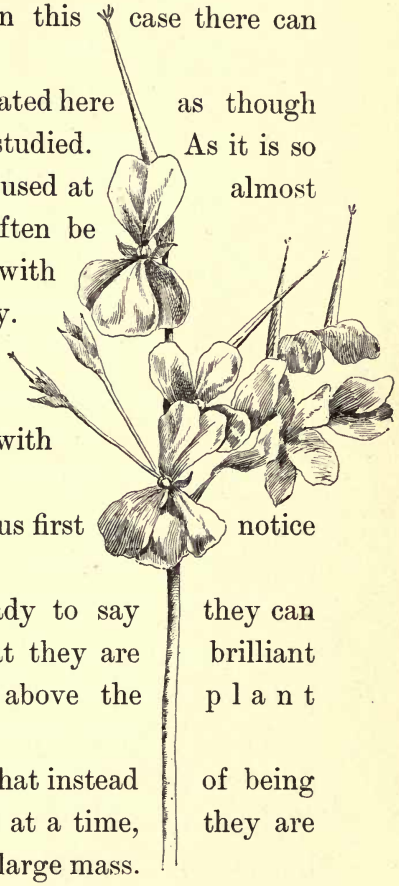
in the house the flower will have to be artificially fertilized.

This is not a disadvantage, however, as the effect of fertilization can be most beautifully shown by setting aside some plants and not fertilizing them, and noticing as time goes on how these unfertilized flowers produce no seeds, while the fertilized flowers seed freely.



As it is sometimes impossible to secure mature fruits from house-grown plants, the teacher who plans to use the geranium as a winter or spring study should secure a quantity of ripe seed-vessels the summer before from plants growing out of doors. Gather them before they are quite ripe, that is, just before the seed-pods begin to open. In order to secure these pods the geraniums, of course, will have to be left untouched and allowed to go to seed.

In order to keep the flower beds tidy and to cause the geraniums to continue blooming, it is the custom to remove the flower cluster as soon as the flowers begin to fade; of course in this case there can be no seed-pods formed.



The pelargonium will be treated here as though the other plants had been studied. As it is so easily obtained and may be used at almost any time of year, it may often be the most available material with which to begin plant study. Consequently the more difficult features will be in addition specially treated with reference to beginners.

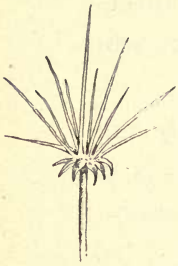
As in the other plants, let us first notice the brilliant, showy flowers.

The children will be ready to say they can be seen a long distance; that they are brilliant in coloring, and stand up above the plant foliage.

Moreover, they will notice that instead of being scattered over the plant one at a time, they are all clustered together in one large mass.

Have them notice that there is a common stem, the peduncle, stout and long,.which bears at its top

the flower cluster. Each flower has, besides, its own little stem, or "pedicel."



Have the children notice how the pedicels all grow to about the same length, raying out from the top of the peduncle something as the rays of an umbrella do from the top of an umbrella stick. The flower cluster hence is shaped a little like an umbrella, and for this reason is called an "umbel."

"Umbel" comes from the Latin *umbella*, which means "a little shadow"; hence it means a "sun-shade," "parasol." The word *umbella* itself comes from another Latin word, *umbra*, which means "a shade."

"Umbrella," therefore, means "a shade." In our climate it is more often used to shade us from the rain than from the sun.

Any flower cluster whose pedicels are about the same length and all grow from the top of the peduncle is an umbel.

What is the advantage of the umbel over the solitary flower?

Evidently, by being massed together, the flowers become more conspicuous.

What extra effort, then, do these flowers make to be seen?

They grow in masses instead of singly.

What do we infer from the pains the flower takes to be seen?

That it wants the insects to see it and come to it.

For what purpose does it want the insects to come?

It wants them to fertilize it.

Try to draw the flower cluster and write about it.

[See Morning-Glory chapter.]

Of course, if this is the first flower studied, the present reference to the insect will be omitted.

There is a fringe of small, withered leaves, or "bracts," at the top of the peduncle, just below the umbel; of what advantage is this?

Look at a cluster of buds before the flowers have begun to open.

They are covered and protected by these bracts as though the cluster were a single bud and the bracts were its calyx.

Later, when the pedicels grow longer and the buds separate and open, these bracts turn back, become brown and withered, and doubtless form a barrier to prevent small insects from crawling up to the flowers.

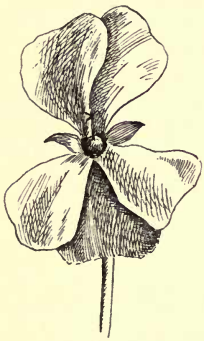
SUMMARY.

1. General appearance of the flower.
2. The flower cluster : *a*. The peduncle. *b*. The pedicels.
3. Umbel.
4. The bracts.

Have as much drawing and writing as possible all through the work. As in the other plants, have a little book on purpose for the geranium work, or if other plants have been studied, add the geranium notes to the general plant book.

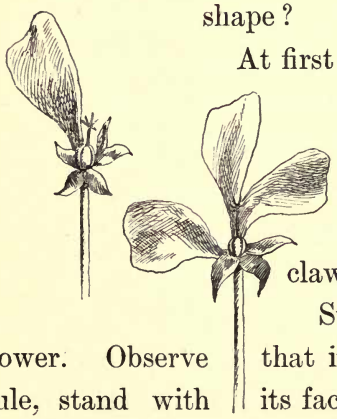
THE COROLLA.

Look at a flower without removing it from the flower cluster. There are five petals; in an older flower some of these will have fallen, and it can easily be seen that the petals are entirely separate, or *distinct*.



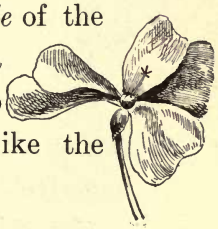
Because the petals are not grown together, are distinct or free, it will be remembered that the corolla is polypetalous.

Are the five petals all the same shape?



At first glance it may appear so; closer looking will reveal the fact that two of the petals are somewhat narrower and have longer claws than the other three.

Study the *attitude* of the flower. Observe that it does not, as a rule, stand with its face looking up to the sky, but is inclined to one side, like the morning-glory and nasturtium flowers.



What position do the two narrower petals always occupy?

They are always the *upper* petals. Notice, too, that they are usually somewhat separated from the three broader ones, the petals thus forming two groups.

Look at the three lower petals; they are broader and overlap at their edges.

They form a sort of platform for the bee to light upon. Is it as good a landing-place as the morning-glory, jewelweed, or nasturtium provides?

It evidently is not as good; the geranium, the older pupils will be interested to know, has not developed so far as the nasturtium, which has made a tube for its bees to go into, and neither nasturtium nor geranium have developed their corollas as perfectly for insect fertilization as have the morning-glory and the jewelweed. In the morning-glory the "cohesion" of the petals has formed the tube which is the best sort of a protection to the pollen and forms the best landing-place for insects.

The jewelweed has utilized both calyx and corolla to form a tube for the convenience of visitors.

The pelargonium has modified its corolla for the better accommodation of insects very little. The imperfect platform, made by the grouping together

and overlapping of the three broad lower petals, is the first step towards a more perfect arrangement.

Perhaps the pelargonium will go no farther in this direction. Perhaps in course of ages its descendants may gradually form the corolla into a tube by the gradual cohesion of the petals.[1]

Where is the nectary in our geranium?

Are there any nectar guides to help us find it?

We cannot find any lines or marks that attract our attention at first glance. Careful looking shows deeper, darker veins towards the base of the upper petals and running down into the heart of the flower. They are not conspicuous enough to attract attention, and cannot be seen except when one is close to the flower. Do they lead to the nectary?

Here the teacher may have some difficulty, for in house-grown geraniums the nectary is sometimes absent.

Where it exists it is in the form of a long tube grown fast for its whole length to the pedicel.

Sometimes this tube, or spur, is very short; usually it is an inch or more in length, reaching almost to the base of the pedicel.

[1] See Flowers and their Friends.

It is usually impossible to obtain nectar from the pelargonium.

The tube, or spur, is too small to admit of the entrance of even a slender toothpick.

Look at the base of the two upper petals and you will find a round opening leading to the nectary. To this opening the darker lines already noticed on the upper petals converge.

What is the meaning of this long, slender nectary? It resembles somewhat the long spur of the nasturtium, only that is free, and this is grown fast to the pedicel.

The nasturtium spur was evidently formed for some bird or insect abundant in its South American home.

The home of the pelargonium is South Africa, where it undoubtedly has for its friends butterflies or moths with long, slender tongues able to enter the nectary.

Our bees do not seem to care much for it, though they visit it sometimes for pollen, and so effect fertilization. Even out of doors it very often does not fruit freely.

Where the nasturtium has been studied, the children will be much interested in the peculiarities of its relative the pelargonium.

They will want to know why it sometimes fails to mature pollen and form a nectary.

House-grown plants are not in their natural surroundings. We do not know just what conditions they are used to, and if we did know we might not be able to supply them. So the plant does the best it can with what it has. If it has not the right food or temperature or moisture, it may not be able to develop a perfect flower. There may be other reasons for its conduct.

SUMMARY.

1. Five distinct petals.
2. Shape and position of petals.
3. Attitude of flower.
4. The nectary.

If this is the first flower studied, it may be well to omit all reference to the nectar and nectary.

Pass from the general appearance of the flower to the form of the corolla, then to the stamens.

THE STAMENS.

HAVE the children see flowers with perfect anthers. Touch the ripe anther with the point of a toothpick and gather the pollen.

The teacher may then tell how the bee collects the pollen and what she does with it.

From this starting-point proceed as in the study of the morning-glory to find the structure of the stamens.

The pupils will discover a varying number of anthers in their flowers. They will find from two to four anthers crowding the throat of the flower and covered with dark red pollen.

Lower down there will be two or three short-stemmed anthers.

Interest the little ones as much as possible in the coming of the bee for pollen.

SUMMARY.

Stamens — anthers, pollen.

The older pupils will notice that the anthers do not all ripen at the same time. As in the nasturtium,

they ripen at different times, thus prolonging the period of pollen-bearing.

They will also notice that the anthers are ripe before the pistil appears. It is, therefore, like the nasturtium and the jewelweed, proterandrous.

They will also notice that the anthers are so placed in the throat of the flower that an insect could not approach the opening to the nectary without becoming dusted with pollen. The opening to the nectary is at the base of the two upper petals, and so *above* the essential organs.

Sometimes there may be found seven perfect anthers in a flower, never more. On the other hand, flowers will be found which have *no* perfect anthers.

Look now at the whole stamen. This may be done by turning back the sepals of an old flower. The anthers will have fallen, but the filaments remain.

They are pointed at the top, and the attachment to the anther is innate.

