FLOWERS AND THEIR FRIENDS

Margaret W. Morley.

GINN & COMPANY.

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BY

MARGARET WARNER MORLEY

AUTHOR OF "SEED-BABIES," "A FEW FAMILIAR FLOWERS," ETC.

BOSTON, U.S.A., AND LONDON
GINN & COMPANY, PUBLISHERS
The Athenæum Press
1897

A LETTER

TO THE READERS OF THIS BOOK.

DEAR CHILDREN, —

It would be very stupid indeed to try to read a book written in Arabic or Hebrew; we should soon tire and put it down.

It is just as uninteresting to read English words whose meaning we do not understand; we might as well devote ourselves to a foreign and unknown tongue.

I hope you will never do it. If you do not know what a word means, find out. There is a list of words you may not know at the back of this book to help you. They are all words used in the book, and if you look you may not find them as stupid as you think. Some day you will discover that the dictionary is quite an exciting and interesting volume.

Meantime enjoy the flowers and their insect friends all you can, and be sure you know the meaning of all the words that tell about them.

Your friend,

THE AUTHOR.

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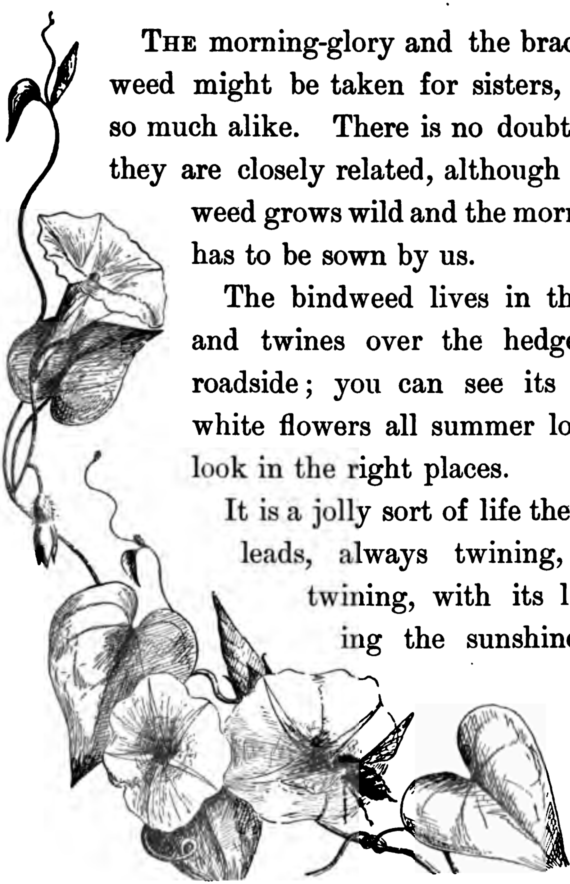
THE FLOWER.



THE morning-glory and the bracted bindweed might be taken for sisters, they look so much alike. There is no doubt but that they are closely related, although the bindweed grows wild and the morning-glory has to be sown by us.

The bindweed lives in the country and twines over the hedges by the roadside; you can see its pink-and-white flowers all summer long if you look in the right places.

It is a jolly sort of life the bindweed leads, always twining, twining, twining, with its leaves facing the sunshine and its flowers dancing on their slender stems.

We often call the bindweed the wild morning-glory, and we and the bees are fond of it. We enjoy looking at it, and probably the bees do, too, though they have yet another reason for liking it. Just watch one go into a wild morning-glory some fine day. You will think she expects to find something very delightful indeed from the way she hurries in. And so she does. She buzzes down the white line to the very bottom of the flower, crowds her head as far in as she can get it, and then thrusts her long brown tongue yet deeper in to where the honey lies. For the flower makes honey for the bee, and keeps it hidden as deep as possible. There are five openings in the bottom of the flower cup that go straight into the honey wells. You need only look into a morning-glory and you will see them. All kinds of morning-glories, as well as the bindweeds, have them.

The bees know this, and wherever you see the morning-glories you will see their little winged friends.

Very many flowers provide honey for the insects, and it is fortunate for us that they do; for if they did not, we should see no butterflies and have no honey, for butterflies and bees cannot live without the honey the flowers give them.

Flower honey has a special name; we often call it nectar, for a good reason which I mean to tell you another time.

The places where the nectar is stored are the nectar holders, or nectaries.

It must be a fine thing to go to a flower and take a drink of honey whenever you wish; but what will you say when I tell you the bees get bread as well as honey from the flowers?

Yet this is what happens. You could not live upon honey alone; neither could a bee. Perhaps you could not live upon bread and honey; but you could if you were a bee, that is, *beebread* and honey.

For beebread is much more nutritious than the bread we eat. In fact, it takes the place of meat and eggs and milk and all the other things we take such pains to get.

You do not see where a bee finds bread in a flower?

That is because you are not a bee. If you were, you would know at once.

Suppose you watch a bee go into a morning-glory.

She will be in a great hurry, and you will have to keep your eyes open, or it will be all over before you know what has happened.

She will suck up the honey, and then very likely she will turn around and around on the white pole-like part that stands up in the middle of the flower. She is not doing this for fun, nor because she is confused and does not know which way to go next.

She is gathering fine flour of which to make bee-bread.

Put your finger into the morning-glory and you, too, may gather this fine flour.

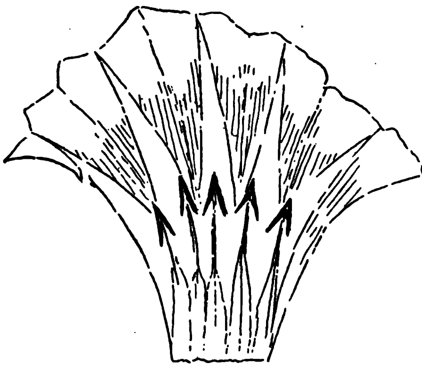
When you take your finger out there will be something like fine white powder clinging to it. Well, that is the flour from which the bee makes her bee-bread. We call it *pollen*, and if we look closely we shall find it is stored in five tiny boxes.

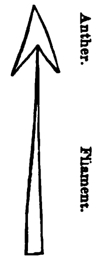
These boxes, which are called *anthers*, open by a slit along one side, and the bee puts her funny little feet into the slits and scrapes out the pollen, which she moistens with honey and packs into baskets on her hindermost legs, or fastens to the hairs on the under side of her body.

Then she goes home and packs her load away in the hive for future use.

You see it is not much trouble to make beebread — that is, if you know how. It does not have to be raised or baked, yet I doubt if you or I would be able to make it so that a bee would consider it fit to eat.

These anthers are held up on long white stalks which grow to the inside of the flower cup, and which are named *filaments*.





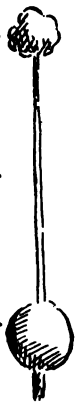
Since there are five anthers there are five filaments.

We call the whole thing, anther and filament, a *stamen*.

But this is not all there is to be found in a morning-glory flower. There is something else, and if it were not for this something else we should not have the fun of learning about honey and stamens, because there would be none! Both honey and stamens exist because of this something else.

It is in the very center of the flower, and the stamens stand about it in a circle. It stands up like a pole and has a knob at the top. The knob sticks out above the stamens as a rule. When the flower cup falls, the stamens fall too, because the filaments grow fast to it. But this something else does not fall. It stays on the vine, and you can see it better after the flower cup has fallen.

We call it the *pistil*. It has neither honey nor pollen, yet on its account the bees and butterflies visit the flowers.



THE PISTIL.

Here is its picture, and you may look at it as carefully as you please. The knob at the top is called the *stigma*, the long, slender part is called the *style*, and the round bottom the *ovary*.

If you look over all the vine you will make a discovery. You will find a great many of these pistils in different stages of growth. When the flower cup first falls off, the pistil is very small and has its style and stigma. Then the style and stigma fall, and only the ovary remains. This grows larger and plumper, and you tell me it is the seed-pod and is full of seeds. You are right about that; it *is* the seed-pod, and the pistil is the part where the seeds grow.

So now you see how very important it is, and I would advise you to take another look at it.

If there were no seeds there could be no more plants, so the growth of the seed is a matter of great importance.

When the seed first begins to form it is tiny and soft and delicate. It is attached to the inside of the ovary, and we do not then call it a seed, but an ovule. The word "ovule" means "little egg," and the ovules are really the eggs of the plant, as you will agree if you think a moment.

If all goes well, the tiny, soft ovule becomes a large, hard seed. But it cannot do this alone; it needs help. Probably you never could guess what helps it, so I will tell you at once: it is the pollen.

If a pollen grain can unite with an ovule, the two thus joined together can grow into a seed. So you see the flower does not provide pollen for the use of the bee alone. It makes it for its own seed-children.

But the bee is the messenger that carries the pollen to the ovule. You see the pollen grain of our morning-glory lies in the anther below the stigma, and it must reach the stigma so as to find its way down to the ovary. Just how all this comes about you will know later; only now remember that the pollen must get to the stigma, and that the bee puts it there. Not on purpose, though. The bee collects pollen for her own use, but in doing so touches the stigma with her pollen-covered body, and some of the pollen grains stick to the stigma instead of remaining on the bee.

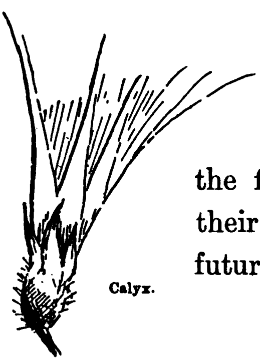
When the pistil is ripe, the stigma is sticky and holds fast the pollen grains that touch it. The union of ovule and pollen is called *fertilization*, and by flying about from flower to flower the insects carry pollen from one flower to another, and thus fertilize the plants.

You will know a great deal more about this later.

So we see the pollen is made for the sake of the seeds. The honey is also made for the sake of the seeds, for it attracts the insects that are necessary to fertilize the flower. Even the flower cup has its bright and beautiful coloring to attract the attention of the insects and call them to it. The name of the flower cup is the "corolla," and means "a little crown" or "garland."

The corolla is not the only covering the inner parts have. Look at the end of the flower next the stem and you will see the green calyx. When the corolla falls off, the calyx stays and protects the tender ovary. The calyx has five parts, or sepals, and these fold about the ovary like a green cup and keep it safe.

When the ovules are ready for the pollen, the flower puts on its beautiful garland as a sign that the life of the plant is to be renewed.

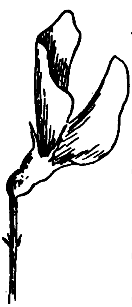

Calyx.

When we look at the flowers in the fields and gardens we may know that their loveliness is also a promise for the future.

THIS IS THE FLOWER SO BRIGHT AND GAY.

MOST flowers have, like the morning-glory, corolla, stamens, and nectar to assist the pistil in developing the seeds.

The sweet pea has, and somebody once told a story about it that I am going to tell you, because I think it will help you to remember the parts of the flower and their uses.



This is the flower so bright and gay.

This is the stamen that lives in the flower so bright and gay.

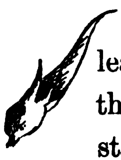
 This is the anther that grows on the stamen that lives in the flower so bright and gay.

This is the pollen that lies in the anther that grows on the stamen that lives in the flower so bright and gay.

This is the bee that gathers the pollen that lies in the anther that grows on the stamen that lives in the flower so bright and gay.

This is the stigma that brushes the bee that gathers the pollen that lies in the anther that grows on the stamen that lives in the flower so bright and gay.

This is the style that leads from the stigma that brushes the bee that gathers the pollen that lies in the anther that grows on the stamen that lives in the flower so bright and gay.



This is the ovary that stands under the style that leads from the stigma that brushes the bee that gathers the pollen that lies in the anther that grows on the stamen that lives in the flower so bright and gay.

This is the ovule that hides in the ovary that stands under the style that leads from the stigma that brushes the bee that gathers the pollen that lies in the anther that grows on the stamen that lives in the flower so bright and gay.

This is the seed that grows from the ovule

BECAUSE

the ovule hid in the ovary, the ovary stood under the style, the style led from the stigma, the stigma brushed the bee, the bee gathered the pollen, the pollen lay in the anther, the anther grew on the stamen, and the stamen lived in the flower so bright and gay!

THE CALYX.

The calyx is green.

The calyx is strong.

The calyx protects the ovary.

It has five sepals — five green sepals.

They overlap like the tiles on a roof and thus protect the ovary from rain. They also protect it from insects that otherwise might destroy it.

The calyx covers the base of the corolla and forms a green urn, a little vase, in which to hold it secure from harm.

It is not bright and delicate like the corolla, but what would the flower do without it?

BLOSSOM DEAR.

Blossom dear, what is the power
  Draws the shining wings to thee?
Nestled in thy dainty bower
  I can always find a bee.

Little friend, my bees find honey
  Hidden deep as deep can be.
Without fear and without money
  Come they for these sweets to me.

Flower, flower, give *me* honey,
  Give me honey from thy store.
I will pay with love and money;
  Piles of money, and love much more.

Dear, I cannot give you honey.
Shall I truly tell you why?
Bees are better far than money
As they have wings, but you
can't fly!

So I coax them with my honey,
Feed them with my very best,
While their wings bear life to many
Waiting in the cradle nest.

For the children of the flowers
Need the precious pollen dust,
And the bees have winged powers
To bear to them this sacred trust.

WHAT HAPPENED IN THE GARDEN.

THE morning-glory lay rolled up in the bud down under the leaves. One day it bloomed.

The firm stem held it up, the bud unrolled, and the blossom stood there, fresh and fair.

The bees saw it from afar, and came as fast as they could.

They flew to the pink corolla, and, entering, enjoyed the feast spread for them.

The morning-glory, because of their coming, had filled the nectar cups and opened the boxes of snow-white pollen.

One after the other the bees came, drank the nectar, and carried away the pollen. As fast as the cups were emptied they were filled again.

The honeybees and the bumblebees were provided with baskets, which they filled with pollen; but the other bees carried it away on the long hairs of their bodies.

The morning-glory glowed in the sunshine all day long, happy, no doubt, in the consciousness that the little seed-children had begun to grow. It was because of them the bees were made so welcome.

We can imagine the flower might feel like saying, "This is my seed-children's birthday party; come often, dear bees, and sip my nectar and take my pollen. But be like the good fairies and bring each a gift to my seed-children."

The bees buzzed and came and went and came and went.