Examine an anther and find it dehisces by a longitudinal slit, as is the case with all the anthers so far studied.

The filaments are broad and are all grown together into a sheath which surrounds the ovary.

Look at the older flowers, even at ripe fruits, and find this filament sheath persisting. The filaments cohere to form this sheath.

When petals grow together we say the corolla is "gamopetalous"; when sepals grow together we call the calyx "gamosepalous."

When filaments grow together into one sheath we say the stamens are "monadelphous." We know that "mono-" or "mona-" means "one"; "delphous" comes from a Greek word meaning "brother," and "monadelphous" means "one brotherhood."

The stamens, you see, are all united into one brotherhood by their filaments.

Linnæus, the celebrated Swedish botanist who lived in the seventeenth century, gave this pretty name to the united filaments.

We remember how the anthers of the jewelweed "connived" and "cohered." In its relative the pelargonium it is the filaments that cohere.

Count the filaments of the pelargonium. There are ten, but only seven bear anthers. Stamens which have no anthers or which for some reason produce no good pollen are said to be "sterile."

There are three or more sterile anthers in the pelargonium flower.

What is the meaning of the antherless filaments?

Evidently the pelargonium flower has undergone changes. At one time in its ancestral history it probably possessed ten perfect stamens. As time passed, for some reason ten stamens proved too many—perhaps the flower throat contracted to suit its most helpful insect visitors, so there was not room for ten perfect stamens; moreover, they were no longer needed. Whatever the reason, the fact remains that the pelargonium learned to develop but seven anthers, only the three other filaments remaining to show the original plan of the flower.

THE PISTIL.

After the anthers have shed their pollen the pistil opens.

The children will notice the little five-rayed star that pushes up above the ripe stamens. These are the lobes of the stigma. The style lengthens to carry them above the anthers. The stigma lobes do not spread apart until they are well above the anthers.

If this is the first flower studied, have the children look at the five-rayed star and then at an older flower where the petals have partly or wholly fallen and left exposed a long column, the pistil. The star will be found at the top of this long column.

Look at the base of this column. There are five little swollen parts; they contain the seeds, as can be shown by reference to a dried fruit.

Tell here stories of the mother part of the plant and her seed-children.[1]

The flower is glad of the presence of the little seed-children, and says so by placing about them the bright petals.

[1] See lessons on the Morning-Glory; also Flowers and their Friends.

If the children have studied the nasturtium, they will at once recognize the star as a five-lobed stigma, and this opinion can be confirmed by reference to a forming fruit.

Put away a few plants with unfertilized flowers.

As a rule the flowers which have been fertilized will set seeds, and the seed-pods will develop, even if conditions are not favorable to their fully ripening.

If care is taken to keep them moist and to prevent their being handled, some of the plants will ripen their seeds in about three weeks.

Have the children watch the two sets of plants and see how the unfertilized flowers fall and leave no fruits, while the fertilized pistils develop into long columns.

If this is the first flower studied, the teacher may have the children transfer the pollen to the stigmas without telling them why; also set apart some which the children know have not been so treated. In two or three days it will be evident that the stigmas which have been dusted are different from the others.

As soon as it can be shown that the long columns that develop from the fertilized flowers hold the seeds, — and this can be shown by having on hand some dried fruits or a plant whose fruits have

ripened, — the story of the work of the pollen may be told.[1]

If the children have studied the other flowers, as soon as they notice the position of the stigmas high above the now empty anthers, ask them how the geraniums are fertilized.

They will probably say by insects.

Then ask how this can be accomplished in the schoolroom, where there are no bees or butterflies.

Remembering the nasturtium, they will at once provide a swarm of very efficient bees in the form of toothpicks, and will themselves fertilize the flowers by dusting the stigma lobes with pollen from the ripe anthers of another flower.

SUMMARY.

1. The pistil { ovary. style. stigma.
2. Ovary in five parts.
3. Style long and thick.
4. Stigma five-rayed.

The pistil ripens after the stamens and pushes up between them as the style lengthens.

The pistil is *superior*. All the other flower whorls are attached to the receptacle below it. It is also compound, because it has five lobes to the ovary and five to the stigma.

[1] See lessons on the Morning-Glory; also Flowers and their Friends.

THE CALYX.

HAVE the children look at the back of the flower.

They will notice the calyx with its five sepals.

Are the sepals distinct, or do they cohere?

They are found to be for the most part distinct; the calyx is therefore polysepalous.

The topmost sepal is usually prolonged into a tube, which adheres by one side to the peduncle.

This, as we know, is the nectary. Recall the nasturtium spur, which is also a prolongation of the sepals.

Examine a bud and see how the calyx protects and covers up the delicate petals forming within.

Notice how the sepals are folded over each other, like the tiles on a roof; they are, as we remember of the morning-glory sepals, *imbricated* in the bud.

SUMMARY.

The calyx { 1. Five sepals. 2. Nectary. 3. Imbrication. 4. Use of sepals.

Notice how partial the geranium is to the number five.

Each whorl has five parts or a multiple of five. There are five sepals, five petals, ten stamens, five divisions to the ovary and to the stigma.

THE BUD.

THE young bud is completely covered by the green calyx.

Both calyx and peduncle are "pubescent," or covered with fine hairs. The down protects the bud from drying up.

The petals, like the sepals, are imbricated in the bud. In this way they are packed closely together and mutually protect each other.

The cluster of young buds is covered by a number of bracts, which are imbricated over them like a calyx.

The cluster of buds turns down at first, then as the older buds begin to open, the peduncle rights itself and holds the flower cluster straight up. When this happens the pedicels of the younger buds turn down, so the small green buds hang down below the flowers until their turn comes to open.

Then their pedicels straighten and they stand up in the sunlight.

In this way the tender buds are protected until the time comes for them to unfold.

Summary.

1. The bud : Calyx imbricated ; petals imbricated.
2. Outer covering of bracts to bud cluster.
3. Position of bud cluster at different times.
4. Position of buds in cluster.

THE FRUIT.

THE fruit of the pelargonium is somewhat difficult to obtain, as it does not mature readily in house-grown plants.

The best way is to go to a florist's garden before frost in the fall and ask for the ripe seed-pods. Or, if you or your friends have geraniums in the garden, see that a few thrifty plants are thoroughly fertilized, and leave them undisturbed until the fruit is matured.

The fruits are very interesting and afford much fun to the children. When they ripen, the pod containing the seed splits away from the central shaft of the pistil. This pod is attached by the style, which reaches almost to the stigma. This slender style splits loose from the central shaft and curls up, and as it does so, out from beneath it spreads a tuft of hairs that looks like a little feather!

Each of the five seed-cases splits loose in this way. The long style remains fastened to the very top of the central column just below the stigma.

As the style portion breaks loose it also *twists*, and finally even the point lets go, and the seed-pod goes sailing off in the wind, its feathery part acting as a parachute.

It is sometimes blown a long way from the parent plant.

We remember how the jewelweed *snapped* its seeds into new fields. The pelargonium provides wings for its dear seeds to sail away and find new homes.

When finally the seed with its strange attachment of feathery wings and long style reaches the ground, it proceeds to plant itself! As the style dries, it curls up. When moistened, it straightens out. The end of the seed-pod opposite the feather is furnished with some fine bristles that point back like the barbs on a fish hook.

Now see what happens when this funny seed-pod falls on the ground.

In the first place, the feathery part catches in the grass or loose particles of earth and prevents it from being blown away again.

In dry weather the stem-like part curls up like a corkscrew.

When a shower moistens it, it uncoils. In straightening out, the little barbed end is pressed into the ground. Then when dry weather comes, our funny little seed-case curls up again. But it cannot pull the seed out of the ground again, for the barbed point holds it fast! So it just curls down closer to the ground.

Now comes another rain or a heavy dew and straightens our seed-case! Deeper into the earth is pushed the point.

When again the seed-case curls up, the barbed point holds the seed fast, so in a few days it may be quite covered by the earth and ready to grow.

Surely the geranium family is an ingenious one!

The nasturtium curls up its pedicels to protect its fruit.

The jewelweed snaps its seeds far into the thicket.

The pelargonium furnishes its seeds with wings to fly and with tools by which they can plant themselves.

The seed all this time lies in the rounded part of the seed-pod, and when planted proceeds to grow in due time.

Have the children place some seed-cases upon the earth in a flower pot. Watch them as they dry up; moisten them, and watch them straighten out.

SUMMARY.

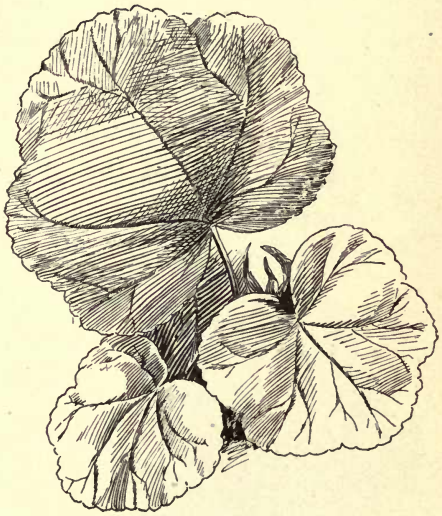
1. Separation of seed-cases.
2. Hairs forming means of transportation.
3. Slender, twisting style, which changes shape when dry and moist.
4. Barbed point of seed-case.

THE LEAF.

Look down upon a geranium plant and see how the leaves are arranged so as to interfere with each other as little as possible.

They form a sort of *rosette*. In house-grown plants they will all turn towards the light.

Let the children try to draw the leaves in position. This is not difficult from the position and shape of the leaves.



THE PETIOLE.

ARE the petioles long or short?

Some are long, some short. Those attached to the lower part of the plant are long to bring the leaves out into the light and air.

The petioles are cylindrical in form, shaped like a cylinder, a tube, or a piece of wire.

They are pubescent. So densely are they covered with fine hairs that a very small insect would find it difficult to creep up the plant. Notice the pubescence of all parts of the plant, excepting the petals and essential organs. This protects the plant from excessive evaporation. The geranium can stand a good deal of dry weather. In its African home it probably has to contend with long droughts, and so has provided itself with its hairy covering.

Notice the small, green, leaf-like parts at the place where the petiole is attached to the stem. These are called "stipules." The word comes from a Latin word meaning "a blade."

Because the geranium leaf has stipules, it is said to be "stipulate."

As the stipules grow old they turn brown and finally fall off. When the young leaf first forms it is surrounded and protected by the large green stipules. They do the eating for the plant until the tender leaves are old enough to do their work. The young leaf can be seen folded up between the stipules. When their work of protecting and helping the young leaf is done, the stipules wither and fall.

Recall how carefully the young buds are protected by their pubescent bracts, also by their position.

They turn down away from the light. Then the peduncle straightens, but the younger buds turn down until time to blossom.

Now we find the young leaves carefully protected by pubescent stipules until they are large enough to care for themselves. What inference can we draw from the fact that the pelargonium takes such care to protect itself from evaporation in the heat of the sun? It takes no pains to protect against the entrance of water to its stomata, as the leaf is wet on both sides upon being immersed in water. This shows that the hairs are not grouped about the stomata. Evidently the pelargonium belongs to a hot, dry climate.

Notice the position of the leaves on the stem. In some cases two leaves grow opposite each other at the same node. Such an arrangement of leaves is called "opposite."

Not all the leaves are opposite; some are alternate. The geranium does not seem quite to know which it likes best, opposite or alternate leaves.

SUMMARY.

1. Arrangement of leaves in regard to each other.
2. Petiole: Its length, shape, and covering.
3. Stipules: Their work; stipulate.
4. Position of leaves: Opposite and alternate.

THE BLADE.

TRY to draw the leaf blade.

In general shape it is nearly *circular*. It is for this reason called "orbicular."

The venation is palmate and the leaf is net-veined.

Look at the back of the leaf and see how the petiole branches into seven or more large veins, or ribs.

The margin is not entire; it has several large scallops. Each of these scallops is scalloped again. The leaf is thus doubly scalloped. But we do not speak of a *scalloped* leaf. We say "crenate" instead. "Crenate" comes from the Latin word *crena*, meaning "a notch." So our geranium leaf is "doubly crenate."

Both sides of the leaf are covered with fine silky hairs, which give it a velvety appearance. This is particularly so of the upper surface.

The color is dark green above, lighter green beneath. On the upper surface is often a band of very dark green or sometimes brown.

Because of the shape of this band the plant has obtained its common name of "horseshoe geranium."

The leaves have a slight aroma, which becomes stronger when they are crushed.

SUMMARY.

1. Orbicular.
2. Doubly crenate.
3. Palmately veined.
4. Velvety surface.
5. Aroma.

VERNATION.

THE leaves are folded together in the bud like a fan when it is closed. Therefore they are said to be *plaited* in the bud.

The stipules cover them over and protect them.

THE STEM.

The stem is stiff, cylindrical, and, when young, green. It is *pubescent*, or covered with downy hairs, like the rest of the plant. Old plants become quite woody and grow very large, sometimes six or even ten or more feet high.

The older part of the stem looks brown and hard. It branches in an irregular manner.

If any part of the stem becomes covered with earth it sends down roots. We remember how the nasturtium stem sometimes rooted.

Even a piece broken or cut from the stem of a geranium will send down roots and grow.

For this reason geraniums are artificially propagated by "slips" instead of by seeds. It is an easier and surer way and saves much time, as it takes much longer for a geranium to grow up from the seed and blossom than to grow from a slip.

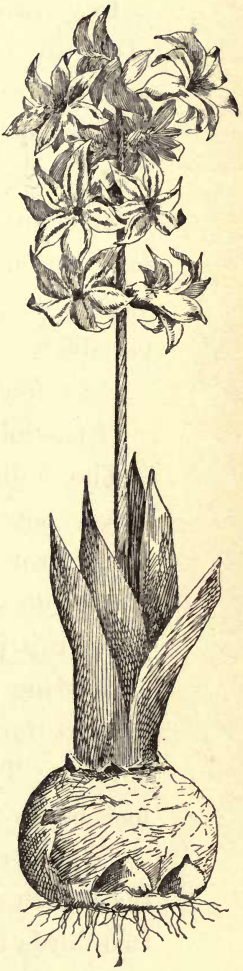
THE ROOT.

The root of the geranium, like that of the nasturtium and of the jewelweed, is small for the size of the plant. It is fibrous.

If the other roots have been studied, this can be omitted, as it involves pulling up a plant which would otherwise continue to grow and blossom.

If one is pulled up, wash the roots, study them, then replant them, and the geranium, after first losing most of its leaves, will continue to grow.

THE HYACINTH.



No more delightful subject for study can be found than the hyacinth.

It is, with one or two exceptions, an ideal plant for early spring or late winter work.

It is easily obtained, easily cared for, shows the whole method of plant growth from root to blossom, as it can be grown in a tumbler of water, and is one of the most delightful of all flowers in its blooming season.

The teacher planning to use the hyacinth may begin her work right after the Christmas holidays if she so pleases. Work with the hyacinth may follow winter work with seeds to good advantage, or it may be the first plant work done.

As it takes some time for the plant to develop, it will be well, until it is in bloom, to have the hyacinth lesson once

or twice a week instead of every day. Work upon seeds may be carried on at the same time if it is desirable to have a plant lesson every day.

In working with the hyacinth the growth of the plant can be watched and its changes observed in a way not feasible with any of the other plants.

The bulbs should be procured from some reliable seed-dealer, so they will be sure to bloom.

They are not expensive and are quickly and safely sent by mail or express. Send for *single-flowered* varieties. Ask for as much variety in color as possible.

Set a few more bulbs than are needed.

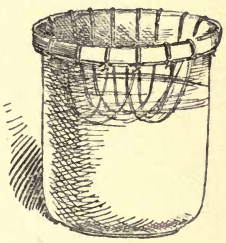
If possible, let each child have his own bulb.

The bulbs can be planted in window boxes or flower pots, but by far the better way is to have them grown in glass receptacles. Ordinary jelly glasses do very well and are within reach of all, or glass fruit jars may be used.

In using the jelly glass or fruit jar, make a little support for the bulb to prevent its sinking to the bottom. Tie a string around the top of the glass just below the projecting rim.

To this tie other strings which shall reach across the mouth of the glass and hang down into it about two-thirds the height of the bulb. In this or some

other way form a little basket or net for the bulb to rest upon and so be supported near the top of the vessel, and yet arranged so as to be easily seen. Have a label pasted upon each glass, bearing the owner's name, where each child has a bulb.



It may be well to start the bulbs two or three weeks before the regular work upon them is to begin, sparing a few moments occasionally to look at them.

Fill the glasses with water, and when the time comes place the bulbs in them, the lower end resting upon the network. The pointed end is the top of the bulb.

If possible, have the children prepare their own glasses, either in school or at home. Also have them care for the bulbs themselves, the only care required being to keep the glasses full of water. One child may be detailed to fill the glasses once a day for a certain length of time, then another may take his place, and so on.

After the bulbs have started to grow they should not be subjected to a very low temperature; they will stand an occasional frost without being killed, but their development will be retarded by it.

Do not allow the children to handle the bulbs after

they have been placed in the water. Impress upon them the fact that the bulbs are *alive;* that they are delicate and sensitive, and must be let alone in order to develop the beautiful flowers.

Have the glasses all ready before the bulbs arrive upon the scene. Have a shelf or window seat ready to receive them.

Prepare the children to receive the bulbs with respect and affection.

Something wonderful is coming to live in the schoolroom with them. It is not beautiful to look at, but it holds something very beautiful deep in its heart, and if properly cared for, this beautiful object will one day come forth to make everybody happy. Each child is to have one of these treasures. He may love it all he wants to, but must look at it without touching it.

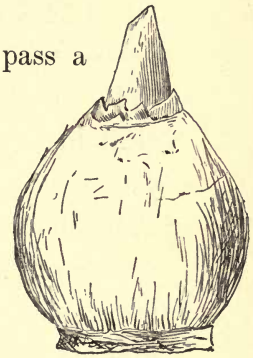
Suppose the class in readiness. Curiosity has been stimulated by the preparation of the glasses. Each child is wondering what sort of an object is to go into them.

The teacher holds a bulb before the children.

Her own attitude towards it will do much to influence their feelings.

This, she tells them, is the casket that holds a rare and beautiful treasure. They cannot see what

is inside it, but some day, if all goes well, something beautiful will come out of it.



It is a good plan at this point to pass a bulb around the class and let each child feel of it and look at it.

Ask if it is hard or soft. Call attention again and again to the *hardness* and *firmness* of the bulb.

Have the children record the result of their observations in a note book kept for the purpose. A few pages of drawing paper can be stitched into this book.

Notice the *shape* of the bulb. Place a bulb on each desk and have the children draw them in their note books. Be sure the bulbs are standing in their right position, with the pointed end up.

Do not let the children handle their bulbs more than is absolutely necessary. Have them satisfy their curiosity upon the bulb or bulbs passed around for that purpose.

If necessary, have the bulbs drawn several times, until the children have the correct shape and are quite familiar with their appearance. Use the dry bulbs for drawing; do not put the bulb in water until after the drawing is done. When ready, each child may place his bulb in the glass of water bearing his name.

Henceforth it is not to be handled. It is to be left, like a seed which has been planted, to grow in peace.

Be sure the glasses are clean and the water in them clear to begin with, so that the changes in the bulb can be watched.

If this is the first plant studied, the teacher is referred to the chapter on the Morning-Glory for the method of directing observation and drawing the information so obtained from the child.

The child should be helped, by skillful questioning, to see the important truths about the plant and to express himself about them. Do not tell him what to see; have him tell you what he does see.

SUMMARY.

1. Preparation of hyacinth glasses.
2. Introduction of bulbs to the class.
3. Consistency and shape of bulbs. Written account.
4. Pictures of them.

With the younger children leave the bulbs and await developments. With the older ones it may be well to examine two or three bulbs. The interior is so interesting and instructive that its examination justifies the sacrifice of a few bulbs.

Meantime a number of extra bulbs, the number depending upon the size of the class, should be put to grow in water by the teacher, as a reserve in case of need. Also plant two or three in a box or pot of earth. Do not plant too deep, barely cover with earth. Keep them well watered.

With all but the youngest pupils the teacher may now examine a bulb before the class.

Review what has already been learned about the bulb concerning its consistency and shape.

Peel off the outer skin-like covering to the bulb. In color and general appearance it is not unlike the skin of an onion. The children may handle this outer covering, smell of it, and look at it.

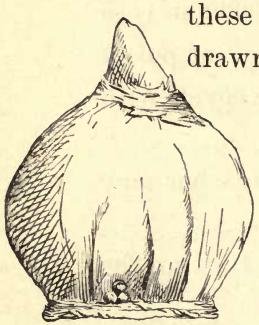
It is dry and husk-like. It is merely the outer wrapper that protects the bulb.

Look at the bulb from which the skin has been removed. It is yellowish white, and resembles the inner part of the onion. (It is better to call upon the child's memory of the familiar onion than to have it dissected by the children, because of the disagreeable effects of the onion when handled.)

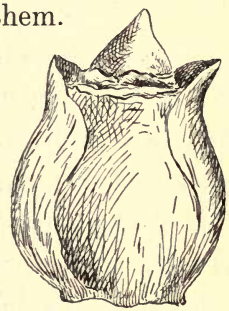
Peel off this inner coat, or "scale," as it is called. Beneath it is another similar one. A dozen or more of these thick whitish scales can be removed.