Each time they took away nectar and pollen to their hives, and each time left something for the seed-children.

Do you suppose they left a cap of darkness, and a pair of seven-league boots, and a sword that always conquered, and a magic carpet that took people wherever they wanted to go, as the fairies used to do in the times when fairies were alive and came to the christenings of little children?

I do not think the bees brought any of these things to the birthday party of the seed-children.

The bees, not being real fairies, were obliged to bring what they could.

Now, the day that the pink morning-glory bloomed, a great many other morning-glories came out of their buds, and they all gave the bees a welcome.

They filled their cups with nectar and opened their boxes of snow-white pollen.

Such a feast as was spread for the bees! Blue morning-glories, and pink and purple and white ones, on all sides they stood, fresh and smiling, and invited the bees to come.

And the bees came. They went from one to the other as fast as they could. They sucked up nectar from all, and took it home and made morning-glory honey of it. And they gathered snow-white pollen from all, and took it home and made morning-glory beebread of it.

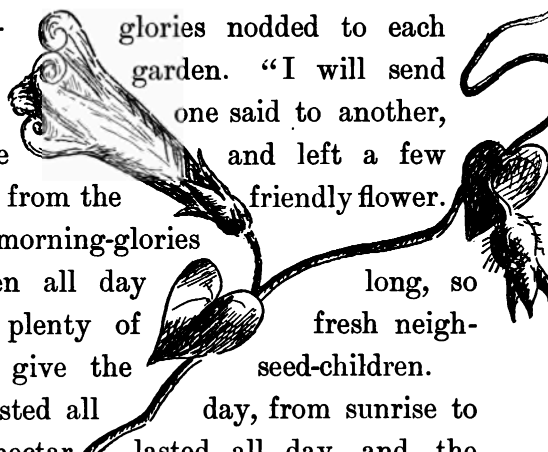
But they did not carry home all the

snow-white pollen. They bore some of it as gifts to the seed-children.

The seed-children needed the pollen; they could not grow into seeds without it, and they needed the pollen from another flower, not that from their own.

So the pollen the bees brought them was better far than caps or boots or carpets or any of those things the fairies used to bring to human children.

And this is why the morning-glories made the bees so welcome. They could not take their pollen to each other, for they could not leave their stems; so they employed the bees to carry it for them.



The morning-glories nodded to each other across the garden. "I will send my bee to you," one said to another, and the bee came and left a few grains of pollen from the friendly flower. In this way the morning-glories exchanged pollen all day long, so that each had plenty of fresh neighbors' pollen to give the seed-children.

The flowers lasted all day, from sunrise to sunset, and the nectar lasted all day, and the snow-white pollen. But when night came the bees went home to sleep, and the morning-glories, too, slept. They rolled in the edges of their corollas so that the way to the nectar cups was closed.

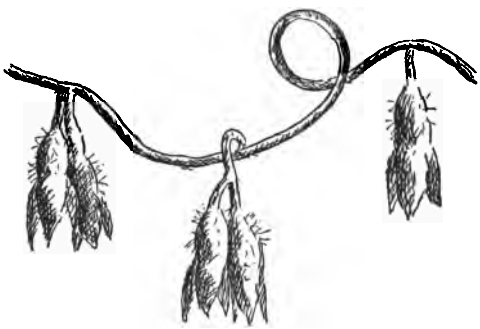
Next day the morning-glories did not open again. There was no more nectar in their cups and no more snow-white pollen in their anther cells. Other morning-glories came out of their buds and invited the bees, but these staid shut. Soon the corollas, faded now and no longer lovely to look at, fell off. Their work was done. They had been beautiful to show how happy they were and how lovely life was; by their beauty, too, they had brought the bees and gained the pollen they wanted to make other lovely flowers live. Now, their messages of love and happiness given, they fell off, and the pollen boxes, empty and withered, fell with them.

But they left behind life and hope, for each tiny seed had received its grain of life-assuring pollen. For only the corolla and the stamens fell. The seed-children still clung to the stem; they lay in their cradles, nicely wrapped up by the green calyx leaves. And then the little stems that held the seed-babies' cradles turned down and hid the little cradles under the leaves.

The seed-babies grew and grew. They would soon have outgrown their cradles, only the strange thing is, the cradles grew too! They grew as fast as the seeds and kept them snug and safe.

So all summer long, until the frost came and it was time for the morning-glories to take their long winter sleep, the buds opened in the morning. All summer long the bright morning-glories filled their cups with nectar and opened their boxes of snow-white pollen for the bees. And all summer long the seed-children received their pollen and grew and grew in their cradles that grew too. But after a while the green cradles turned brown. And after another while the brown cradles opened to let the seed-children look out, and as soon as this happened every little black seed—for they had grown quite black by this time — fell out of its cradle! It did not hurt it to fall out, for it tumbled and rolled down to the earth, where, at last, the wind came and covered it with leaves, as the robins covered up the babes in the woods. And the little black seed-babies lay there as snug as seed-babies could be.

Then the snow came and spread a blanket over them, and the leaves and the snow kept them as warm as they wanted to be until springtime came and the snow went away; and the seeds began to stretch themselves and think it was time to wake up and go out and see what was going on in the big world above.



THE OVULES.

WHEN the ovules get ready to grow, the flower prepares to bloom.

All about the ovules the delicate walls of the ovary shut tightly.

The white filaments of the stàmens group themselves about it; you cannot see the ovary, they stand so close to it.

Their anther cells reach halfway up to the stigma, for the white stigma stands above the anthers. The anthers and the stigma are there for the sake of the ovules.

But this is not all.

A delicate corolla of bright colors surrounds the stamens and pistil. It holds them in its white tube, and spreads the bright border out wide for the bees to see and come to the help of the ovules.

But this is not all.

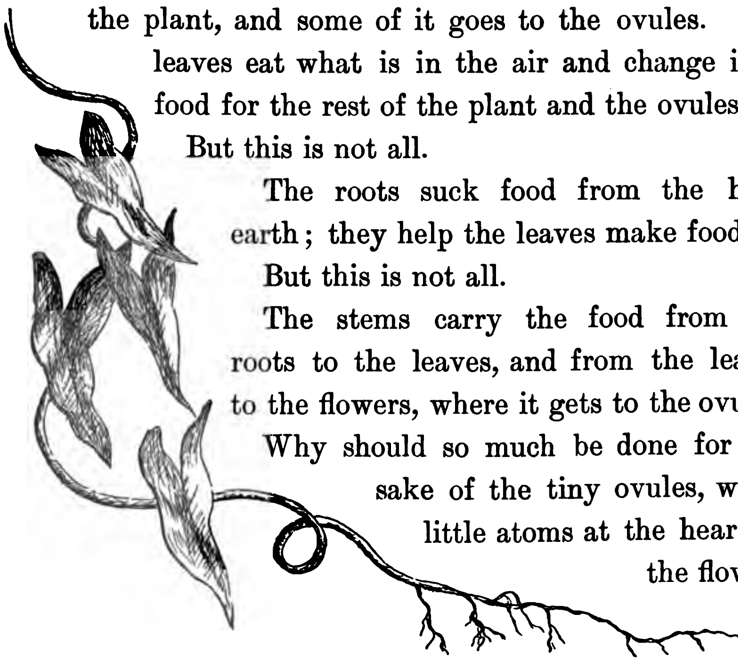
The green calyx wraps its sepals about the end of the corolla tube, and when the corolla falls the calyx covers nicely the ovary and helps it protect the ovules.

But this is not all.

When the bees have been and have left their message of life, and when the corolla has faded and fallen, the stems of the flowers turn down and hide the ovary with its seedlets under the leaves.

But this is not all.

The leaves work day and night to make food for the plant, and some of it goes to the ovules. The leaves eat what is in the air and change it to food for the rest of the plant and the ovules.



But this is not all.

The roots suck food from the hard earth; they help the leaves make food.

But this is not all.

The stems carry the food from the roots to the leaves, and from the leaves to the flowers, where it gets to the ovules.

Why should so much be done for the sake of the tiny ovules, white little atoms at the heart of the flower?

Why should the flowers care? Why should they spread bright corollas and arrange these cunning protections and draw up the sap for the sake of the tiny white ovules?

Look into the ovary and see them.

Six small white things are they, so small and soft you would scarcely think they were worth much care.

But look again and think a little. They are very wonderful, although so small. They grow to the ovary by a little stem; they get the good sap to grow on through this stem. They have a little hole through their delicate coats, and through this hole the pollen enters.

When the pollen is in, the little hole closes, and the ovules feel strong and alive. They draw in the sap the leaves have made them through their little stem; they grow larger and firmer. They cease to be tiny white round things; they get two leaves with a little stem and a bud between them.

They are no longer ovules, they are seeds. They are little sleeping vines. In each black little seed is a whole vine packed away.

After a time the old vine will fade away. It will fall and turn brown. It will do no more work of changing gases and minerals into living plant. It will not again have green leaves and bear bright flowers.

But there will be more morning-glories, for the vine has stored some of its life in the seeds, and they will not fade and cease to work. All that is left of the life of the vine is in the seeds. All the morning-glories that will grow and delight us with their bright flowers next summer lie packed away in the dark seeds.

Dear little seeds, live on through the cold winter; without you we never again could see our bright morning-glories!

And that is why the vines take such care of the seeds; the whole race of morning-glories is in their keeping.

THE LEAVES.

THE leaves of the morning-glory consider each other. They stand close together, but, as you see, they do not crowd.

They turn a little to one side that all may have as much room as possible, for each needs all the light and air it can get.

The leaves also have regard for the roots working away in the dark earth. Instead of being flat, they have a channel down the middle, a gutter to convey the rain water from leaf to leaf, and finally to the ground above the roots.

Some of the roots, it is true, stray away, but some stay close to the plant and suck up the rain the leaves send them.

The young leaves fold together. They are very tender, and too much cold or too much heat would harm them; and if they were open, the sun would draw away too much of their water.

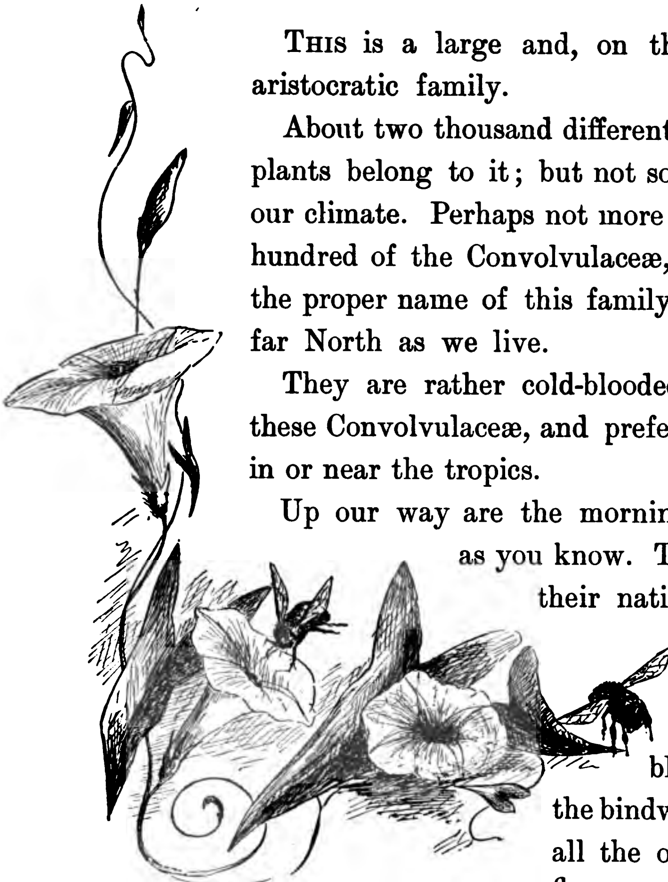
So they lie close and snug, and do not open until they have grown large and strong enough to meet the bright sunshine and the cold night.

Then they open wide; they become green and do their work, which is to make food for the plant.

TO THE MORNING-GLORY.

WHAT do you do with your
pollen so white?
What do you do with your
honey so sweet?
What is the use of your border
so bright?
And what is the use of your
calyx so neat?

THE CONVOLVULUS FAMILY.



THIS is a large and, on the whole, aristocratic family.

About two thousand different kinds of plants belong to it; but not so many in our climate. Perhaps not more than two hundred of the Convolvulaceæ, which is the proper name of this family, come as far North as we live.

They are rather cold-blooded people, these Convolvulaceæ, and prefer to stay in or near the tropics.

Up our way are the morning-glories, as you know. This is not their native home, though, as it is of the bloodroots, the bindweeds, and all the other wild flowers.

They were brought here from the hot part of America, near the equator. Somebody saw them, no doubt, and of course fell in love with them and sent some seeds to their friends in the North, or else took them when they went home.

Perhaps a sailor boy, landing in South America and seeing the bright flowers in the morning sunshine, thought of the New England village where he lived and which he often longed for there in that strange hot country, and perhaps he sent the seeds of these bright flowers home in a letter. But whoever may have sent the first seeds, it is certain the morning-glories received a hearty welcome in our Northern world. And they soon behaved like old settlers.

They grew cheerily where they were planted, and their seeds fell to the ground, where they managed to survive the cold Northern winter.

This must have been a great surprise to them the first time they felt it!

Then up they came in the spring just as though they were at home. They even strayed away from the people's gardens and grew wild near the villages.

Perhaps they met their Northern cousins the bindweeds there. And what a surprise *that* must have been,—to come up from South America and find a member of one's own family who had always lived in the cold North!

See how astonished the morning-glory at the bottom of the page looks as it gazes upon its cousin the bindweed!

For the bindweeds, you must know, are like the bloodroots and mandrakes and other wild flowers; they are natives of our Northern climate.

There are several kinds of bindweeds just as there are several kinds of morning-glories; but they are all, morning-glories and bindweeds alike, descended from some way-back convolvulus ancestor, just as you and your cousins and your second cousins and your third cousins and your fourteenth cousins are all descended from the same great, great, great, way-back grandfather.

There is another member of the Convolvulus Family with which we are all pretty well acquainted, and that is our little red-flowered cypress vine. You remember it, with its feathery leaves which we train over trellises in our flower gardens.

You would hardly think at first glance that it was a relative of the morning-glory. But it is, as you would discover if you looked at it very carefully and saw how much it is like a morning-glory in its way of growing, in spite of appearances.