Notice how *fleshy* they are.

At the base of the bulb beneath some of the scales a tiny white bulblet, or offset, will be found. Have these little bulblets carefully looked at and drawn in position.

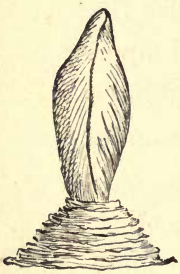


They are so simple that the children can place them after merely looking at them as the bulb is passed around. If necessary, two or more bulbs can be dissected at the same time, so that all may have a chance to see them.



The scales do not completely encircle the bulb. One goes about two-thirds of the distance around, then another laps over, and so covers the space left.

Finally the last fleshy scale is removed. But there is a central part left which differs from the outer fleshy scales.



Notice the platform upon which this column stands. It is the part to which the scales were attached, and the marks they left when removed are plainly visible.

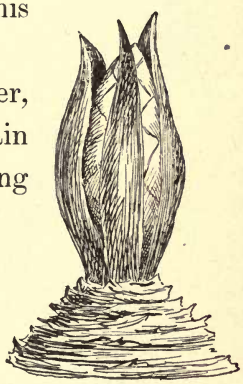
Draw a picture of this central portion with its platform.

The central column is composed of long, thin,

white, *leaf-like* parts folded about each other much as the scales were.

Carefully remove these one at a time; there will be found from five to ten of them, according to the plant.

Look at the delicate veins running from top to bottom of them. Their tips overlap and project from the apex of the bulb in the form of the blunt cone we see in the undissected bulb. This blunt point is hard and firm.



When the outer circles of these inner, leaf-like parts are removed there remain three which partly conceal something within.

Carefully fold back these three leaf-like parts; at last the center is reached.

What is this standing up in the heart of the bulb?

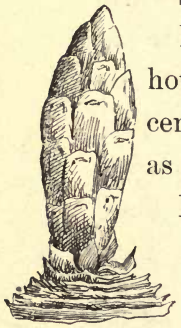
It looks like a pyramid of little white pods.

Open one of them. It is surely a flower bud!

Now we have the secret of our hyacinth. All those leaves and scales were protections to this delicate, undeveloped flower cluster.

The thick, fleshy scales folded over the inner parts. The thin, white, leaf-like parts made a delicate lining to this pretty nest of the flowers.

Outside of all the dark, red-colored skin wrapped up the bulb.



Surely this flower cluster is well protected!

Look now at the little white flower buds. See how they are flattened and packed away in the center of the bulb so as to take up as little room as possible.

Each one is pressed into the shape of a *tooth*. That is because they are packed so closely together. The rounded side of the tooth-shaped bud is towards the leaves; there is more room for them to swell out in that direction, but the other two sides are pressed quite flat by contact with other buds.

How can this queer-looking, flat, three-sided bud straighten out into a pretty flower?

Have the result of these observations, together with any reflections the children choose to make on the subject, written in the note books.

Have the flower cluster drawn from the child's memory of it as it was passed around. Train him to express himself readily and quickly by drawing as well as by writing. The finding of the flower cluster at the heart of the hard, forbidding-looking bulb is always a surprise and pleasure to the children.

They watch with great interest for the unfolding of this delicate treasure. They have seen it in its cradle wrapped about by protecting coverings; what will it be like when it comes forth?

The children can hardly wait for the bulbs to unfold, but they must be patient. It takes time for the wonderful transformation they are about to behold to take place. They must take care of the bulbs, but not disturb them, as they need to be left in peace to grow.

Because the bulb is wrapped around by so many coats, it is said to be "tunicated."

A tunic was a loose dress worn by the Romans.[1]

The hyacinth bulb wears a great many tunics!

We get the name "bulb" from our old Roman friends as well. They called the onion and plants with similar underground parts *bulbus*.

SUMMARY.

1. The hyacinth bulb is hard and compact.
2. It is covered by a reddish brown skin.
3. Beneath the skin are twelve or more fleshy white scales or coverings — tunicated bulb.
4. Growing to the base of the bulb and covered by the scales are several small bulbs.

[1] See Flowers and their Friends: "Tunics."

5. As the scales are removed they are found to be attached to a thick, short stalk that makes a sort of pedestal for the central part of the bulb.

6. At the center of the bulb, wrapped about by the scales, are six or seven thin, yellowish white, leaf-like parts, their points projecting in the form of a blunt cone at the apex of the bulb.

7. These surround an undeveloped flower cluster.

If other plants have been studied, or with older pupils, call attention to the broad, circular disc to which the scales, leaves, and flower stalk are attached.

See how the scales are arranged upon it alternately, like leaves on a *very short* stem. And this is what it is, a very short stem, with scales instead of leaves attached below, and above, towards the center, are attached the true leaves and the flower stalk. The little offsets and bulblets grow in the *axils* of these scales.

Heretofore we have worked with flowering plants, and have begun at once with the most conspicuous part, the bright flower.

Here conditions are different; we have no flowers, and so begin to work with what we have.

We first look at the dry bulb, then we have the privilege of watching the growth of the root.

THE ROOT.

After the bulbs have been drawn and placed in water, leave them for a week, or longer if necessary. Then have the glass vessels containing them placed upon the desks.

Has any change taken place in the bulbs?

Some one soon makes a discovery. Tiny white roots are putting out from the base of the bulb!

They grow out towards the sides and down towards the bottom of the glass.

They do not grow *up*.

Draw the bulb with its fringe of roots as seen through the sides of the glass.

Have the bulbs drawn the natural size, and compare each time with the former drawings. In this way the work will be kept on a more uniform scale, and the changes that take place will be more carefully noted.

If, for instance, the first drawings are smaller than nature and the later ones larger, in looking at the drawings later the children will get the impression

that the bulbs have grown; or, *vice versa*, they will think they have shrunken. Since change in the size of the bulb is an important point to be established later, have the normal size of the bulbs carefully preserved in the sketches, as well as in the measurements.

Be careful about moving the bulbs, as the roots are very brittle.

What is the use of the roots?

They draw up water for the bulb to use.

Notice how the water in the glasses disappears.

What has become of it? Part has doubtless evaporated.

Place another glass of water with no bulb in it by the side of the glasses with bulbs. Put in it a smooth stone the size of a bulb, supported in the same way. Have the conditions of the glass with the stone as nearly as possible the same as of those containing bulbs. In one is the living bulb, in the other the lifeless stone.

Notice the difference in the amount of water that disappears. The water in the glass with the bulb is lower at the end of twenty-four hours.

What has become of it? The little roots have sucked it up for the plant to use in growing.

SUMMARY.

1. The roots: Small, white, and delicate. They grow from the very base of the bulb, and extend out and downward.
2. They suck up the water.

In a week or two another change will take place in the bulb. The blunt point at the apex will begin to lengthen and turn green.

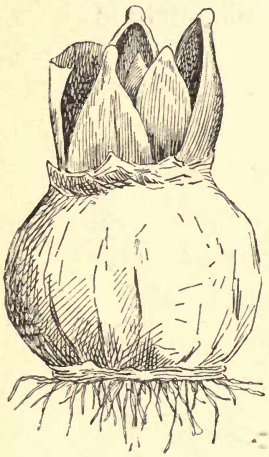
Draw the bulb each week in its changed condition and write about it.

As the apex develops we are led to the study of the leaves.

THE LEAF.

Look carefully at the apex of an unopened bulb and gently touch it; it feels hard, almost horny. Its extreme point is white and shining.

When the apex begins to open out it is seen to be composed of the leaf-like parts that wrapped the flower cluster. They are green now, not white as when seen in the dissected bulb.



The leaves are turning green and peeping forth!

Those thin, white, leaf-like parts that wrapped up the flower buds were indeed the young leaves. White and delicate, they lay in the heart of the bulb until the warmth and moisture called them forth; then they grew and came out into the air and sun. As soon as they felt the effect of the sun they became green.

Why was this?

The leaves make the food for the plant. They change air and minerals into plant material, and they

can only do this work when they are green. The plant must be fed and green leaves must feed it, so the first thing the leaves do when they start out into the world is to turn green.[1]

The children will be quick to discover the lengthening bud cluster as soon as the apexes of the leaves separate. It can be seen between the leaves.

Let us look at the leaves a little more closely.

Examine the apex of one. It is not sharpened like a spear, but is turned over like a little hood. At the point of this hood is the hard white spot.

What is the meaning of this?

Look at the box where the bulbs were planted in the earth. The leaves are seeking to come out into the light. They have to find their way through the hard earth. Sometimes the ground in which they lie is quite hard, and they have to pierce it to find their way to the light.

So they have this hood-like arrangement with the hard spot on the outer leaves. It is less conspicuous on the inner leaves, and some of them do not have it at all.

It is a good instrument for piercing the ground, and it also very nicely protects the leaves from

[1] See Flowers and their Friends.

damage, as well as protecting the flower cluster beneath.

The leaves never forget the flowers they have in charge.

In its wild state the hyacinth grows in the earth; it is often planted in gardens too, and only occasionally has so easy a time as it has in our tumblers of water.

As the leaves push their way out of the bulb they spread apart, thus making a fine open space above the flower cluster. The flower cluster is not slow to take advantage of this opening; it may be seen growing up into it.

The delicate buds could not force their way through the hard earth. They lie still until the stiff, strong leaves grow up and open a passage for them.

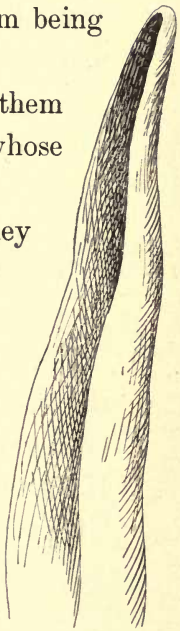
As soon as space appears between the leaves the buds grow until sometimes the space made by the spreading leaves is quite filled by the bud cluster.

Sometimes the buds fail to develop, and then the leaves do not spread apart so much. They grow closer together, although at the very beginning they do spread, as though they knew a flower cluster ought to come forth. When none appears they stand more erect, and so close the central space.

Wherever the plant fails to develop, make the most of what can be learned by the failure. It will

console the owners of flowerless bulbs to find their plants are also interesting and can teach the class something.

Make much of these flowerless plants. Use them in studying the leaves and in all ways possible, so as to save the plants preparing to bloom from being injured by handling.



Notice the shape of the leaves. Study them on those plants which have no buds or whose buds have blighted.

The leaves grow long and narrow. They have a channel down the middle.

This channel was formed by the way the leaves folded about each other and about the cluster of buds in the center.

As they grow larger they do not flatten out. They preserve the channel.

Why is this?

The hyacinth likes plenty of water. These leaves collect all that falls within the radius of their tips and conduct it to the bulb. They make fine gutters to catch the rain water. You may often see a little pool of water at the heart of the hyacinth growing in the garden.

The leaves turn a dark, rich green as they lengthen out in the sunshine.

Draw the leaves in all their stages and write about them.

Look at the venation of the leaf. If the children have studied the net-veined leaf, compare this with it.

Is it net-veined?

Hold up the tumbler bearing the plant so that the light shines through the leaf. Long lines are seen extending from tip to base. There is no branching and no crossing of veins. Because the veins lie so nearly parallel to each other, the leaf is said to be "parallel-veined."

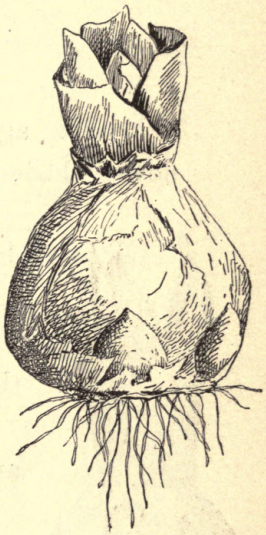
Draw the leaf with particular reference to its venation.

Review the use of the veins in a leaf, or, if this is the first leaf studied, the teacher may tell the story of the veins. [See chapter on Morning-Glory Leaf.] If the children are old enough, read about leaves in "Flowers and their Friends."

SUMMARY.

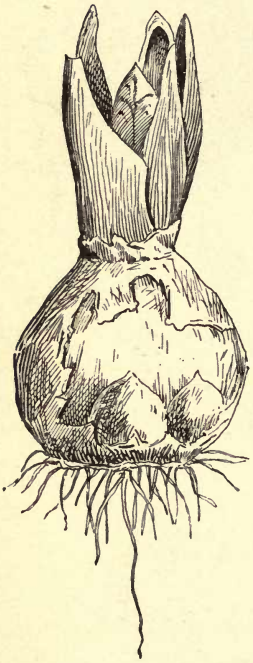
1. The leaves have a special formation at the tip to pierce the earth.
2. They turn green and spread apart as they lengthen.
3. They open the door of the earth for the flowers to come out.
4. They are long and narrow.
5. They have a channel down the middle.
6. They are parallel-veined.

As the leaves put forth, and sometimes sooner, small bulbs will break through the scales of the large bulb in some of the plants. Where this occurs, have the bulbs drawn with the small bulbs in place. If the children have seen a bulb dissected they will recognize these as the tiny bulblets they saw at the bases of the scales.



THE FLOWER CLUSTER.

NOTICE again how the leaves wrap about the flower cluster.



Watch the flower cluster enlarge from day to day.

The buds are green and tooth-shaped. They fill up the space made for them by the leaves.

Draw the bulb with the opening leaves and enlarging bud cluster.

What color will the flowers be? Who can tell?

Some day a most extraordinary thing will have happened.

Kate: "Oh, Miss A!"

Teacher: "What is it, Kate?"

Kate: "My top bud is turning red!"

Nellie: "And mine is turning blue!"

Fred: "And mine has got sort of pink!"

The children eagerly examine their buds; a number show signs of color.

In a few more days the color of many of the flower clusters will be apparent, though the buds will not yet have opened.

The taking on of color by these green buds is one of the most charming habits of the hyacinth. It is a symbol of resurrection, a beautiful new birth.

The children will be greatly interested in the colors of their flowers.

How can the green buds change to these bright colors?

Why do the green buds turn so many lovely colors?

How does the plant know just how and where to turn its green color into the beautiful delicate tints worn by the hyacinth blossoms?

This is the secret of the plant; we cannot penetrate the beautiful mystery.

Some plants, of course, will be prettier than others, have larger clusters and lovelier flowers.

The owners of the less fortunate plants may need a little help to enable them to take an unselfish pleasure in the good fortune of their neighbors. Here is an admirable opportunity for a skillful teacher to inculcate one of those moral lessons which should be the foundation of all school teaching.

The schoolroom should do as much for morality as for intellectual development. The true teacher will feel the same responsibility for the moral life of the children that she feels for their mental growth.

Morality should never be set aside as something to be taught by itself upon special days or in a special manner. It should be the web of the fabric of character of which mental development is the woof.

There should be no need of special schools to teach morality; it should be the keystone of the common school education. But do not preach.

Convey the moral lesson just as you do the truth about corolla or nectary, in a natural and *attractive* manner.

Make the generosity and helpfulness discoverable all through nature, as well as that shown to one another, seem *beautiful*, and therefore desirable to the children.

Make the children as happy and as good as possible through their nature study.

If some owner of a blighted plant takes his loss *very* much to heart, the teacher may, with the approval of the class, give that child one of her reserve bulbs that is doing well.

Remember each child is an *individual*, and must have individual treatment.

It might do one good to have a blighted bulb if he could be helped to an unselfish pleasure in the good of others in that way; it might do another harm by making him unhappy and envious, and causing him to think himself abused, and, finally, to lose interest in the work.

The disposition of the child should always be considered, and that plan adopted which would do that particular child the most good. No one rule, however good theoretically, can be successfully applied to all people.

Perhaps the best test of a teacher's work is in the *happiness* of the children.

Remember how it is with yourself; the things you are happiest in doing you do the best, with the least vital expenditure, and the memory of them lasts the longest.

Remember, too, things that seem trifling to the teacher may be of great moment to the child. The teacher should endeavor to look at things from the child's point of view.

To return to our hyacinth.

After the color has begun to show in the buds the change will be comparatively rapid.

In a few days the topmost bud will open.

Even before a single flower opens the arrangement of the flowers upon the stalk will be evident. A single stalk with the flowers growing upon it rises from the center of the bulb.

Such a flower stalk which bears no leaves and does not grow out of a stem, but comes directly up from the ground, is called a "scape." "Scape" comes from the Latin word *scapus*, meaning "shaft," "stem," "stalk."[1]

The scape lengthens and finally carries the flower cluster up above the leaves.

Draw the scape and buds at different stages.

Keep the book well supplied with notes.

Notice the tiny bracts at the base of each peduncle. Of what use are they to the flower?

They cannot protect as the geranium bracts protect; they are too small to be of any use. Probably they were larger once upon a time

[1] See Flowers and their Friends: "Hyacinth Stories."

way back in the history of the plant. As the plant developed and changed, it no doubt found it no longer needed the assistance of the bracts, and they became smaller and smaller, until they are as we now see them.

The plant does not waste power making useless organs, so some time or other the bracts must have served some good purpose. On the other hand, an organ having once been formed, it does not disappear at once; the change is very gradual.

This subject of bracts will be interesting to only the older pupils. Pass it by with the younger ones.

As the buds enlarge, their shape changes. They lose their three-sided, flattened form. The lower part of the flower rounds into a broad tube.

At length a flower opens!

This is an event in the class. Several plants will open their first flower at about the same time.

The colors are delicate and pure, a delicious perfume fills the air, and the texture of the flower is lovely.

Soon the flower cluster is in full bloom. It is a beautiful object. The fondest expectations are more

than fulfilled. Out of the hard, dark bulb has come this lovely treasure.

The room is bright with the delicate shades of red, pink, and blue which adorn the hyacinths. Some are white, and even a pale straw color may be seen.

The air is as sweet as when the orange trees bloom in the South.

The children are delighted; the teacher, too, enjoys the flowers, and is happy in the pleasure of the children. She begins to ask questions.

Why does the plant send forth this lovely flower cluster? Why has it its rare colors? Its rich perfume?

If other flowers have been studied, the children with one voice will say the flowers are giving the birthday party of the seeds, and desire the bees to come as their guests.

The bright color is to attract the winged messengers; the heavy perfume is the note of invitation sent to call them from a distance.

Within the corolla the children will expect to find rich honey.

The children will notice that the flowers are all clustered together, as are those of the scarlet geranium. This enables them the more readily to be seen.

If the children have studied the geranium, they will notice the flowers do not grow at the end of the peduncle like the geranium flowers; they do not form an umbel. They grow on slender, short pedicels of about the same length along the sides of a common peduncle, forming a flower cluster known as a "raceme." "Raceme" comes from the Latin word *racemus*, meaning "a bunch of berries" or "a cluster of grapes." The flowers grow somewhat like a cluster of grapes.

SUMMARY.

1. The gradual enlargement of the flower cluster.
2. Shape and green color of the buds.
3. Gradual change from green to some bright color.
4. Arrangement of flowers upon stalk.
5. Scape.
6. Bracts.
7. Buds change shape as they enlarge.
8. The flowers open; color and perfume.
9. Raceme.

THE FLOWER.

THE children will want to find the honey. Have them look at the outside of the flower for evidence of nectaries.

The tooth-shaped buds have opened out; the flowers have rounded tubes, more or less angular in outline. There are no spurs or other receptacles for nectar to be seen, unless the bulging angles make a convenient lodging-place for honey. The children probe carefully with the toothpicks. They search all the nooks in the angles of the flower cup, but search in vain. There is no nectar to be found.

But there is plenty of pollen. Does the hyacinth provide only pollen as an inducement to the insects?

STAMENS AND PERIANTH.

Look now at the stamens. There are six of them. They may be seen covered with pollen crowding the throat of the flower.

It is difficult to study these stamens without sacrificing the flower.

But at first do not suggest this. Merely notice their presence, covered with pollen, and their number; then look at the floral envelope. It is gamopetalous, but the border is composed of *six parts*.

How many parts had the floral envelopes of the morning-glory, the nasturtium, and the geranium? They seemed to prefer the number five. The hyacinth is the first flower studied which has six parts; it is also the first which has parallel-veined leaves.

All our five-parted flowers had net-veined leaves. Recall this fact frequently to the minds of the children.

If the children have studied some of the other flowers, ask whether the floral envelope of the hyacinth is a calyx or a corolla.

At first they will say corolla. Then they will readily recall how it was at first green and calyx-like.

Certainly there is no separate calyx or corolla.

What shall we call this envelope?

Some one will remember a similar difficulty in the case of the jewelweed or balsam, and suggest that it be called *perianth.* This is the right name for it.

If this is the first flower studied, tell the children the name of the bright part is *perianth,* and explain the meaning of the word. [See chapter on Morning-Glory.]

If this is the first flower studied, talk of the pollen and the bees as in chapter on Morning-Glory. Do not speak of nectar, since there is none, unless with older pupils. As a matter of fact, insects do obtain juice from the hyacinth flower, but not in the usual way.

Those pupils who have studied about the honey in other flowers will be interested to know that the insects pierce the succulent tissue of the hyacinth perianth and draw out its juices. In other words, they actually eat the perianth instead of taking honey from a special receptacle.

If this is the first flower studied, talk about the color and odor of the flower, the form of the peri-

anth, its making a tube for the reception of the bee and the pollen, all in relation to the visit of the insect. For hints in this work, see chapters on the Morning-Glory, Nasturtium, and Geranium.