It comes to us from Mexico, and you could hardly expect a Mexican convolvulus to be just like a South American one, the habits of the two countries are so different, you know.

Why, you would hardly know your own relatives if they had been born and brought up in South America for a few generations.

The next time you go to Mexico be sure and look out for the cypress vine, which, for all I know, may be looked upon as just a common weed there, the way we look at thistles and dandelions here. We would think thistles and dandelions beautiful flowers if we had to raise them in gardens with a great deal of trouble. But because we have to dig them out of our gardens and lawns we call them weeds and detest them.

Way down South, and also in some parts of Florida, there lives a lovely convolvulus. It grows something like our morning-glories, only its leaves are all sorts of shapes, heart-shaped and halberd-shaped and angled, all together on the same vine sometimes.

Its blossoms are real flower queens, they are so large and white and fragrant. They have a tube which is three or four inches long, and a snowy border still larger. They are called *bona nox*, which you know very well is the Latin for "good night."

The reason they are called this is, they do not open in the morning at all, but always at night.

People have them growing over their porches sometimes, and sometimes call them "moonflowers."

The long white buds are twisted tightly shut in the daytime, but as soon as the sun sets, if you are watching, you will see something to astonish and delight you. For see, the bud moves a little! Then, all at once, the great white flower spreads out its corolla with a grace and serenity that thrill you. Before your very eyes the bud unfolds, and you have seen a flower blossom out! At the same moment a delicate and delightful fragrance fills the air.

But why does it bloom at night you ask.

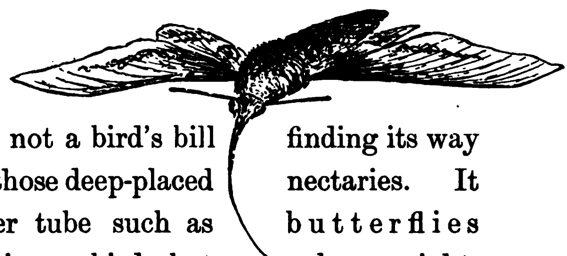
The morning-glory has a bright bell to call the bees, but the bees do not fly at night. Does this large, fragrant white flower not care for the bees? Does it not wish pollen from other flowers?

That it does; above all things it wants pollen, and that is why it has opened this large, white, fragrant corolla.

See its tube, how long and deep. What bee could reach into *that* nectary?

A humming bird might, but the humming birds are all tucked up on their tiny perches sound asleep. They will never sip the nectar from those large white moonflowers.

But what am I saying? Here comes one now! Such a whirr of wings! Such a dainty bird as poises before the large sweet flower! It thrusts in its bill,



but stay! that is not a bird's bill finding its way to the bottom of those deep-placed nectaries. It is a long, slender tube such as butterflies have, and this is no bird, but a large night-flying moth.

These moths are heavier than butterflies and look very much like humming birds when darting through the air.

But if you see one at rest you know at once it is no humming bird. When the humming birds are darting about in the sunshine, these moths are hidden beneath a leaf or in some other safe place.

Perhaps they fear some bird with a taste for moths will eat them if they come out. Perhaps they love the quiet night. However that may be, as soon as it is dusk they fly out. They are hungry after their sleep through the long summer day, and dart about to find flowers that are still open.

The morning-glories, we know, are closed, for they love the bees, but the moonflowers are filling the air with perfume; their fragrance guides the moths to the white flowers that shine out in the dim light.

Now you see why the moonflowers are white and why they are fragrant. They wish to call these friendly nightmoths to come and carry pollen from flower to flower.

If they were red or purple the moths could not so easily see them, and if they had no odor the moths could not smell them a long way off, and so might not come close enough to find them.

So our fair Southern friend the moonflower loves the moths and not the bees. Into its long white tube their long, slender tongues can easily reach and find the nectar, and in taking it they brush the pollen against their tongues or their faces, and when they go to another flower it is rubbed against the stigma.

The sphinx moths are the fellows with long sucking tubes that fly in the evening.

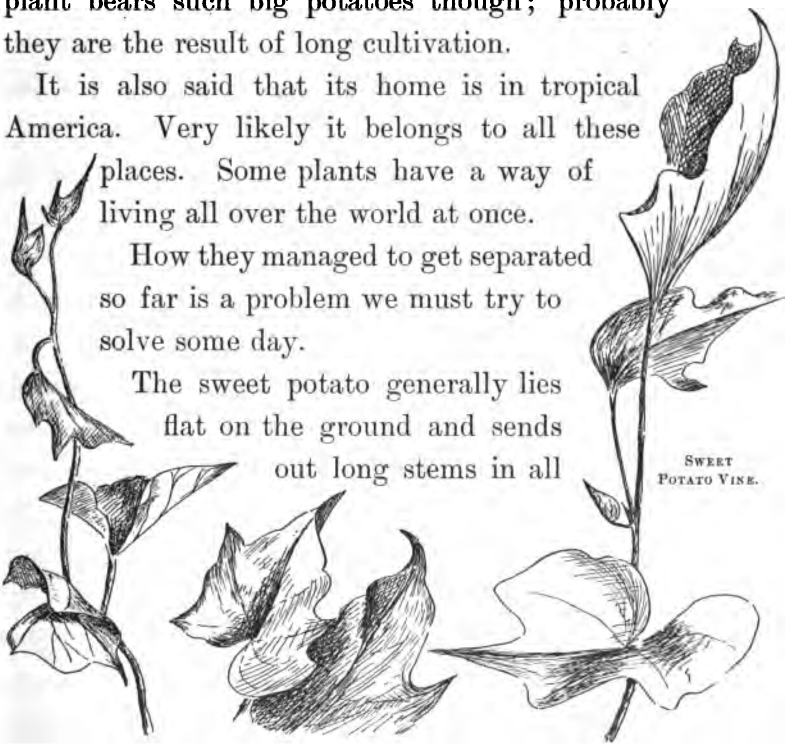
A good many members of the Convolvulus Family make us happy by their beauty, but some of them do more than this. The sweet potato, for instance, gives us something to eat. You know what it gives us, but probably you did not know the sweet potato is a convolvulus and first cousin to the morning-glory and moonflower, and that it has come to us all the way from India.

Some say its home is in the East Indies too, and when you go there, if you look in the right place, you may see it growing wild. I doubt if the wild plant bears such big potatoes though; probably they are the result of long cultivation.

It is also said that its home is in tropical America. Very likely it belongs to all these places. Some plants have a way of living all over the world at once.

How they managed to get separated so far is a problem we must try to solve some day.

The sweet potato generally lies flat on the ground and sends out long stems in all



SWEET POTATO VINE.

directions. Its leaves, as you can see, are more or less like morning-glory and bindweed leaves. Its flowers are also like morning-glories, though they are not so pretty. It has a habit of storing up quantities of starch and sugar in its roots. It does this, hoping to use the starch and sugar again as food in forming new shoots. But sometimes we step in and disarrange all these fine plans, for we, too, need starch and sugar as food, and we take the big sweet roots and eat them.

People plant large fields of sweet potatoes, particularly in the South. So next time you eat a sweet potato, remember it is one kind of morning-glory which has given it to you.

The sweet potatoes are no relation whatever to our common potatoes; they do not belong to the same family.

The sweet potato is not the only useful morning-glory. There is the jalap, though if you have ever made its acquaintance you may differ from me as to its value; for however useful it may be from the doctor's point of view, it certainly possesses properties which are quite the reverse of agreeable.

It, too, forms large tubers, which it stores full of plant food, but it so happens that this particular plant food is not fit for human food. We put it to quite another use. In fact, jalap is used as a medicine. It grows very luxuriantly at Jalapa, or, as the Mexicans spell it, Xalapa, in Mexico, and that is the way it gets its name of jalap.

In spite of its very disagreeable taste and beneficial effect upon sick people, the jalap is a lovely vine with beautiful deep pink flowers.

If you saw it growing along the eastern slopes of the Mexican mountains you would never suspect it of being a medicine plant, and you *might* not suspect it of being a convolvulus, since its flowers are flat instead of tubular in form.

SCAMMONY.

Several members of the Convolvulus Family have the same medicinal properties as jalap, and one in particular, whose name is scammony, is very highly esteemed.

It has an uncommonly bad taste, and its swollen roots are brought all the way from Syria and Asia Minor, not because of their bad taste, but because of their power as a medicine. The scammony, like the jalap, is a pretty plant in spite of its bad-tasting, medicinal roots.

Most of the Convolvulaceæ have a milky, bitter juice, — even our pretty, harmless morning-glories, — and in the jalap and scammony this seems to be exaggerated in quality and quantity.

A few of the Convolvulaceæ manage to make woody stems and become shrubs instead of vines.

Two of these live on the Canary Islands, and their sap, instead of being nauseous and bad-smelling, has a delicate and delicious fragrance. People take the wood from root and stems and press out the oil to be used in making perfumery.

Perhaps you know the odor of oil of rhodium. Whenever you smell it you are inhaling the fragrance from a Canary convolvulus.

It is a little surprising to find our convolvulus so widespread and so really useful in different parts of the world; but there is another side to the history of this highly respectable family. *Every* family, probably, has its black sheep, and not even the Convolvulaceæ can hope to have all their relatives honest and useful or beautiful.

Still, one hates to speak of the dodders. They are in the world, however, and they belong to the Convolvulus Family; there is no denying that, however much one might like to. None of the Convolvulus Family ever speak of them — at least I have never heard of their doing so.

As a rule, the members of the Convolvulus Family are aristocrats. They have descended from a long line of plants that have gone on improving. That is what makes an aristocrat in plant land,—to be descended from a long line of plants that have *kept on improving*. Simply to belong to an old family does not count for much in the plant world, unless that old family has kept on doing something to improve itself.

We know the Convolvulaceæ are aristocrats for one thing by their tubular corollas; it took good, wide-awake ancestors to make corollas without separate petals anyway, and particularly tubular ones. Then their color tells their history. They are often blue or purple, which is a *very* aristocratic color among flowers. Instead of being blue-blooded, they are blue-colored.

The moonflower is not blue, but think what a tube it has and what a large fine corolla; and then think, too, that it has learned to bloom at night so as to get fertilized by the moths, and *that* is a very aristocratic thing to do, I assure you.

If a flower blooms at night it is as great an honor as to wear a blue corolla. For you see it has taken as much growth in the direction of progress to acquire the night-blooming habit as to acquire a blue corolla.

The cypress vine has a red corolla, which is a good color, but not quite as advanced as blue. You see, in the beginning of the world flowers were yellow; then some became white, then pink. Probably red was the next step, then came purple, and last of all blue.

But the cypress vine has very finely divided leaves, as you remember, and in that it is ahead of the morning-glories. For in the beginning of the world, we are told, leaves were not divided, and only after a long time did some plants learn to divide them, and so increase their usefulness as leaves.

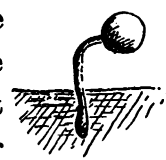
But when we come to the dodders, they have no leaves at all. The reason for this is, they do no work for themselves. The green leaves, as you know, prepare the food for the plant and work very hard to do it. If the dodders have no leaves, where do they get their food? That is just the trouble. They make other plants give it to them. They are very much like tramps, going about and living on other people. Only they are worse than tramps, for they do not say, "Please give me something to eat. I am hungry and want some starch and nitrogen compounds." They do nothing of the sort. They catch hold of another plant and take away its juices without leave or license. So you see they are really thieves and robbers, these rascally dodders. No wonder the morning-glories are not proud of them. Not that the dodders care. It is a question whether they even know they are related to the morning-glories.

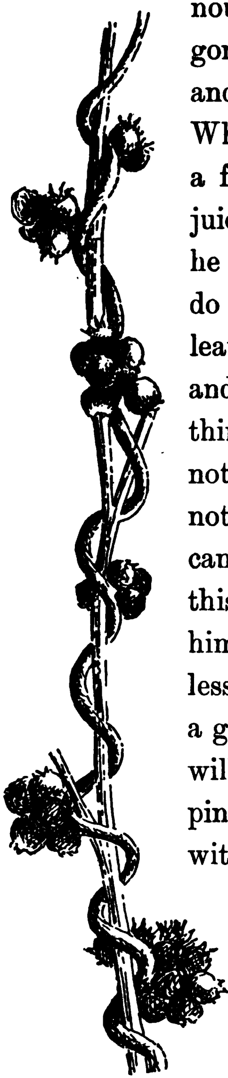
They think of little but how to get something to eat out of other people.

They begin their shameful career from the very seed. Instead of sprouting in the spring with the other seeds, they lie still until all the other plants have gone out of their seeds and are at work making green leaves and storing their stems with plant juices.

Then Dodder the Robber comes out. But instead of sending down a root and up a stem like other

seeds, he just pushes out a little thread-like body, which fastens into the ground. You might think this an honest little root going down into the ground if you did not know friend Dodder. But it is no root; it does not suck up juices from the earth: it simply anchors the little robber so he cannot be blown away. Now the thread-like body grows larger and sticks up out of the ground, carrying the seed-coat with it. The seed-coat is packed with food which the parent plant stored away there. The young dodder





nourishes itself with this food until it is all gone; then it casts off the empty seed-coat, and behold young Dodder ready for the fray. What he very much wants at this time is a fresh young twig to cling to and suck the juice out of. If nothing of the sort is handy he is in a bad way, for he is too helpless to do anything for himself. He has no green leaves, and does not know how to make any, and without green leaves he cannot get a thing to eat. Poor Dodder! after all, it is not wholly his fault he is such a good-for-nothing specimen of planthood. You see he came from bad stock. His parents were like this before him, and no one has ever taught him any better. Well, there he lies, as helpless a plant as you can imagine. But just let a green shoot come within reach! *Then* you will see! He twists around it without stopping to say "by your leave." He pierces it with little suckers that draw out its juices. Now Dodder is all right. He has plenty of food without the trouble of making a bit of it himself.

And then how he grows! Up the poor weed he twines, a slender yellow stem that looks as much like yellow yarn as anything else. Around and around he turns; he has no leaves to make, only useless little scales that show where long ago his ancestors once had honest leaves.

You will sometimes find the weeds in a damp place a perfect tangle of dodder vines, so that nothing else is to be seen. They cover the weeds, sucking out their juices and smothering them. And when the time comes the dodder breaks out into innumerable bunches of flowers, which grow at short distances along the yellow stems. These flowers are small and generally white, and clustered so close together that they form a sort of knot or rosette on the stem.