We now approach the most difficult, and, for beginners, the one unsatisfactory part of our hyacinth.

THE PISTIL.

This is so low in the flower that it cannot be seen; the anthers fill the throat and completely hide it. It does not wait its turn and then come forth, as is the case with the nasturtium, jewelweed, and geranium pistils. The succulent perianth grows brown and flabby, and wraps yet closer about the pistil. The whole stalk of flowers takes on an appearance of decay; its odor is no longer agreeable. Finally the dried and withered perianth falls off, leaving behind a well-developed fruit. The stigma in most cases has disappeared. There is no clue to the story of fertilization.

In this event, what is to be done? The older pupils who have studied fertilization in other flowers can readily understand the explanation that the flower is self-fertile, though it is often cross-fertilized by insects, and no doubt desires this to take place, as is shown by its color and perfume.

Perhaps the best way out of the difficulty will be to cut the flowers from as many reserve stalks as necessary to supply one flower to each child. This

will be better than mutilating *all* the flower clusters, particularly as children often object to picking even one flower from the stem they have so long watched unfold.

This feeling of affection for their bright flower clusters need not be discouraged. If possible, supply flowers from the reserve bulbs; if this is not possible, then with a small knife or pair of scissors clip off one flower from each cluster where it will show the least.

Slit the perianth down to the peduncle and lay it open. Now the structure of the flower is very plainly visible.

The six stamens are seen attached to the perianth tube just above the pistil. The filaments are broad and very short. The anthers are long and open, or dehisce, by a lengthwise slit. The filament is attached at one point to the back of the anther. The cells open towards the center of the flower, so the pollen falls down upon the stigma.

We remember that the dehiscence of the morning-glory stamens was *extrorse*. They opened *away* from the center, so that an insect entering the flower for honey would be sure to become dusted with pollen.

The opening to the hyacinth anthers is *introrse*. They dehisce towards the center, and so are able to fertilize their own stigmas.

The pistil is of the same texture and color as the rest of the flower, and the stigma is often the color of the border of the perianth. The stigma is three-lobed and the style very short.

The ovary is a three-cornered, berry-like pod.

If this is the first flower studied, tell about the action of the pollen upon the ovules and its method of getting to them.[1]

The pollen ripens and falls upon the stigma.

Very often when the flowers grow out of doors, bees and other insects visit them and carry pollen from other plants. When this happens, the hyacinth probably prefers the foreign pollen, as its flowers are often crossed, as is shown by the colors.

The importance of the insect to the life of the hyacinth is much less evident than is its importance in many other flowers. Still, the coming of the bee for pollen and the use she makes of it will be very interesting to the children.

The color and fragrance of the hyacinth attest its desire for cross-fertilization. Doubtless an occasional

[1] See chapter on Morning-Glory; also Flowers and their Friends.

cross is essential to the well-being of the plant, and it may be that in some former stage the hyacinth was more perfectly adapted to cross-fertilization than at present.

Cut the ovary in two transversely. It is plainly composed of three cells, with two rows of ovules in each cell. The ovules are numerous and are attached to a central placenta. Notice that the seed-pod is triangular in shape.

Instead of cutting the ovary, a mature seed-pod can be examined if there are any such. Allow some of the pods to ripen and notice how they dehisce.

Each cell splits open down its back. A pod that opens this way is said to be "loculicidal," from the Latin word *loculus*, a cell, and another Latin word meaning "to cut." The cell is cut open down the back.

All the facts about the hyacinth should be discovered by the children themselves with the teacher's help, and at each step the children should write and draw in their books. For details in helping the children find and study the meaning and structure of the parts, see chapter on the Morning-Glory.

SUMMARY.

1. No nectar.
2. *Six* stamens.
3. Gamopetalous, *six-parted* perianth.
4. Filaments adhere to perianth.
5. Dehiscence of anthers introrse.
6. *Three-lobed* stigma; short style.
7. *Three-cornered* ovary; *three* cells to ovary with numerous ovules.
8. Central placenta.
9. *Triangular* pod; loculicidal dehiscence of pod.

Notice how three or a multiple of three recurs in the parts of the hyacinth. Recall how *five* recurs in the parts of the other flowers studied.

THE BULB AND LEAVES.

In the glass-grown plants it will be seen the roots are comparatively small and weak, and the plant has nothing but water and air to live on.

How can the stalk of flowers, the green leaves, and the offsets be developed from air and water?

Most plants require the mineral food found in the earth in order to grow and blossom; they cannot live on only air and water.

Where does our hyacinth get its food?

If we were to keep it in the water and not plant it in the earth at all, in time it would die unless we were to dissolve certain minerals which it needs in right proportions in the water; in that case it would continue to live from year to year just as though it were in the ground.

But we have not yet settled where it gets its materials for flowers and leaves.

Look at the bulb; how thick and solid it is. It is packed full of plant food which the leaves made for it in preceding years. Those who saw the bulb dis-

sected will know how it is made of fleshy scales; it is these fleshy scales that contain the plant food.

These fleshy scales are really transformed leaves, just as the bracts on the geranium are transformed leaves. These queer leaves do not grow up green and tall; they stay under ground, mere storehouses of food.

Only a few leaves near the center of the bulb grow up green and tall.

The bulb is in reality a very short, thick stem with scales instead of leaves. In the axils of these scales we find buds. The buds near the base grow into short, thick stems with scales instead of leaves; in other words, they become little bulbs. But in the axils of the upper scales, those near the center of the bulb, the buds develop true leaves and flower stalks.

These leaves are the ones we saw pushing out of the bulb and making room for the flower stalk. They open the door of the earth to the flowers. They get their material for growth from the food stored in the bulb. Then in return they work hard and make food out of air and water for the plant. The leaves and flower stalk are able to grow so fast because of the food stored in the bulb scales. The bulb would soon be exhausted if it were not for the

activity of the leaves. But they send food down to be again stored up in the bulb.[1]

After awhile the leaves fade and fall. But near the heart of the bulb, in the axil of one of the upper scales, a new bud has been formed. This contains tiny leaves and a tiny bud cluster, but it will not grow much until the next season, when again the leaves and flowers will spring forth.

Meantime from the axils of the lower scales other tiny buds have sprouted. They are in the form of bulbs and are only transformed branches, which, in fact, is what a bulb is,—a short branch bearing scales instead of leaves.

These bulblets have small scales stored with food drawn from the mother bulb; they have also a tiny bunch of leaves at the axil of one of the uppermost scales. In time they, too, will give forth leaves and flower stalks.

Thus we see the hyacinth has two methods of reproduction: one by seeds and one by buds, the buds being in the form of bulbs.

Hyacinths do not seed freely in this country, neither do they develop vigorously by means of bulbs. Our hyacinth bulbs soon "run out," as we say, or fail to put forth flowers, and we have to con-

[1] See Flowers and their Friends: "Chlorophyll," "Root Cells," etc.

tinually renew our stock from Holland, where the bulbs grow to great perfection. Much attention is paid to bulb culture in Holland, which is famous for its beautiful flowers.

SUMMARY.

1. The bulb as a storehouse of food.
2. Its scales transformed leaves.
3. Two kinds of buds in the bulb : Leaf and flower buds ; bulblets.

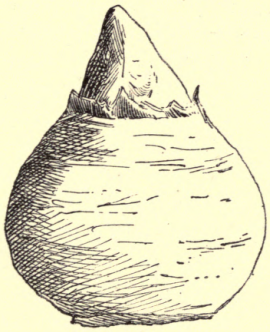
The younger pupils will not be able to understand the structure of the bulb ; for them it will be enough to know the thick scales are the storehouses of food for the plant.

The hyacinth has chosen the early spring for its blooming time. It needs water, and so comes up in the early spring rains. By the time the hot, dry summer weather arrives its work is done. It has matured its seeds, refilled its subterranean storehouse, and developed new bulbs. Now its leaves fade and fall. All that is left are the hard brown bulb and the young bulblets down in the ground, and the seeds that have fallen on the earth.

But we know what is stored up in the bulb, and how, when the next season rolls around, the hyacinth will be one of spring's first harbingers. We know,

too, that the seeds will sprout, if everything is favorable to their development, and that the leaves that grow from them will store up food in bulbs under the ground, and that in time these bulbs will also put forth long green leaves and stalks of bright flowers.

Under the dry, hot earth the bulbs lie all summer, while other plants, that require different conditions, live out their lives and shade the earth above the bed of the hyacinths.



GLOSSARY.

L. = Latin. A.-S. = Anglo-Saxon.

A.

Acuminate, *a.* L. *acuminatus*, sharp. Said of leaves that end in a long tapering point.

Acute, *a.* L. *acutus*, sharp. Said of leaves ending in a sharp point. Both acute and acuminate come from the same root *ak*, which means "to pierce."

Adhere, *v.* L. *ad*, to, *hærere*, to stick; to stick to. Said of unlike parts that grow together, as where petals grow fast to sepals.

Adhesion, *n.* L. *ad* and *hærere* (see above); the action of sticking. In the *adhesion* of flower parts one part *adheres* to the other.

Adnate, *a.* L. *ad*, to, *natus*, born or grown; grown to. An anther is adnate when grown by its whole length to the filament.

Air, *n.* The fluid which we breathe and which surrounds the earth; the atmosphere. The air is composed of oxygen and nitrogen in about the proportion of one to four. It also contains a very small quantity of carbon dioxide and more or less watery vapor.

Alternate, *a.* L. *alter*, other, *alternatus*, done by turns, first one and then another. Alternate is used of leaves standing singly at the nodes of a stem, one following another.

Angled, *a.* L. *angulus*, an angle, a corner; having angles. Said of stems, like those of the mint, which have angles instead of being round.

Annual, *a.* L. *annus*, a year; a plant that lasts but one year or season.

Anther, *n.* From a Greek word meaning "a flower"; that part of the stamen containing the pollen.

Apex, *n.* L. *apex*, point, tip; the end of a leaf farthest from the stem.

Axil, *n.* L. *axilla*, little armpit; the angle formed between the upper side of a leaf and the stem or branch to which it is attached.

Axillary, *a.* Pertaining to the axil ; growing from the axil. Flower buds and branches often grow from axils.

B.

Balsam, *n.* The name of a flowering plant closely related to the jewelweed.

Base, *n.* Old English *bass*, low. Applied to the lower part of a leaf, or the part next the stem.

Beard, *n.* A crest, tuft, or covering of spreading hairs found in the corolla of some flowers.

Bindweed, *n.* The name of some members of the Convolvulus Family, so named because of their habit of twining about and binding the weeds together.

Blade, *n.* A.-S. *blœd*, a leaf, broad part of a thing. Applied to the broad part of a leaf.

Bract, *n.* L. *bractea*, a thin plate of metal, gold-leaf. Used of small, usually thin, leaf-like parts, often found near a flower or flower cluster.

Bracted bindweed, *n.* The name of a convolvulus whose sepals are covered by two large bracts.

Branch, *n.* A subdivision of the main stem of a plant.

Bulb, *n.* L. *bulbus*, a bulbous root, an onion ; the name of the underground, scale-covered part of hyacinths, etc.

Bulblet, *n.* A little bulb. Used in this book of the tiny bulbs growing in the axils of the scales of the hyacinth bulb.

C.

Calyx, *n.* From a Greek word meaning "to cover"; the outer set of envelopes which form the perianth of a flower. They are often green and persistent, and serve to protect the ovary.

Capitate, *a.* L. *caput*, head, head-shaped. Used of a thick, rounded stigma.

Carbon, *n.* L. *carbo*, a coal ; an element found in nature. The diamond is one form of carbon, graphite is another, coal is another. In union with oxygen, one atom of carbon to two of oxygen, it forms carbon dioxide, a heavy gas.

Carbon dioxide, *n.* A heavy gas, found as an impurity in the air. It is breathed out by animals and plants. Plants also absorb it and use it in constructing plant material.

Carbonic acid gas, *n.* An old name for carbon dioxide.

Carpel, *n.* From a Greek word meaning "fruit"; a simple pistil or one of the chambers of a pistil.

Chlorophyll, *n.* From two Greek words meaning "light green" and "leaf," leaf-green; the green coloring matter of vegetation.

Claw, *n.* A.-S. *clawn*, a claw, hoof; the narrow base of a petal.

Cohere, *v.* L. *co*, together, *hærere*, to stick; to stick together. Used of the union of different parts of the same flower whorl.

Cohering, *a.* Sticking together.

Cohesion, *n.* The state of sticking together.

Conduplicate, *a.* L. *con*, together, *duplicare*, to double; to double or fold together. Said of leaves in the bud when they are folded down the middle so that the halves of the blade lie face to face against each other.

Cone, *n.* L. *conus*, a cone or peak; the name of a solid form; the fruit of the pine, fir, and spruce.

Connive, *v.* In botany has the same meaning as converge, to have a gradual inward direction, to be brought close together. Said of anthers that grow towards each other so as to touch.

Connivent, *a.* Brought close together.

Convolvulaceæ, *n.* The name of the family to which the bindweed, morning-glory, and other similar plants belong.

Convolvulus, *v.* L. *con*, together, *volvere*, to roll; to roll or wind together; the botanical name of the bindweed, so called from its twisting habit.

Cornucopia, *n.* L. *cornu*, horn, *copia*, plenty; horn of plenty.

Crenate, *a.* L. *crena*, a notch. Said of a leaf margin which is cut into rounded scallops.

Cross-fertilization, *n.* The fertilization of the ovules of one flower by the pollen of another.

Cupid, *n.* In Roman mythology the god of love, son of Venus, the goddess of beauty; generally represented as a beautiful boy with wings, carrying a bow and quiver of arrows.

Cylindrical, *a.* Shaped like a cylinder.

D.

Dehisce, *v.* L. *de*, off, *hiscere*, to gape, yawn. Used of the splitting open of ripe seed-pods or anthers.

Dehiscence, *n.* The opening of a seed-pod or an anther for the discharge of seeds or pollen.

Distinct, *a.* L. *distinguere*, to separate, divide; separate. Said of flower parts of the same whorl which are not united, but stand free from each other.

Down, *n.* The fine, soft covering of hairs upon some plants and fruits and seeds; the light feathery hairs upon some seeds, as the dandelion and thistle, by which they are borne upon the wind.

E.

Entire, *a.* L. *integer*, whole; whole, unbroken. Applied to the margin of a leaf that is not notched or cut.

Essential organs, *n.* The pistil and stamens are called "essential organs" because they are necessary to the formation of seed, and consequently essential to the continued life of the plant.

Evaporation, *n.* L. *evaporatus*, dispersed into vapor; the conversion of a solid or liquid by heat into vapor. Most often used in reference to the conversion of water into vapor. The warm air of summer causes a rapid evaporation of the water from the leaves of plants.

Exotic, *a.* and *n.* From a Greek word meaning "foreign," "alien." Said of plants introduced from a foreign country.

Extrorse, *a.* L. *extra*, outside, *versus*, turned; contracted from Latin word *extraversus*, turned toward the outside. Applied to an anther turned away from the center and opening toward the perianth.

F.

Feather-veined, *a.* Having a series of veins branching from each side of the mid-rib of a leaf, somewhat resembling the structure of a feather.

Fertilization, *n.* The process by which the pollen acts upon the ovule, resulting in the production of seeds.

Fertilize, *v.* L. *fertilis*, fruitful; to make fruitful or productive, in the flower, by introducing the pollen to the ovule, enabling them in union to become a seed.

Fibres, *n.* L. *fibra*, a filament, a fibre; fine, thread-like parts of a plant.

Fibrous roots, *n.* Fine thread-like roots.

Filament, *n.* L. *filum*, a thread; the stem of an anther, often thread-like in form, though it varies greatly; any thread-like part.

Floral envelopes, *n.* The calyx and corolla that fold about or envelope and protect the essential organs.

Free, *a.* When flower parts are not united with, or inserted upon, other flower parts in a different whorl.

Fruit, *n.* The matured ovary and all it contains or is incorporated with. Sometimes the calyx forms part of the fruit, as in the apple.

G.

Gamopetalous, *a.* From two Greek words meaning "marriage" and "leaf" or "petal"; having the petals united or grown together.

Gamosepalous, *a.* This is not a very good word, as it is formed by a mixture of Greek and Latin. *Gamo* comes from a Greek word meaning "marriage" or "union," and *sepalous* from L. *sepalum*, a division of the calyx; it means having the sepals united or grown together.

Ganymede, *n.* In Greek mythology, a beautiful youth, cup-bearer to the Olympian gods.

Geranium, *n.* From a Greek word meaning "crane's bill"; the name of a plant, so called because of the long projecting beak of the seed-vessel.

Glabrous, *a.* L. *glaber*, smooth, without hair; having a smooth, hairless surface.

Gland, *n.* Certain cells upon or near the surface of a plant that secrete, or take from the sap, certain substances. The nectary is a gland that secretes a sweet juice.

Greeks, *n.* The people who inhabit Greece. When we say "Greeks" we usually mean the ancient inhabitants of Greece, who are noted for their wisdom and for the beautiful buildings and statues they created.

H.

Halberd-shaped, *a.* Shaped like a halberd, or old-time battle-ax. Applied to the base of a leaf of a certain shape.

Hastate, *a.* L. *hasta,* a spear; shaped like the head of a spear. Applied to the base of a leaf of a certain shape thought to resemble a spearhead.

Hebe, *n.* In Greek mythology the goddess of youth and spring, and cup-bearer to the gods on Mt. Olympus until supplanted by Ganymede.

Honey, *n.* A sweet liquid formed by bees and other insects from the nectar of flowers. Nectar is also called honey.

Honeycomb, *n.* The structure of wax cells in which bees deposit honey for future use.

Hyacinth, *n.* The name of a plant; also of a precious stone.

Hydrogen, *n.* Comes from two Greek words meaning "water producing." It is a very light, invisible gas, and when chemically united to oxygen, two parts of hydrogen to one of oxygen, the result is water.

I.

Imbricated, *a.* L. *imber,* rain, *imbrex,* a hollow tile to shed rain from roof; *imbricare,* to cover with gutter tiles; lying over one another, or lapping, like tiles on a roof. Applied to some sepals as they are wrapped about the bud.

Impatiens, *n.* L. *impatiens,* impatient; the name of a genus of plants, so called because of the sudden snapping of the seed-vessels when touched; also called snapweed and touch-me-not.

Included, *a.* L. *in,* in, *claudere,* to shut, close; confined within something. Said of the stamens when they do not project beyond the mouth of the corolla.

Inherit, *v.* L. *in,* in, *heres,* heir; to take by descent from an ancestor, to occupy the position of an heir. Plants, like people, inherit their characteristics from their parents.

Inheritance, *n.* That which is inherited.

Innate, *a.* L. *innatus,* inborn. An anther is innate when borne upon the end of the filament, forming a continuation of it.

Insipid, *a.* L. *in*, without, *sopidus*, having a taste ; without a taste, tasteless. *In* used as a prefix occasionally, as in this case, means "without."

Internode, *n.* L. *inter*, between, *nodus*, a knot, a joint ; the space on a stem between two nodes.

Introrse, *a.* L. *intro*, within, *vertere*, to turn ; contracted from *intro-versus*, turned or facing inward. Used of anthers that open towards the pistil.

Involute, *a.* L. *in*, in, *volutus*, rolled ; rolled in. Said of leaves or petals that in the bud are rolled inward from the edge.

Iron, *n.* A very abundant and very important metal ; found also in the tissues of plants in small quantities.

J.

Jewelweed, *n.* One of the names of the plant called impatiens, so called because of its flowers that hang like pendants from their slender stems, or because of the leaves that shine like silver when held under water.

Jupiter, *n.* In Roman mythology the chief of the gods.

L.

Lady's eardrop, *n.* A name for the jewelweed, so called because of the bright pendent blossoms.

Lady's slipper, *n.* A name sometimes given to the garden balsam because of the shape of the blossoms.

Leaf, *n.* The green expanded organs of plants by means of which they receive and use carbon dioxide, and give off water and other wastes.

Line of dehiscence, *n.* The line along which a seed-pod or an anther splits open.

Linear, *n.* L. *linea*, a line ; like a line or thread. Said of very narrow leaves or stigmas.

Linnæus, *n.* A celebrated Swedish botanist and naturalist. Born in Sweden, 1707 ; died, 1778. Wrote many important books on botany.

Lobe, *n.* From a Greek word meaning "the lobe of the ear"; a rounded, and more or less globular projection or part. Used of the divisions of the stigma.

Loculicidal, *a.* L. *loculous*, a cell, *cædere*, to cut. Used when a seed-vessel splits open down the back. The cell itself is cut open, instead of separating from the neighboring cells.

M.

Magnesium, *n.* A metal that is very abundant in solutions in sea water, and also in the earth's crust. It is found in the composition of animals and some plants.

Margin, *n.* L. *margo*, edge, border. The edge of a leaf is called its margin.

Mid-rib, *n.* The rib in the middle of a leaf.

Minerva, *n.* In Roman mythology one of the principal goddesses, the goddess of wisdom and of war.

Monadelphous, *a.* From two Greek words meaning "only," "alone," and "brother"; one brotherhood; having the stamens united by their filaments into one set.

Morning-glory, *n.* A well-known plant belonging to the Convolvulus Family.

Mt. Olympus, *n.* In Greek mythology the abode of the gods.

N.