You would never imagine to look at them that they belonged to our Morning-Glory Family.

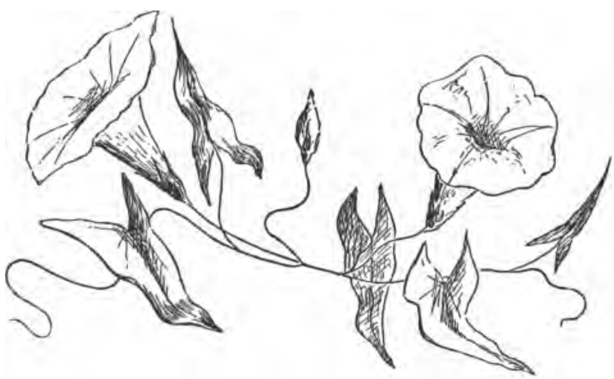
Their corollas are more or less cleft, being grown together only at the base.

Sometimes the flowers are orange-colored or reddish, but they do not seem to attract the insects much. Nor do they care, for they can easily fertilize themselves, the anthers and stigmas being so close together. They have none of the ingenious arrangements for cross-fertilization that characterize their more fortunate relatives. They are thoroughly degraded plants.

There lives a dodder in Europe which grows upon flax, and so does damage to the flax fields, and I am sorry to say this little pest has tramped his way across the ocean into *our* flax fields. We do not thank Europe at all for sending us such an emigrant.

As the dodders have nothing to do but suck the juices of other plants and make seeds out of them, you may be sure they set any quantity of seeds to keep up the disreputable race of dodders.

Yet, in spite of the dodders, dear Convolvulus People, let us say to you, as our beloved old Rip Van Winkle says to us, "May you live long and prosper, and all your family!"

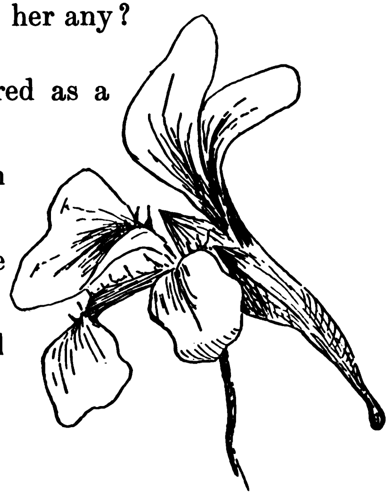


Stories About the Geranium Family

TROPÆOLUM STORIES.

TROPÆOLUM HONEY.

If you had a horn as red as
a rose,
And full to the brim with
honey,
If a bee came along and
begged you for some,
Now tell, would you give
her any?



If I had a horn as red as a
rose,
And full to the brim with
honey,
If a bee came along I'd invite
her in,
And give her all she could
carry!

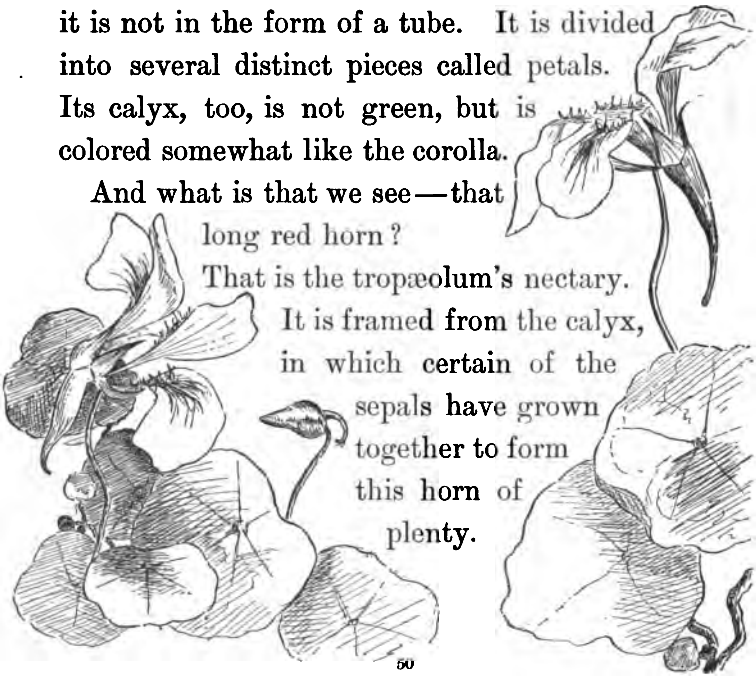
THE TROPÆOLUM.

LIKE the morning-glory flower, the tropæolum, or nasturtium, as we usually call it, has several important organs. It has a pistil and stamens, and plenty of rich nectar.

Its corolla, as you know, is large and showy, but it is not in the form of a tube. It is divided into several distinct pieces called petals. Its calyx, too, is not green, but is colored somewhat like the corolla.

And what is that we see—that long red horn?

That is the tropæolum's nectary. It is framed from the calyx, in which certain of the sepals have grown together to form this horn of plenty.



We are tempted to call it a horn of plenty because it is shaped like a cornucopia and is overflowing with sweet nectar.

It is no wonder the bees and humming birds visit Tropæolum so constantly.

She has provided a most attractive dish of honey for them, but she has so cleverly placed it that they cannot reach it without doing her a service. In our climate bees and humming birds are her constant visitors, but in her own home, in South America, she may have visitors we do not know. She may have a favorite moth whose tongue just fits into her long red horn, or it may be a humming bird that comes to her there, for South America is the home of the humming birds, or it may be a butterfly. We do not know about that, but we do know that her red spur has doubtless grown to its present form to please some beloved bird or insect, and that the bill or tongue of that bird or insect is as long as her red spur.

Why do you suppose Tropæolum makes honey for the insects and the birds?

Why does she love to have them come and take the nectar from her long red horn?

I think I know the reason why. She has placed her horn of nectar just back of her stamens. The bees must walk over the stamens before they can reach the nectar. The humming bird must touch the anthers when he thrusts in his bill. Whatever takes the honey must touch the anthers.

This is why Tropæolum has a long red horn full of rich nectar. She wishes the birds and insects that come to her for honey to touch her anthers, which are overflowing with red pollen.

She has made the pollen for her friends, and not for her own use. She wishes her neighbors, the other tropæolums, to have the beautiful gift; but how can she send it to them?

She makes herself beautiful and bright; she fills her horn with honey and exhales fragrance.

The bees and the humming birds see her and approach. No doubt they rejoice in the bright colors, the perfume, and the nectar. They come on bright wings, and as they approach the nectary the grains of red pollen cling to them.

They cannot get enough nectar from one flower; each gives them a little, then they fly to others for more. From flower to flower they hasten and scatter pollen as they go. The pollen from one flower is often left in another, and this is what the tropæolum wants. It wishes its pollen to reach another flower, and uses the bees and the humming birds as its messengers.

Its stamens lie flat on the floor of the flower. When one is about to ripen its anther rises and stands up in front of the spur, where the nectar is ready. Then out bursts the fine red pollen. Only one anther ripens at a time. It sometimes takes several days for the tropæolum to shed all its pollen.

As soon as the pollen is gone the anther lies down again out of the way.

The stamens do not crowd the doorway of the spur; they lie down out of the way until they ripen, then they stand in front of the spur, and when their pollen is shed they lie down again.

They do not obstruct the way to the nectary because they wish the bees and birds to find an easy entrance.

Why does one anther ripen at a time? Why do not all shed pollen together, as is the habit of the morning-glory, and finish in one day?

Perhaps the tropæolum fears the rain may ruin the chances of the seeds to get pollen. We know that water spoils the pollen, and though the tropæolum has fringes to keep it from the nectary, and a roof to protect it, more or less would doubtless beat in during a hard shower.

Does the tropæolum bloom, then, in the rainy season in its own hot home—in the rainy season when the showers are terrific?

We should like to know that.

If it did, that would be a good reason for ripening the anthers one at a time. If one were spoiled, another might succeed.

We may be sure there is a good reason for this habit of the tropæolum, though we may not have discovered it.

When at last the pollen is gone and the anthers are empty and shriveled, the spur is still full of honey.

In front of it has risen, not a stamen this time, but a dainty five-rayed stigma. It is held in place by the style, and is ripe and ready for pollen. It has unfolded its five rays that it may catch and hold the pollen grains.

But all its pollen is gone! The bees and the birds have carried it away. The bees ate some and carried some home to their hives. None remains for the five-rayed stigma. But here comes a bee, a large, yellow-banded bumblebee. She has a ball of red pollen in each of her two baskets. She gathered it in another tropæolum blossom, and intends to take it home to feed the young bees; but as she enters our pollenless flower for nectar, lo! she brushes aside the five-rayed stigma. A few grains of pollen from her legs cling to the stigma, for it is sticky and holds them.

The bee hurries away. She does not know what she has done; she does not know that in brushing aside the stigma that stood in her way she has given life to the seeds and provided for a new generation of tropæolum vines.

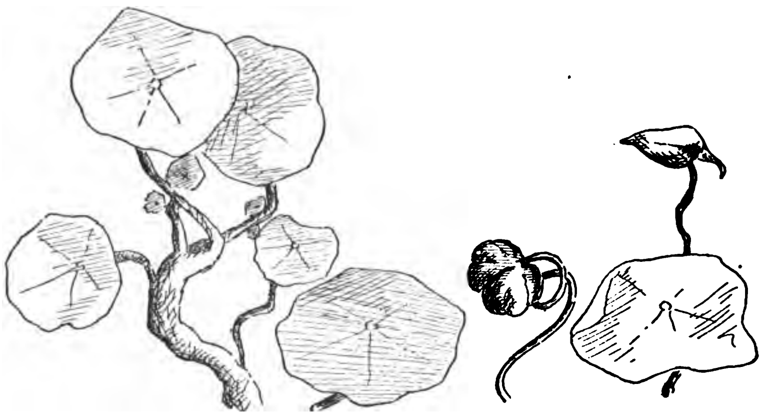
The flower gave pollen to its neighbors, and now in its need they have sent pollen to it.

Soon the bright corolla fades and falls. Its work is done. It expressed its joy in life; it called the bees, and by them sent pollen to its neighbors, and took pollen from them in return.

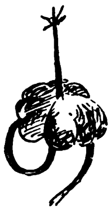
For many days it kept its long red horn full of sweet nectar, until its stigma rose and took the pollen, when the flower faded and fell. But the five-rayed stigma did not fall. It remained attached to the green little fruit that lay hid in the heart of the flower.

It is not easy to see this fruit when the flower first opens, for it is small and hidden by the stamens.

But after the pollen has reached the stigma the fruit grows rapidly. The corolla falls, and the stem that holds the fruit curls up. It curls up until it has drawn the green fruit down under the leaves, out of the way of the buds that wish to open. The stigma and style fall off at last, and leave the fruit to ripen alone.



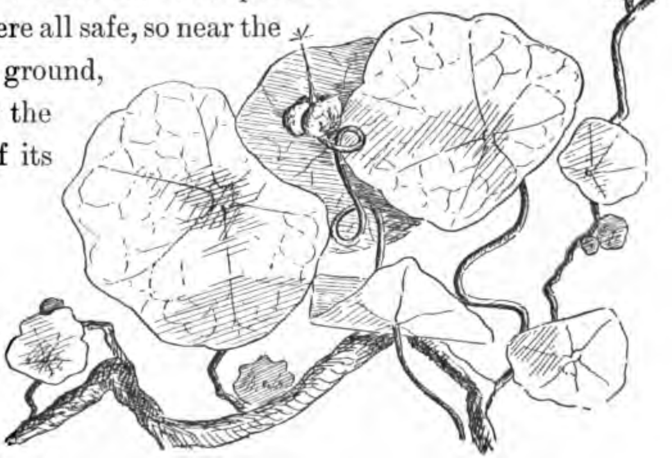
WHO LIES CURLED UP?

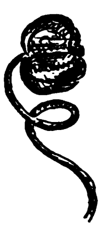


Who lies curled up under the shields?
  Under the shields of its parents?
A cunning young fruit peeps out o'er the world,
  From under the shields of its parents.

It is parted in three with a seed in each part,
  This cunning young fruit I've told you about.
It is parted in three, yet the three are one fruit,
  Lying under the shields of the parents.

The stems curl up and pull it down
  Under the shields of its parents.
It lies there all safe, so near the
  warm ground,
  Under the
shields of its
parents!





MORE ABOUT THE TROPÆOLUM.

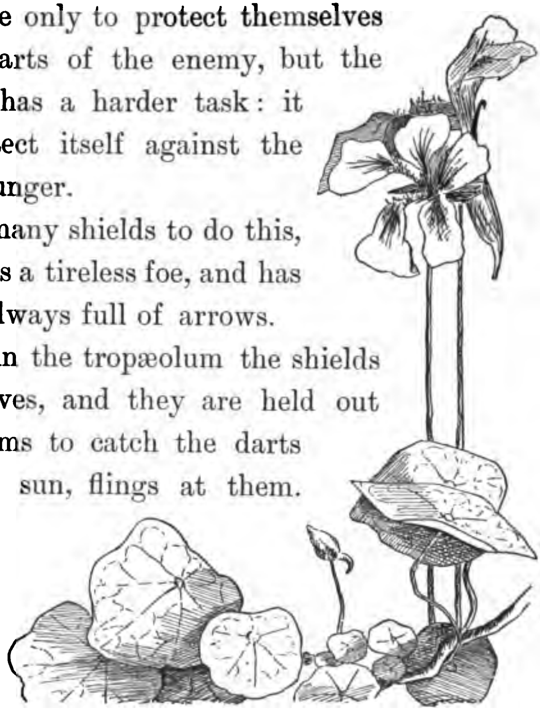
THE tropæolum, which people call nasturtium, has shields to defend itself.

Warriors are content with one shield, but the tropæolum has many.

They have only to protect themselves from the darts of the enemy, but the tropæolum has a harder task: it has to protect itself against the pangs of hunger.

It needs many shields to do this, for hunger is a tireless foe, and has his quiver always full of arrows.

You see, in the tropæolum the shields are the leaves, and they are held out on long stems to catch the darts Apollo, the sun, flings at them. These are not unfriendly darts, but as they



strike the little shields of the tropæolum they make them tingle with life. Then the shield leaves go to work and make food for the plant. They make starch and many other things. They make a spicy juice, for one thing, that causes our tongues to smart if we taste it. Sometimes we bite a tropæolum stem, for we like the taste of the sharp juice. But we do not want too much of it, for it makes the palate at the back of the nose tingle, and that is why we call it "nasturtium." "Nasturtium," you know, comes from two Latin words, *nasus tortus*, which mean "convulsed nose"; and nobody likes to have a "convulsed nose" very long at a time!