Nasturtium, *n.* L. *nasus*, nose, *tortus*, convulsed; the name of a plant, so called because of its acrid juice that causes a stinging sensation at the back of the nose when it is tasted.

Natural Selection, *n.* A term given by Darwin to that process of nature by which some animals and plants are preserved and others destroyed. If the animal or plant is in harmony with its surroundings, it continues to live. If for any reason the surroundings change, so that the animal or plant cannot agree with them, the living forms die out, leaving only those that *can* agree.

Nectar, *n.* The drink of the gods on Mt. Olympus. Applied to the honey of flowers.

Nectar guides, *n.* The colored lines on flowers which lead to the nectary, and are supposed to lead insects to the nectar.

Nectary, *n.* The receptacle in which the nectar of flowers is collected; also the gland which secretes the nectar.

Net-veined, *a.* Said of a leaf when it is traversed by fine veins forming a network.

Nitrogen, *n.* One of the gases that compose the air and which is necessary to the formation of all living bodies, whether plant or animal.

Node, *n.* L. *nodus*, a knot; the part of a stem which bears a leaf or leaves. It is often a little larger than the rest of the stem.

O.

Opposite, *a.* L. *op*, *ob*, over against, *positus*, set or placed; set over against. Applied to leaves where there are two at a node standing opposite to each other.

Orbicular, *a.* L. *orbiculus*, a small disc. Said of a leaf which has a nearly circular outline.

Ovary, *n.* L. *ovum*, an egg; the lower part of the pistil which holds the eggs or seeds of the plant.

Ovate, *a.* L. *ovum*, an egg; egg-shaped. Said of a leaf which is broader at the base than at the apex; shaped like the section of an egg cut lengthwise.

Ovule, *n.* L. *ovum*, an egg; a little egg. Applied to the rudimentary seeds of plants, which, upon fertilization and growth, become true seeds.

Oxygen, *n.* One of the gases that compose the air and which is essential to life. It is also found in composition in the tissues of plants and animals.

P.

Palmately veined, *a.* L. *palma*, the palm. Said of leaves which have the veins branching from the stem, somewhat like the fingers from the palm of the hand.

Parachute, *n.* L. *parare*, to prepare, guard against, French, *chute*, a fall; an umbrella-like apparatus for descending unhurt from high places.

Parallel-veined, *a.* Said of leaves whose veins are parallel or nearly so.

Parenchyma, *n.* From two Greek words meaning "beside" and "pour in"; something poured in beside; the cellular tissue that fills in the spaces between the veins of leaves, and between the stiffer fibres of other parts of the plant.

Pathfinders, *n.* Nectar guides.

Pedicel, *n.* L. *pediculus*, a little foot; the stalk that supports only one flower where there are several on a peduncle.

Peduncle, *n.* L. *pedunculus*, a little foot; a flower stalk. It sometimes supports one flower, sometimes a cluster of flowers.

Pelargonium, *n.* From a Greek word meaning "a stork"; a member of the Geranium Family, so called because of the beaked seed-pods.

Peltate, *a.* L. *pelta*, a light shield; shield-shaped. Said of a leaf which is nearly circular and has the stem fastened near the center.

Perfect, *a.* Said of flowers which contain both stamens and pistils.

Perianth, *n.* From two Greek words meaning "around" and "flower"; around the flowers; a name for the floral envelopes which stand around the essential organs.

Persist, *v.* Said of bracts, petals, or other organs which do not fall, but remain in their places, often drying up.

Pestle, *n.* L. *pistillum*, a pounder; a sort of handle with a knob for pounding substances in a mortar.

Petal, *n.* From a Greek word meaning "a leaf"; one of the leaves of a corolla.

Petiole, *n.* L. *petiolus*, a stem or stalk of fruits; the stem of a leaf.

Pistil, *n.* L. *pistillum*, a pestle; the seed-bearing organ of a flower, composed generally of three parts: ovary, style, and stigma; called pistil because of its shape.

Placenta, *n.* L. *placenta*, a cake; that part of the ovary of flowering plants which bears the ovules. Often flattened and softer in texture than the surrounding parts.

Plaited, *a.* L. *plicatum*, folded; folded, pleated. Used of the fan-like folding of leaves in the bud.

Pod, *n.* The name of any dry, dehiscent, several-seeded seed-vessel.

Pollen, *n.* L. *pollen*, fine flour; the dust or grains of fertilizing material found in the anthers of flowers.

Polypetalous, *a.* From two Greek words meaning "many" and "leaf." Said of a flower having two or more separate petals.

Polysepalous, *a.* From a Greek word meaning "many" and the Latin word *sepalum*, sepal. Said of a flower whose calyx is composed of two or more separate sepals.

Potassium, *n.* A substance found in combination with other things in the earth's crust, and forming an important element in the substance of plants and animals.

Proboscis, *n.* From two Greek words meaning "before" and "feed"; the trunk of an elephant; the "tongue" of a fly, bee, butterfly, etc.

Proterandrous, *a.* From two Greek words meaning "being before" and "male"; the ripening and discharge of the pollen or male element in a flower before the ripening of the stigma or female part.

Pubescent, *a.* L. *pubes*, downy; covered with fine hairs or down.

Pungent, *a.* L. *pungere*, to prick; pricking, stinging to the taste.

R.

Raceme, *n.* L. *racemus*, a cluster of grapes; a cluster of flowers like that of the lily of the valley or of the hyacinth.

Receptacle, *n.* L. *recipere*, to receive; the end of a flower stem which receives the flower parts or to which they are grown.

Reproduction, *n.* L. *re*, again, *producere*, to produce; the process by which new plants or animals are produced from those already existing.

Ribs, *n.* The large veins forming the framework of a leaf.

Romans, *n.* The inhabitants of Rome, the capital of Italy.

Root, *n.* The part of a plant that usually grows down into the soil, fixing the plant and absorbing nutriment.

Rootlet, *n.* A little root; one of the final divisions of the main root.

Rosette, *n.* L. *rosa*, a rose; a circular ornament having many small parts regularly arranged around the center; a circle of leaves.

S.

Sac, *n.* L. *saccus*, a bag; a sac, bag, or pouch.

Schedule, *n.* A list, catalogue, or table.

Secrete, *v.* L. *secernere*, to separate; to form from the materials of the sap or the blood a new substance. Glands secrete.

Secundus, *n.* L. *secundus*, second ; the name given in this book to a suppositional plant.

Seed, *n.* The fertilized and matured ovule of a flower.

Seedlet, *n.* A little seed.

Seed-pod, *n.* The pod or case which contains seeds.

Seed-vessel, *n.* The case which contains seeds.

Self-fertilization, *n.* The process by which a flower is fertilized by its own pollen.

Sepal, *n.* L. *separ*, separate ; one of the separate leaves that form the calyx.

Serrate, *a.* L. *serra*, a saw ; notched or toothed on the edge like a saw.

Sessile, *a.* L. *sedere*, to sit. Said of a leaf which has no petiole, but sits directly on the branch ; of a flower that has no peduncle, and a stigma that has no style.

Sexual reproduction, *n.* The form of reproduction which requires the union of two sexes.

Sheath, *n.* A case or covering.

Side ribs, *n.* The large veins which are arranged at each side of the mid-rib, and which help form the framework of a leaf.

Silica, *n.* A substance found in certain rocks, also in glass. Very hard. It is found in the substance of certain plants.

Snappers, *n.* A name for the jewelweed, because of the snapping of the seed-pods.

Snapweed, *n.* The same as snappers.

Sodium, *n.* One of the elements of common salt, and also found in tissues of plants and animals.

Species, *n.* L. *species*, a particular sort ; a special division of plants or animals.

Spiral, *n.* L. *spira*, a coil ; a coil like that of a watch spring.

Spur, *n.* A pointed instrument worn on the heel to goad a horse ; any sharp projection formed somewhat like a horseman's spur.

Stamen, *n.* L. *stamen*, a thread, string, fibre ; the organ in the flower containing the fertilizing pollen.

Starch, *n.* A substance composed of carbon, hydrogen, and oxygen, forming one of the principal elements in plants and necessary as food to animals.

Stem, *n.* A.-S. *stemn*, stem, trunk of a tree; the stalk which supports flower, fruit, or leaf; also used for the trunk of a tree or other plant.

Sterile, *a.* L. *sterilis*, unfruitful. Said of a stamen without pollen or of an ovary without perfect seeds.

Stigma, *n.* The structure at the top of the style where the pollen is received.

Style, *n.* L. *stilus*, a stake, a stem; the slender portion between the ovary and the stigma.

Succulent, *a.* L. *succus*, juice; juicy.

Superior, *a.* L. *superior*, higher; more elevated in place. Said of the ovary when it is above the other flower parts, that is, when they are attached to the receptacle below it.

Survival, *n.* L. *super*, alone, *vivere*, to live; the act of surviving or living beyond the life of another.

T.

Tissue, *n.* L. *texere*, to weave; a woven fabric; the cellular fabric of plant structures.

Touch-me-not, *n.* A name of the jewelweed, so called because of its snapping seed-pods.

Tropæolum, *n.* From a Greek word meaning "a turning," hence a turning of the enemy, a defeat; finally, the sign of a defeat, a trophy; the name of a genus of plants, so called because of the shield-shaped leaves, many shields together suggesting the trophies taken from the enemy.

Tunic, *n.* L. *tunica*, a tunic; the name of a garment worn by the Romans, a loose flowing robe, hence any garment; a name given to the scaly coverings of bulbs like the onion and hyacinth.

Tunicated, *a.* Having a tunic.

Twine, *n.* A.-S. *twīn*, a double thread, a thread made of two strands twisted; to make double by twisting two strands together, hence to twist, to wind or coil about something, as the morning-glory or convolvulus vine.

U.

Umbel, *n.* L. *umbella,* a sunshade, parasol; a flower cluster in which the pedicels all grow from the top of a peduncle and are about the same length, making the top of the flower cluster more or less the shape of a parasol.

V.

Valve, *n.* L. *valva,* one-half of a double door; one of the divisions into which a seed-pod separates when ripe.

Veins, *n.* The stiff, thread-like parts forming the framework of leaves, petals, sepals, etc.

Venation, *n.* The manner in which veins are distributed in the blade of a leaf.

Venus, *n.* In Roman mythology the goddess of love and beauty.

Vernation, *n.* L. *venare,* to be like spring; the position of leaves in the bud before unfolding (leaves generally unfold in the spring).

Versatile, *a.* L. *versare,* to turn; able to move. Said of anthers hung in the middle so as to swing freely.

Vine, *n.* L. *vinea,* a grape vine; a plant with a long, slender stem that cannot stand alone.

W.

Water, *n.* A well-known liquid composed of two parts of hydrogen to one of oxygen.

Whorl, *n.* A ring of organs all from the same center.