"Nasturtium" is not the right name for our plant with its many shields.

There is another plant which "convulses" our noses, and which the botany tells us is the nasturtium, but which we call *water cress*. We eat it in the spring of the year.

The right name of our garden nasturtium is "tropæolum," which comes from a Greek word meaning "trophy," its many shields probably being likened to so many trophies taken from the enemy.

Another name for it is "Indian cress," and, like the water cress, it sometimes is eaten, only in this case it is the flowers instead of the leaves that find themselves converted into a salad. The fruits, too, share a similar fate. Like the rest of the plant, they are filled with spicy juice. This is a misfortune to them, since it tempts people to take these juicy, spicy fruits and pickle them to eat.

Perhaps the plant learned to store up this stinging, spicy juice to protect itself from being eaten by animals. But what can it do to protect itself from the pickle jar?

Perhaps, however, the stinging juice was but a result of the plant's peculiar method of growth. Of course juice must have some sort of taste, and why not a stinging taste as well as any other?

This plant prepares another liquid which is not sharp and stinging, but sweet and spicy; with this delicious nectar it fills its long spur and keeps it full.

The bees collect it and convert it into tropæolum honey to fill their waxen cells.

This the plant does not object to. It makes the nectar for the bees, and when they take it away and store it up for winter use the tropæolum suffers no loss. But when some one comes along and picks the fruits and stores *them* up for winter use, that is another matter!

We are tempted to call the spur of the tropæolum its "horn of plenty," for that is the name of the horn overflowing with good things that never is empty.

The Goddess of Plenty owns this horn. You can see it in her pictures, as it always stands at her side, and there overflows with flowers and fruits. All that is good that grows in the earth is in the horn of the Goddess of Plenty. It is her cornucopia, for "cornucopia," you know, means "horn of plenty."

The goddess got her horn from the Naiads. They, you know, are the nymphs of the brooks and fountains, and they gave it to her.

This is the story of how she got it.

The river god, Acheloüs, and Hercules, the god of strength, struggled together. Hercules threw the god Acheloüs and seized him by the throat. Then Acheloüs, in order to escape, changed himself into a serpent.

This did not help him, for Hercules seized him by the neck and would have choked him, but Acheloüs again changed his shape.

He became a bull, but this was not enough to defend him from the great strength of Hercules, who seized him by the neck and dragged him to the ground, and in the struggle rent one of his horns from his head.

The nymphs of the brooks and the fountains, who were related to the river god, Acheloüs, consecrated the horn and gave it to the Goddess of Plenty.

SATURN.

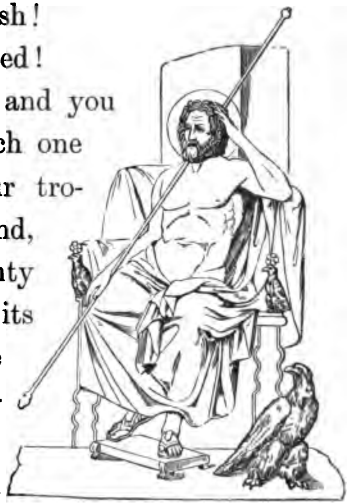
That is one story, but some say the following is the history of cornucopia.

You know Saturn, the oldest of the gods, had a bad habit of swallowing his children. When Jupiter was born, his mother, Rhea, did not wish his father, Saturn, to swallow him; so she gave him to the care of the daughters of the king of Crete. They fed him on milk from the goat Amalthea, and watched over him and protected him so that his father should not find him. The people of Crete danced about him and made such a noise when he cried that his father could not hear him.

He must have cried very loud indeed to make all that necessary; but then, he was destined to become a very great god, so no doubt he *did* make more noise than ordinary babies.

Out of gratitude to his kind nurses, and also as a token of esteem to the good Amalthea, Jupiter broke off one of her horns and endowed it with a very wonderful power. It became filled at once with whatever its possessor might wish!

This was a horn of plenty indeed!



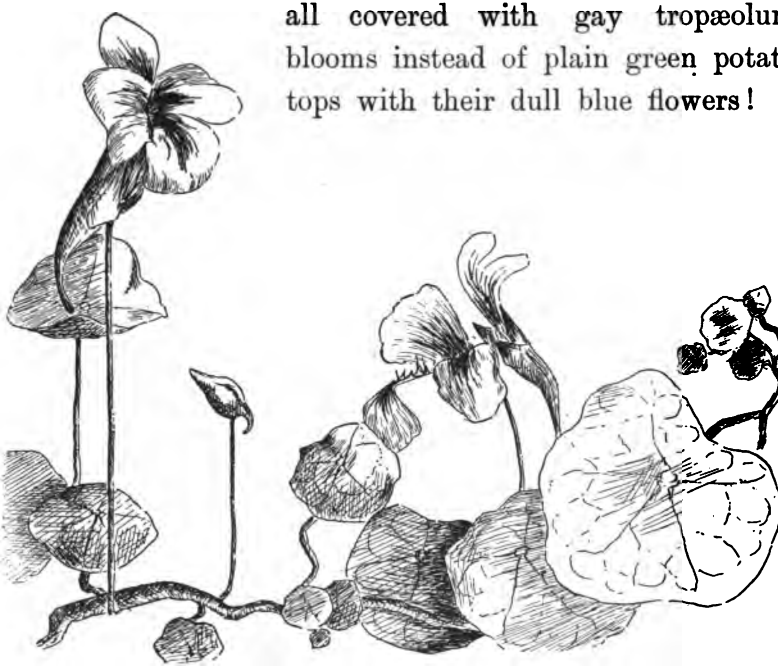
JUPITER.

Now you know both stories, and you may take your choice as to which one you will believe. Whether our tropæolum had either of these in mind, it certainly made a very dainty cornucopia when it constructed its honey-horn and filled it for the bees, the butterflies, and the humming birds.

The tropæolums we have in our gardens are not the only kinds; there are, in fact, some forty different tropæolums living in South America and Mexico, and in Peru there is one which has large tuberous roots filled with plant food, which is also good food for man, and is eaten in some parts of South America instead of potatoes!

How would you like to dig your potatoes out of the nasturtium bed?

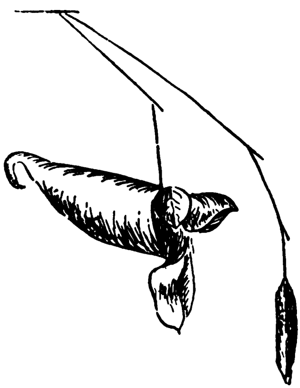
It certainly would be a pretty place to work on a summer day, and how fine the fields would look all covered with gay tropæolum blooms instead of plain green potato tops with their dull blue flowers!



JEWELWEED STORIES.

A DAINTY CAVE.

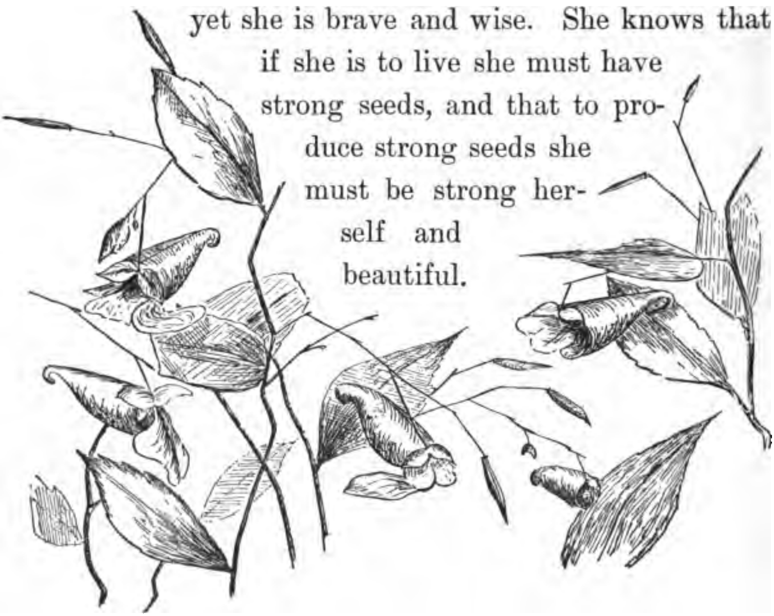
TOUCH-ME-NOT has a dainty cave
  Spotted with red and poised in the air.
Touch-me-not is a pretty knave
With ruby spots and yellow cave,
    Swinging there
    So fresh and fair.



TOUCH-ME-NOT.

TOUCH-ME-NOT lives in moist places. Her feet stand in the damp earth and her head looks up above the bushes. Other plants love the damp, rich soil along the brookside, and Touch-me-not is sometimes crowded for room.

She is a tender little plant, this Touch-me-not, and yet she is brave and wise. She knows that if she is to live she must have strong seeds, and that to produce strong seeds she must be strong herself and beautiful.



She finds it easy to be beautiful in the pleasant world, where the sun shines upon her and the breezes fan her.

So forth from the axil of every leaf she swings out her dainty buds. They open their petals at last, all yellow and spotted with red. Cunning caves for the bee, they swing on slender stems. The tangle of weeds by the brookside is dotted all over by the bright blossoms. Light as they are, their slender stems bend under their weight.

The bees see them from a distance; they are attracted by the bright colors and fly to visit the touch-me-nots. They search for honey, and of course they find it, for the touch-me-not has wisely provided nectar for bees and birds.

The pretty yellow flowers contain rich honey in the little spur at the back. The end of the spur turns down, and it is in this turned-down tip the honey is made. From there it runs into the upper part of the spur, where the bees can reach it.

The moist roadside in many places is dotted with yellow touch-me-not flowers. They hang like ear-rings from their stems, and many call the plant "jewelweed" because of them. It is a pretty sight in the morning to see the bright jewels sparkling in the dew.

"Rubythroat" flashes about among them. "Rubythroat" is our northern humming bird. His throat is ruby red and sparkles in the sun. The rest of his body is green and brown. He shines like a jewel in the sunlight and darts from flower to flower. You cannot watch him, he flies so fast. But when he wishes a sip of honey he poises on his tiny wings before the jewelweed.

Into the dainty swinging flower he darts his slim black bill. He is partial to the honey of the touch-me-not, and wherever it grows in abundance you will be sure to see the rubythroats darting about.

Rubythroat does the flower a favor in return for the honey he gets.

You know about that. He carries pollen to it from some other flower. This new pollen enables strong seeds to form. The jewelweed is very careful to have strong seeds. It covers the pistil with a hood of its own anthers. Behind the anthers in a dark little room the pistil waits until all the pollen is gone and the anthers have fallen off.

The flower does not wish its pistil to receive its own pollen. The earth is crowded, and the seeds must be strong to grow. So the pistil is hidden behind the screen of the anthers until there is no more pollen left; then it comes forth and waits for the birds or the bees to bring it fresh pollen.

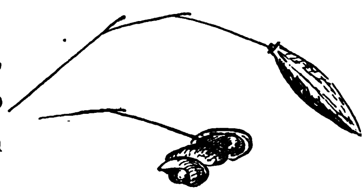
The anthers and pistil are not on the floor of the touch-me-not flower, as they are in the nasturtium. They hang from the roof like tiny chandeliers.

The bees do not walk over them, but touch them with their heads or backs, and the humming bird touches them with the top of its bill or with the feathers on its face.

When the birds or the bees have brought the pollen, the yellow corolla falls off and the fruit grows fast.

It is a smooth and delicate fruit, and it may be you know what it does to help the seeds find room.

When the fruit is ripe, the outer covering all of a sudden splits and curls up with considerable force, acting like a spring and shooting the seeds far over the thicket.



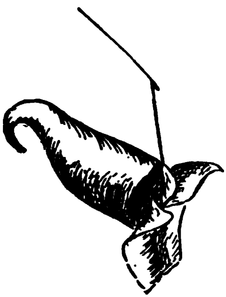
It spreads them far and wide, so they have a better chance to find a place to take root when the time comes.

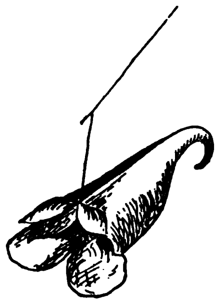
The fruits are so eager to send the seeds on their journey, and so fearful that some harm will come to them, that they snap them away if any one touches the pods. If you jostle these eager plants you will hear the seeds flying in all directions. If you touch a seed-pod it goes off in your fingers. No wonder we call the plants "touch-me-nots"! Some call them "snapweed" or "snappers," and the botany calls them "impatiens," because they are so impatient!

They have yet another name, "lady's eardrop," and I do not know how many more. People must like the pretty things to give them so many names.

EARDROPS.

EARDROPS of gold with red rubies beset,
Hang from the ears of a
dear little maid.
"Where did you get them,
my darling, my pet?"
"Down by the brook
you can pick them,"
she said.





LADY'S SLIPPER.

In the garden grows a relative of our jewelweed. It is called the "garden balsam," and sometimes "lady's slipper."

Its own home is far-off India.

Its flowers are larger than those of the jewelweed and are not yellow, but white or red or pink, and sometimes pink and white spotted. In shape, however, it is very like the jewelweed; it hides its pistil beneath the anthers in the same way and snaps its seeds afar.

Its flowers grow double and close to the stalk, and it makes a fine show in the garden in the fall of the year.

There is one thing I should like very much to know, and that is, just when and how this Indian balsam and its cousin the North American jewelweed got separated.

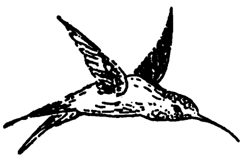
Way, way back, farther back than the building of the pyramids, these two plants must have had the same ancestors. Now, where did those ancestors live? In India? In America? Somewhere between?

And what caused them finally to get so widely separated?

Who is going to tell us?

For over two hundred and fifty years the Indian balsam has been cultivated as a garden plant, and no doubt this long cultivation has done much to bring about changes. Still, its resemblance to the jewelweed is quite unmistakable, and we cannot doubt the relationship of the two.

THE HUMMING BIRD.

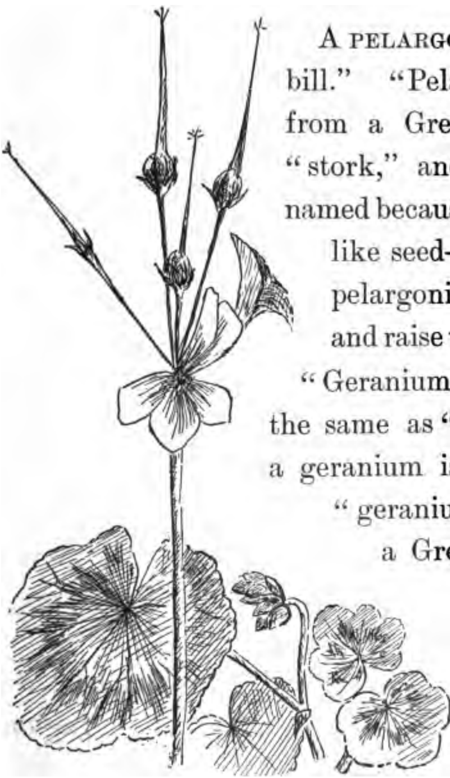


FLASHING in the sunshine,
  Dashing through the air,
Sparkling like a jewel,
  See him everywhere!
Poised before a flower
  For a moment's space,
Off again like lightning
  On some headlong chase!

Blossoms all set swinging
  On each slender stem.
Touch-me-nots are happy
  When he visits them,
For he shakes the pollen
  From his shining crest.
Rubythroat is joyous,
  Touch-me-not is blest!

PELARGONIUM STORIES.

THE PELARGONIUMS.



A PELARGONIUM is a "stork's bill." "Pelargonium" comes from a Greek word meaning "stork," and the plant is so named because of the long, beak-like seed-pods. We call the pelargoniums "geraniums," and raise them in our houses. "Geranium" means almost the same as "pelargonium," for a geranium is a "crane's bill," "geranium" coming from a Greek word meaning "crane," and the plant is so called because of the shape of the seed-pods.

I do not think there is much difference between a crane's bill and a stork's bill, and these two plants with their seed-pods so very much alike were, no doubt, named "stork's bill" and "crane's bill" to distinguish them from each other. But we have succeeded in hopelessly mixing them up, for everybody insists upon calling the pelargonium "geranium," and the geraniums which grow wild in our woods and fields we call "crane's bill" and "herb Robert."

The pelargoniums are mostly Africans. There are a great many kinds of them, and all but ten or twelve live in South Africa among the Bushmen, the Boers, and the Englishmen.

The rest have chosen to settle in the northern part of Africa, in the Orient, if you know where that is, and in Australia. Some people believe there are four hundred different pelargoniums, and some say there are less than two hundred. You see, the pelargoniums change easily. Thus a great many varieties are always arising, and it is almost impossible at this late day to discover which was the original form of the plant.

The pelargoniums we know best are the ones we call "horseshoe geraniums," "Lady Washington geraniums," and "rose geraniums."

We are apt to think of the whole Pelargonium Family as being ornamental rather than useful, but in that wonderful South African country where so many of them live, there is actually a pelargonium that produces edible tubers!

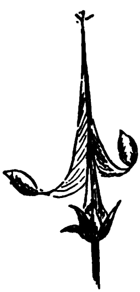
The next time you go to Cape Colony you must be sure and eat potatoes gathered from a geranium plant!

Down in Algeria, where the walls are so white and the sun shines so hot, the people express an oil from their geraniums and sell it. Other geraniums also yield this fragrant oil, but nowhere is it so largely used as in sunny Algeria.

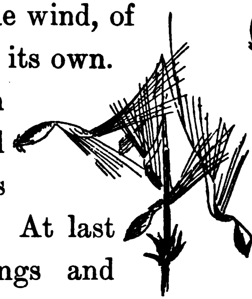
Pelargoniums love to grow. You need only break off a twig and stick it in the ground, and it will grow as merrily as though nothing had happened.

One day a double-flowered crimson pelargonium blew away in a gale of wind. It broke off just above the root and away it went. It was rescued, stuck back into the pot of earth, abundantly watered, and continued to open its flowers as though such an escapade were an everyday occurrence!

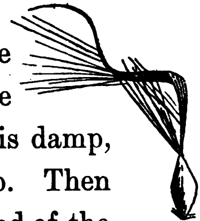
Now about its beak. The pelargonium has a beak, no doubt, but it does not put it to the same use the stork does, for its beak is made up of the long styles of the pistil which cling fast to a central column. The whole fruit looks a *little* like a long bird's beak. This beak *opens*, but not to swallow little fishes the way a stork's beak does.



It opens to let out a feather! When the seed gets ripe, the case in which it lies at the bottom of the pistil breaks away, and the style curves up and breaks loose from the central support. As soon as the style loosens, out comes the feather. Not a real feather, of course, but a tuft of silvery white hairs that grow along the inside of the style and are packed close as can be until the style lets them out; then they separate and form a wide fringe along the loosened style. Finally, the style is only held by the very tip; then this gives way, and the feather flies away with seed and style. It flies on the wings of the wind, of course, since it has none of its own.



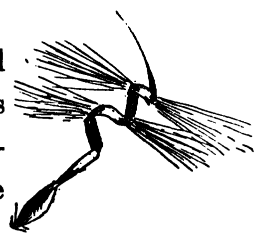
In this way the geranium seeds are sometimes carried long distances. But this is not the end of the story. At last the seed with its coverings and feather rests on the ground. The seed end is towards the ground, and the very tip of the pod is provided with a few short, stiff hairs, that point backwards like the barbs on a fish hook or a bee sting.

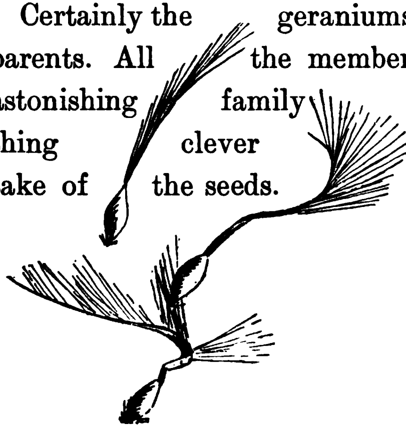


Now what do you suppose these hairs are for? Do you think their being there is a mere accident? Not at all. When the weather is damp, the style, with the feather attached, curls up. Then it acts like a gimlet and forces the pointed end of the seed into the ground. When it becomes dry, the style straightens out. But the seed cannot be pulled out of the ground when this happens, because the barbs on the tip of the seed-case hold it fast! So it does time and again. When it is damp, the seed is forced deeper into the earth. When it is dry, the style straightens out so as to be ready to curl up again.

You see how it is, do you not? The pelargonium is *planting its seed.*

Certainly the geraniums are good parents. All the members of this astonishing family do something clever for the sake of the seeds.





AN AFRICAN.

THERE 's a native of Cape Town
Always wears a scarlet crown.
Not a lord of high degree,
But a simple peasant he.

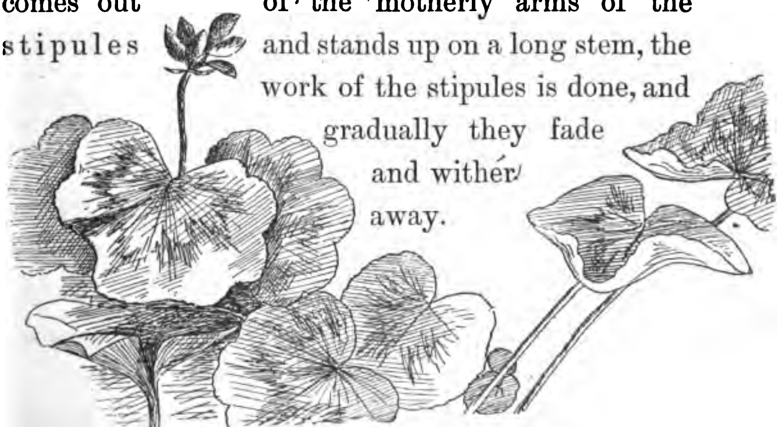
You will see him, if you look,
Resting in some sunny nook.
He 's no Boer nor Englishman,
But a native African!

He just wanders up and down
O 'er the wilds of hot Cape Town;
Takes no part in strife or war,—
Does n't know what it is for.

Boers may fight if they must needs.
Calm he sits among the weeds.
No soldier he in battle's hum,
But just a red geranium!

PELARGONIUM LEAVES.

SOME of the pelargoniums decorate their leaves with horseshoes. All are in the habit of folding their leaves fan-like in the bud. When they grow large these folds straighten out. It is a good thing to be folded up fan-like in the bud; the leaf then takes up less room, and is kept snug and safe until it grows strong enough to care for itself. The pelargonium indulges in large stipules. These are green, leaf-like bodies growing on the leaf stalk where it is attached to the stem of the plant. They fold over the young leaf and protect it; but after the leaf comes out of the motherly arms of the stipules and stands up on a long stem, the work of the stipules is done, and gradually they fade and wither away.



Most pelargonium leaves are covered with a fine coat of hairs. In the warm countries where pelargoniums grow wild they need a coat of down to prevent the sun from scorching them.

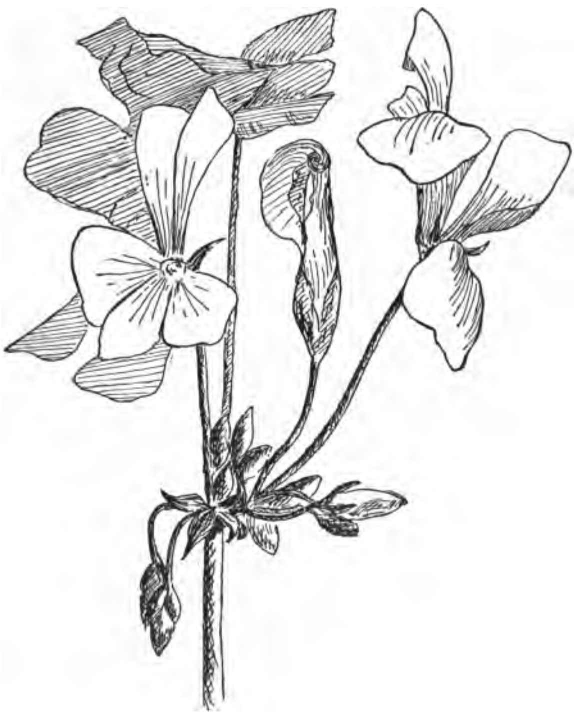
As long as there is plenty of water in the leaves the sun cannot harm them, no matter how warm it shines; but if it can draw out the water, then the leaf must fade. The coat of hairs for one thing prevents the water from evaporating too rapidly. Thus the pelargonium does not wear its fuzzy coat to protect it from the cold, but from the sun. The hairs also prevent the rain or dew from stopping up the breathing pores of the leaf.

Most pelargonium leaves have a habit of using perfumery of one kind or another. They make it themselves out of the food they find in the earth and the air. The rose geraniums we think are particularly successful in this respect.

Why do you suppose the pelargoniums perfume their leaves?

Perhaps it is to prevent animals from grazing them, for animals do not like to eat strong-scented things, even if to our senses the odor is agreeable. If this *is* the reason, we are glad the pelargoniums selected a perfume that we can enjoy.

We think there may be some such reason for the fragrance of the pelargonium, because plants are never wasteful. They make only what will be useful to them in some way. They love to be beautiful, but are never satisfied unless theirs is a useful beauty. The fragrance of the leaves, however, may be due to some cause and useful for some purpose that we know not of.

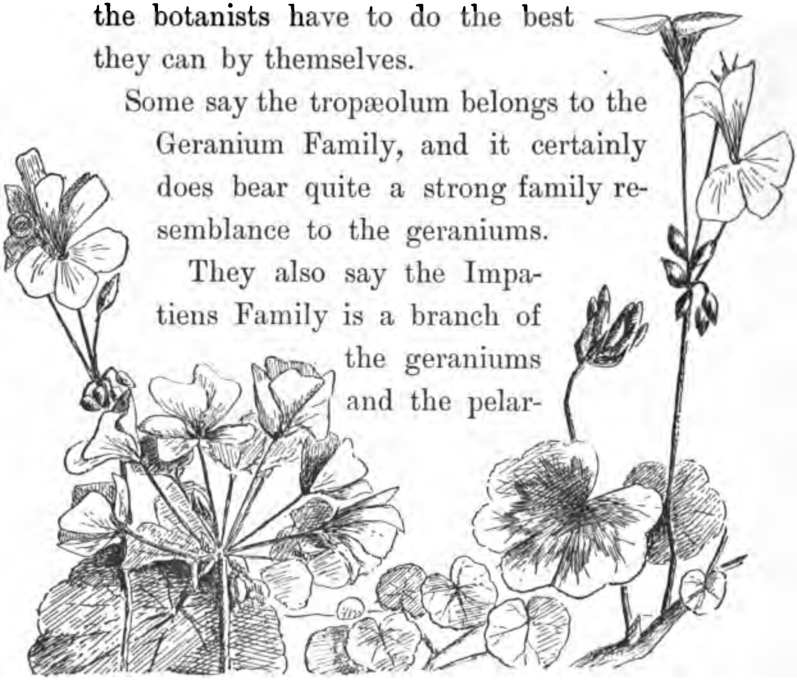


THE GERANIUM FAMILY.

The Geranium People are rather unsettled as to their relatives — or, rather, *we* are somewhat confused on the subject. Probably the geraniums know all about it, but they will not tell the botanists, so the botanists have to do the best they can by themselves.

Some say the tropæolum belongs to the Geranium Family, and it certainly does bear quite a strong family resemblance to the geraniums.

They also say the Impatiens Family is a branch of the geraniums and the pelar-



goniums, which you know we *always* call geraniums. The crane's bills and herb Roberts and all *their* near relations of course are geraniums, and some say the wood sorrels belong to this distinguished family.

Whether these all belong to one family or not, one thing is certain: they are all agreeable to us, and are not so very numerous even when taken all together. The whole of them do not number half so many as do the branches of the Convolvulus Family.

Like the race of white people, they belong principally to temperate climates.

They do not all belong to *our* climate, however.

The nasturtiums, for instance, are South Americans and Mexicans. They like to keep warm better than some other members of their family, and their seeds cannot, as a rule, live through our cold winters. But if we gather the seeds and put them away out of the fierce winter cold and plant them in the spring, then the nasturtiums will grow their best and please us with their bright flowers. We cannot help liking them, they are so jolly with their gay flowers and their round leaves with twisting stalks.

We like them, too, because the flower stem curls up and draws the seeds under the leaves out of the way of the young buds that are waiting to bloom.

I do not know whether wild nasturtiums are as large and bright as the cultivated ones. Very likely not, as people have taken great pains to make them large and bright by selecting the seeds of the largest flowers from year to year and giving them good soil in which to grow.

Perhaps the members of the Geranium Family we really know best are the pelargoniums from the Cape of Good Hope. It is about as warm in their African home as it is in our Florida, so of course they cannot live out of doors through our cold Northern winters. But we take them in the house when cold weather comes, and sometimes put them in the cellar.

Of course they do not grow much in the cellar, but they *rest* there, and when they are taken out in the spring are all ready to wake up and blossom.

The whole Geranium Family seems to take extra care of its seeds.

We know how the nasturtium curls up its stem so as to draw the seeds below the leaves out of the way, giving the buds a chance to come out, and also protecting the seeds.

The pelargoniums do not do that, but they do something much more elaborate for the sake of their seed-children, as we know. They give them a parachute to fly with, for one thing. A parachute, you know, is a contrivance by which bodies can be sustained in the air while falling or blowing along in the wind.

But the parachute is not all, — they give them an auger by which to bore into the ground and plant themselves.

The North American crane's bill seeds perform in a very similar way, their flowers and seed-cases being quite like those of the pelargonium.

How do you suppose North American crane's bills came to be like South African pelargoniums?

This is a matter which needs investigating.

The pelargoniums are not as juicy as the nasturtiums, but they are somewhat juicy, and their juice has a slightly acid taste instead of being pungent, like the nasturtium juice.

Where pelargoniums live out of doors the year round they grow very large and have stems that are quite woody.

Some of them, as we know, are useful to the human race as well as ornamental, supplying food and an oil highly esteemed as a perfume.

The wood sorrels do not look much like the rest of the Geranium Family. But they do resemble it in their habit of caring for their seeds. Out in the fields you will find the small, yellow-flowered sheep sorrel, with its clover-like, sour-tasting leaves. Now hunt for a seed-pod. They are pretty little things that stand up something like Christmas candles. Touch a ripe one and it splits open down each of its five cells and shows you a row of white seeds in each. You think the seeds are not ripe because they are white, and you touch one of them. What has happened? That seed surely exploded! No, there it is — the other side of the table, not white, but dark brown. Queer performance, this. You touch another and another, and at last you get to understand it. Each seed is surrounded by an elastic white covering, and this it is that suddenly curls up, very much as the impatiens pod does, and sends the seed within it flying!

When night comes the sorrel goes to sleep. Its leaflets droop and shut together as you see in the picture, and the flowers, too, close. The sorrel loves the sunshine, and often does not open on cloudy days.

There are a great many sorrels in the world besides our sheep sorrel; in fact, we are told there are about two hundred and five of them!

We have only three or four out of all that number, and they are not all yellow like the sheep sorrel. One that lives in the cool Northern woods is white, with delicate pink veins. Pretty little things they are, and farther South there lives a pretty violet one.

Like the pelargoniums, the sorrels are to be found at the Cape of Good Hope. In fact, most of the two hundred and five kinds live there and in South America.

Like the pelargoniums, too, the South African sorrels are much larger and brighter than their American relatives.

We like them so well we raise them in our greenhouses and window boxes. They are much larger than our wild sorrels and have bright pink or white or yellow corollas.

Down in Peru, too, there grows a very useful sorrel; they call it "oca," and raise it for its potato-like tubers which the people eat.

The Mexicans also have a sorrel with edible bulbs and bright red flowers. In fact, the sorrel, like the potato, has a habit of storing up plenty of underground food which is also good food for man, and several species of sorrel are raised for this purpose in different parts of the world.

In those places, instead of a potato field you have a sorrel field.

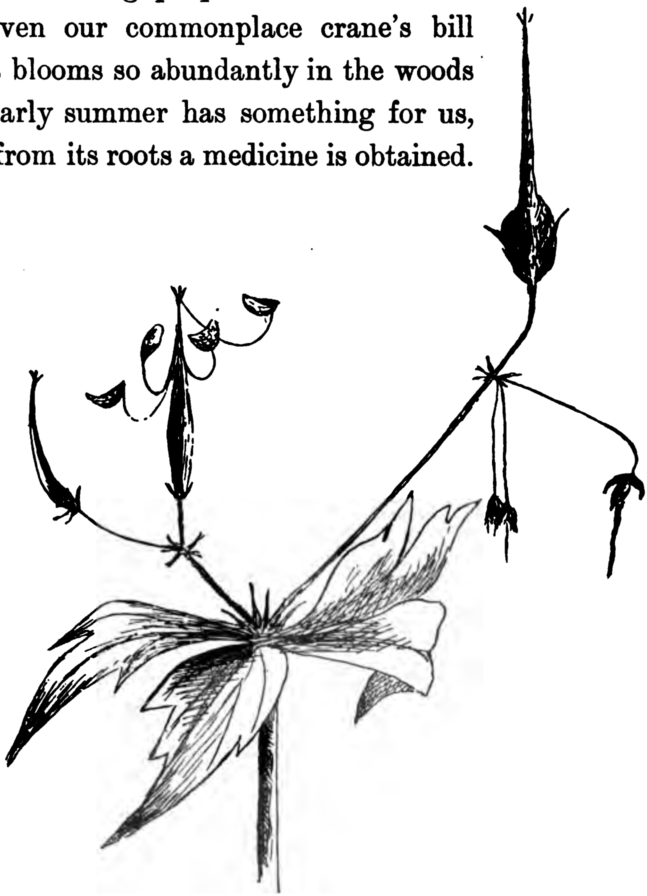
We often eat the leaves of the wood sorrel for the sake of their pleasant acid taste. The proper name of the sorrel is "oxalis," and comes from a Greek word meaning "acid." But if we were to extract this acid from the sorrel and then eat it, we would have a serious time, for in its concentrated form it is a fearful poison. It is sold under the misleading name of "salt of lemons," and for this reason people often ignorantly taste it, thinking that "salt of lemons" can do them no harm.

This dangerous "salt of lemons" is very useful in calico printing, in dyeing, and in the bleaching of flax and straw.

The next time you come across a patch of sheep sorrel, stop and think of all it and its relatives are able to do for us.

We usually think of the Geranium Family as being merely ornamental; but, as we have seen, some kinds of tropæolum, several kinds of sorrel, and at least one kind of pelargonium yield edible tubers which are eaten in different parts of the world, and the modest little oxalis yields a substance valuable for manufacturing purposes.

Even our commonplace crane's bill that blooms so abundantly in the woods in early summer has something for us, for from its roots a medicine is obtained.



Hyacinth Stories

HYACINTH STORIES.

THE HYACINTH.

OUT in the garden there 's something so dear!
Just as dear,
Do you hear?
Something that comes in the spring of the year
Fragrant as roses and fresh as the dew,
Purple and pink and violet too.
Something new,
Darling too.
Guess what it is and I 'll show it to you!

SIGNS OF SPRING.

OUT of doors are signs of spring. The buds on the trees look full, and some are beginning to burst. But there is very little life as yet.

Only in the hyacinth bed it is different, for there the hyacinths have waked up; their stiff leaves have opened the door of the earth for the blossoms to come out. The flower clusters are nearly ready to bloom, but the buds are still green. The tall stem has lifted them up into the air and sunlight, and, although the air is still cold, they continue to grow.

Soon the green buds undergo a change. The topmost one on each flower cluster softens to a tender blue or pink.

The green buds grow lovely as they stand on their stems in the sun. Delicate tints steal over them, the green color fades away, and many colors take its place.

They open into charming flowers and give forth a delightful fragrance. The whole garden is sweet with the odor of hyacinths, and we feel that the beautiful summer has sent us a messenger.

THE HYACINTH'S SCEPTRE.

KINGS bear a sceptre, and so do I.
Theirs is a symbol of power, and so is mine.
Theirs is a costly rod with an emblem at the top.
Mine is a tall green rod bearing flower bells.
My sceptre is called a "scape."
"Scape" means "sceptre," the sign of kings.

TUNICS.

A TUNIC, as everybody knows, is a dress worn by the old Romans. The Greeks wore a garment very much like that of the Romans, and it, too, is often called a tunic.

Tunics did very well in a climate where it was always summer and upon people who did not have to hurry about and work hard. But, graceful as they are, and appropriate to Greece and Italy, they would hardly be suitable for an American business costume in midwinter. For a tunic is not very close fitting. It is a loose garment which would be apt to fly away in our Northern gales.

The tunic was sometimes confined at the waist by a girdle and sometimes let to hang loose.

We do not wear tunics, but we admire them very much in pictures, for they show the beautiful lines of the human form instead of concealing and altering them and making them ugly by ridiculous and tight-fitting clothes — very often tight in the wrong place, as is the case with modern garments.

But there *are* tunics worn in America, and they are never tight in the wrong place, though, truth to tell, they are not loose and flowing like the Roman or Greek tunic.

Perhaps you do not know that so commonplace an object as an onion wears a tunic, yet I assure you it is true. And the onion does not come from Rome or Greece, — that is, probably not. As far as we can find out, that homely vegetable first saw the light in the southwestern part of Asia, but it was known in Rome and Greece at a very early date, and lived in those places long before it found its way to us.

So it has seen more tunics than we have, if it is not a native Greek or Roman. Not that its garments look at all like a classical tunic!

Probably its bulb is said to be "tunicated," or covered with tunics, because the different scales wrap about it like so many garments, and in a general way the word "tunic" is used to mean any garment.

The hyacinth, too, has a tunicated bulb. It came from the Levant, a country where people wear loose garments like the Greek and Roman tunic. I do not think, however, the bulbs are called "tunicated" because they came from the lands where tunics are worn. I think it is merely a name the botanists gave them for convenience to tell that they were covered by coats or scales.

What do you suppose a hyacinth tunic is, anyway? Merely a leaf scale! That is, instead of growing into a leaf it remained a scale, and *some* of the scales on a full-grown bulb are really the lower parts of the leaves. The upper part has fallen off and left the fleshy base to feed the plant.

Tulips have tunics too, and so have many other plants. And bulb tunics are a *very* convenient sort of garment to have, for they not only wrap up the plant, but feed it!

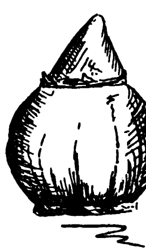
They answer the same purpose that tubers do on potato roots. You know what tubers are? They are just swollen portions of underground stems. When you eat your next potato remember it is a tuber, and that a tuber is merely a short piece of stem *very* much thickened. If you cannot believe this, look a potato in the eyes. There you will see the truth, for the eyes are merely the joints of the stem, and at each is a little bud that in the spring will start to grow, just like the buds on the branches of a tree. The bud grows at the expense of the material in the tuber, and the hyacinth grows at the expense of the food stored in the bulb. Of course, after a while green leaves form and make more food, but the very first food comes from the thick underground scales.

The hyacinth belongs to the royal Lily Family, and is a very great favorite with people all over the world. Sometimes its flowers are single and sometimes double, and they always give forth a delightful fragrance. Its home, as we know, is in the Levant, a country made up of the islands and the coast along the eastern part of the Mediterranean Sea, particularly of Asia Minor and Syria.

It grows so readily and comes up so early in the spring and is so lovely it is no wonder people everywhere cherish it. Its bulb is large and fleshy, and, as we know, is made up of thick *scales*. These scales are full of starch and other food materials to feed the young plant.

For the young plant is in the very center of the bulb, with the fleshy scales folded about it very much as the scales are folded about a tree bud. In fact, a bulb is very much like a bud. The bottom of the bulb is a *very* short, broad stem. The scales grow on this stem as the leaves do on a branch. They are alternate in arrangement, but packed so closely together you have to look *very* carefully in order to discover that they are arranged like leaves on a stem. After all, as we know, these scales are only modified leaves. The bracts of the pelargonium are leaves modified to protect the young buds, and the scales of the hyacinth are leaves modified to protect and feed the plant within.

For what do you think? At the very center of the hyacinth bulb is a tiny flower cluster wrapped about by half a dozen tiny leaves! These are white and delicate and very, very small. But in the spring they grow and come out of the bulb in the form of green leaves and bright flowers.



THE BEE.

I AM a rollicking bumblebee.
I sail through the air as it pleases me.
I sail by the trees and around the flowers;
I love the sun and hate the showers.

I have a taste does credit to me;
I never eat bread and such fiddle-dee-dee.
For honey and pollen 's the sensible food;
They favor digestion and suit the mood.

I sleep in my nest all winter long,
But rush fearlessly forth in the March wind's song,
For I 'm sure there 's some one waiting for me,
Since a hyacinth blue 's in love with this bee!


STORIES
ABOUT
ALL SORTS OF
THINGS

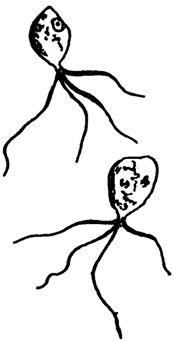
STORIES ABOUT ALL SORTS OF THINGS.

NECTAR GUIDES.

THE bee is always in a hurry. She flies from flower to flower as fast as she can.

She sees the flowers far off and comes straight to them, choosing the brightest. She has learned that the bright flowers hold much honey and often have guides to the nectary, so that she does not have to hunt about, but, alighting on a flower, follows the bright guide. Sometimes it is a spot in front of the nectary and sometimes a line leading to it. It leads her at once by the shortest path to the nectar, and since she is in such haste, the nectar guides are her good friends, helping her to save time.

CELLS.



Cells are a matter of importance.

To be sure there are cells and cells, and some are much more important than others.

For instance, there are prison cells, more's the pity, and anther cells and honeycomb cells and ovary cells and many more like them. All these are small, hollow spaces with walls around them.

But there is another kind of cell, more important than all these others put together, and they are not hollow and do not always have a wall.

Perhaps you are not very much interested in cells, but you had better be in these we are going to talk about, for they have a great deal to do with football games and dancing and going to parties and picnics. In fact, without them there could be no football and no dancing and no parties nor picnics.

All these things depend upon cells. So we may as well begin at once to find out what they are.

These cells that we are going to talk about are alive. They are made of protoplasm. You do not know what protoplasm is? I can tell you it is time you did then, for if it had not been for protoplasm you would not be in the land of the living. The protoplasm made you; so if you are not interested in it, *I* think you ought to have been a cabbage or a squash or a liriodendron or some other thoughtless vegetable not expected to be interested in protoplasm.

Like a good many other interesting things, protoplasm cannot usually be seen by the naked eye; it is in such small quantities that it takes a microscope to find it. And when you have found it, so far as its looks are concerned, it would hardly seem to pay for the trouble, for to the eye it is nothing but a colorless, jelly-like substance. It looks more like the white of an egg than anything else. But remember it is not safe to judge protoplasm or people by looks alone.

Napoleon was small, and he was not handsome; yet if you had seen him, you would have seen the greatest man living in the world at that time.

So when you look at protoplasm you see something very much more wonderful than it seems. In fact, the great Napoleon himself owed his physical life to protoplasm, as did also Shakespeare and Plato, and every person who has ever lived, for protoplasm is the only living matter in the world.

You cannot understand that all in a minute, but you begin to see that protoplasm is *rather* important, and as well worth knowing about as the latest fashion in bicycles or sleeve patterns.

Sometimes a bit of protoplasm lives all by itself. It is just a little speck of colorless, jelly-like substance. Yet it can do a number of things. One little creature, which is only a bit of protoplasm, has a name much larger than itself. We call it "Amœba."

Rather a pretty name, on the whole, and very uncommon. I doubt if you know a single person by that name.

It is a name, too, that everybody ought to know.

Well, as I told you before, and shall probably tell you a great many more times, for I do not want you to forget it, the amœba is only a bit of protoplasm.

Yet it can go about. You watch it some fine day under your microscope and see it travel. It runs out a little, thin bit of its body, so  and then the rest of the body sort of pulls itself up to that. In this way, by putting out little finger-like projections and drawing the rest of the body up to them, it can move quite a distance if you give it time enough. You can imagine so changeable a creature as the amœba can scarcely be found twice of the same shape, and how its friends recognize it is more than I can tell. Suppose you were in the habit of changing your shape whenever you moved, being long and thin one minute, short and thick another, having fourteen arms one day and none the next? How *could* you expect people to know you when they met you?

But perhaps the amœba has an unsocial nature and does not care whether it is recognized or not.

Because it changes its shape so often the amœba has received its pretty name. For "amœba," you must know, comes from a Greek word meaning "change."

It is sometimes called "Proteus" for the same reason. Of course you know all about Proteus, the sea god who lived at the bottom of the ocean and paid homage to the great god Neptune, who was ruler of the seas. Proteus took care of the sea calves, and he had a queer way of changing his shape whenever he chose. He used to go to sleep on the rocks while the calves were sunning themselves, and because he was very wise and could help people who were in trouble, they used to go there and catch him. But he was not as friendly as he was wise, and would never tell anything unless forced to; and when he found himself a prisoner, he would at once change his form, and so try to escape by frightening his captors. He had a pleasant habit of all at once changing into an enormous serpent and opening a mouth full of frightful teeth; then, if *that* did not frighten badly enough, he would all at once turn into a bull or a raging fire or a fierce torrent. He has been known to change into a dozen dreadful things in as many minutes, so no wonder his name has come to mean "something that changes." And no wonder the amœba is called "proteus," not that it indulges in any such outrageous transformations as the sea god, for it never does anything worse than change the shape of its own little jelly-like body.

Although it can move along, I do not think it would amount to much in a race, as it only moves a few inches in the course of a day; still that is a good deal, considering its size.

A great deal depends upon size in this world.

You could go as far in ten seconds as a snail could in as many hours. The distance would not count for much as far as you are concerned, but it would be a good day's work for the snail. So when an amœba travels a few inches, that counts for as much in its life as a long day's walk of a good many miles would in yours, or as a few hundreds of miles on a railway train.

The amœba can do more than travel. If you touch one it will shrink together, showing that this little bit of protoplasm has a sort of *feeling* power.

When it is hungry it eats. For an amœba can get as hungry as anybody.

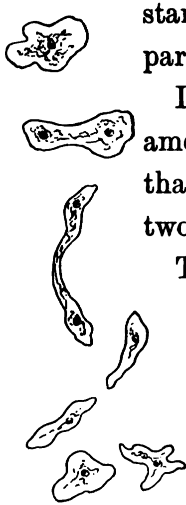
Hunger does not depend upon size. You can get as hungry as an elephant, although you cannot eat as much. You would starve to death, too, as soon as an elephant, perhaps sooner. An amœba no doubt gets as hungry as you do, and it certainly would starve to death if it did not have something to eat.

How can it eat without a mouth? Just as easily as it can travel without feet. You do not know protoplasm if you think it cannot eat when it is hungry. Very likely the reason it travels about is because it wants to find something good to eat. It does not care for roast turkey and cranberry sauce, nor for apple pie and plum pudding.

That is not what it is looking for. It is looking for some tiny speck of food smaller than itself.

It lives in the water, of course. It would dry up if it were out in the air. You should think it would *melt* in the water? Well, it does not, any more than a jellyfish melts. When it comes to some little speck of dead plant or animal, or, for all I know, to some living speck small enough, it proceeds to eat it.

It glides over it in the way you know about, and wraps the food speck up in its body. Then it draws out all the good part of the food into its own substance and goes on, leaving behind the waste particles.



Do you not think that is a good deal for an amœba to be able to do? But it can do more than this; it can divide itself in two and make two amœbæ out of one.

The little amœba is called a "cell." After awhile you will see why. The whole amœba is just one cell.

As to whether it is a plant or an animal you will have to ask the amœba, for I cannot tell you. Some think it is a plant and some say it is an animal.

I do not think it makes much difference which you say it is.

A bit of protoplasm living by itself is called a "cell."

Many plants and animals have, like the amœba, only one cell. Very often the little one-celled being has a thick outside wall. The protoplasm changes part of the food into a hard substance, that is, it builds itself a wall.

Very often cells live together in colonies instead of living alone. In such cases, the first cell divides into two cells, but the two stay together instead of entirely separating. Then each of these two cells divides again, and the four cells stay together, and so it goes on until a large body is built up of many cells.

The truth is, plants are only collections of cells which have agreed to work together. Where there is but one cell, it has to do all sorts of work; but where there are many, some do one kind of work, some another, — just as Robinson Crusoe, living all alone on the island of Juan Fernandez, had to do all sorts of things for himself: make his own shoes and clothes, get his own food and cook it, build his own house, and gather his own wood. But in a town one set of men makes shoes, another chops wood, another raises vegetables and grain, another grinds the grain, and another bakes the bread; then they all exchange with each other, and everybody has enough — or ought to have.

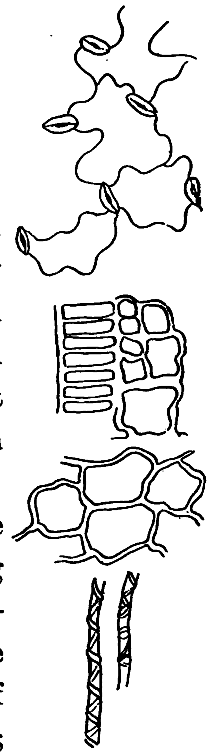
So in the plant made of many cells. One set of cells makes hard walls to protect the plant. Another set draws up water from the earth for all the cells in the plant, for living things require a great deal of water. Another set takes gas from the air and changes it into food. Another set makes tubes for the sap to flow through. Other sets do other things. Each set of cells does something for the whole plant.

If you look at a leaf or a bit of skin from a stem under a microscope, you will see they are built up of cells, as a house is built of bricks. Only the cells are not placed regularly like the bricks in a house, and they are not solid like bricks. The walls of these cells are sometimes hard and sometimes soft, sometimes tough and sometimes tender; but the walls were all built by the protoplasm that lived in them. Sometimes the protoplasm leaves the little house it has built and goes somewhere else.

Then the empty, wall-surrounded space is left like a cell of honeycomb before the honey is put in, or an anther cell after the pollen has fallen out and left nothing in it.

Before microscopes were as perfect as they are now, these empty spaces with their surrounding walls were discovered. Even where the cells contained protoplasm the microscope was not strong enough to reveal it, so only the cell walls were seen.

It was soon known that plants were built up of these little compartments, and because they resembled cells in being small and shut in by walls, they were called "cells." After awhile it was discovered that the living part of the plant was the colorless, jelly-like protoplasm which lived in the cells. Yet later, particles of wall-less protoplasm were found building up plants and animals. What were these soft little protoplasmic atoms to be called?



Some of the cells in one plant.

The plant was really built up by them, and only part of them had walls, so they were called by the name the people had already given to the walled spaces which they supposed built up the plant, and so got the name of "cells," which is not at all an appropriate name.

There is nothing quite so easy as to be mistaken, you see, and the botanists, having seen that the plant was built of little compartments, and never suspecting the presence of the living protoplasm lurking in some of them, had called the compartments "cells"; later, when the protoplasm was discovered to be the real builder, the old name was kept. So you see how the amœba came to be called a "cell."

There are a great many different kinds of cells in one plant.

But every living cell has very much the same powers as the amœba, though in many of them some one power is developed at the expense of all the rest. In this way different sets of cells are able to perform different kinds of work, and do it very well indeed.

The amœba is not the only single-celled creature. There are a great many different kinds of single-celled plants or animals, and some of them take very curious and beautiful forms, with streamers floating about them.

Such are not protean, like the amœba; they do not change their shapes.

Plants are not the only things that have cells. Animals, too, are built up of them. Animal cells are usually softer than plant cells, because they very often have no hard walls. Bone cells of course have hard walls, and there are others, but most of the animal cells are without walls.

So you see all living things are built of cells, and the living part of the cells is the protoplasm.

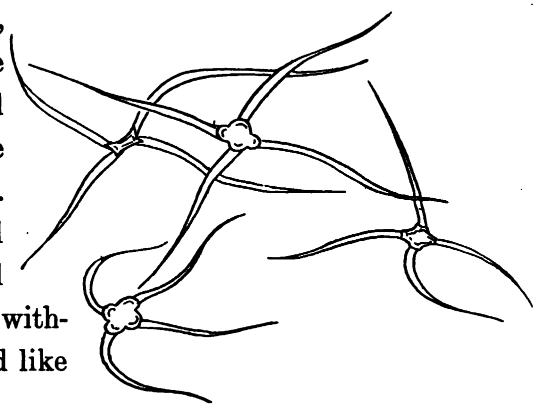
You yourself are built up of millions of cells, and without the help of protoplasm you would not be living, for protoplasm made your cells, and protoplasm is the only thing in you that is alive. Your muscles are made of muscle cells, and the protoplasm in them moves, and when the muscle cells all move together, that moves your arm or your leg or your head or some other part of your body.

Since your muscle cells devote themselves to moving, they do not try to do much else; so other cells digest the food which the blood carries to the muscle cells. Yet other cells build a good thick skin to protect the soft muscles, and yet another set of cells *thinks* for the muscles, and tells them where and when and how to move. Each set of cells has its own work.

Your brain is made up of nerve cells, and the protoplasm in them in some way enables you to think and feel. Your bone cells are hard and resisting, your sinew cells strong and flexible. So each part of your body is made up of different kinds of cells.

But what has all this to do with football and parties and picnics you would like to know?

Why, a great deal, to be sure. If it were not for cells and protoplasm there would be no people.



And how could you have football games and picnics without people, *I* should like to know?

POLLEN CELLS.

IN the dark little dungeon cells of the anthers, the pollen grains lie. Hundreds, and sometimes thousands of them, are packed in there as closely as they can be. But they do not mind it, not in the least. They grow and get ripe, and as soon as this happens, their prison door opens and out they pour.

They are funny little things, not at all what they seem to be. For you would think they were just little specks of dust of almost no shape at all. But that is your fault, or rather the fault of your eyes.

You see your eyes were not meant to look at things so tiny as pollen grains. You can see a common ball or even a small shot very well indeed; but when it comes to pollen grains you are as blind as a mole. You will have to put on your spectacles to see *that,* I can tell you, and very powerful spectacles they will have to

be, too. The best spectacles for you to look through are the ones we call a microscope. Just put your eye to that tube and you will see what you will see, for there are pollen grains at the other end — pollen grains from several kinds of flowers; there are some in the corner from our friend the morning-glory. And now you know what I meant when I said you could not see a pollen grain; for those little specks of dust have all at once become large and important objects. Some are round and some are not, and all are creased or pitted or ridged or covered with little points or marked in some other way. Now you see why they stick so easily to the hairs on the bee or the butterfly or whatever comes visiting the flowers for nectar. They are not smooth, but all roughened over by these ridges and points.

And this is not the end of it. You have not yet seen a pollen grain. You have only seen the outside of one.

For it has an inside. You think it is too small to have anything inside of it?

I can tell you things *much* smaller than that have something inside of them. The truth is, these things seem so small because we are so large. If we were as small as they, they would not seem small at all. They would seem a very ordinary size indeed, and we would expect them to have an outside and an inside.

The truth is, pollen grains are hollow. They are as hollow as the baby's rubber ball. But they are not *empty*. The baby's rubber ball is not empty; it is full of air. These pollen grains are not full of air. If you were to see what is in them, you might not think it very important, but that would be a great mistake, for they are full of — protoplasm!

The truth of the matter is, the pollen grain is a *cell;* it has a wall outside and is made of protoplasm inside.

Protoplasm, you remember, is the material out of which every living thing is made. You are made from protoplasm yourself; flowers are made from it, too, and leaves and birds and *everything that lives.*

So you see if a pollen grain is filled with protoplasm, that is rather a serious matter.

This pollen grain, small as it is, has a tough outer skin. It is not as tough as leather, but it is tough for so small a grain, and is strong enough to keep the protoplasm from running out.

The protoplasm in the pollen grain is what the ovule needs to nourish it and make it able to grow. The ovule, too, is a cell filled with protoplasm, and the protoplasm of the pollen and of the ovule must somehow come together before the ovule can do any more growing.

You know how the bees and butterflies and all sorts of insects carry the pollen from flower to flower and dust the stigmas with it. You may think that when a pollen grain is safely landed on a stigma then the rest is easy enough. But if you suppose the pollen grain can pass through the style you are *very* much mistaken. It cannot even pass through the stigma. It is true, the tissues of both style and stigma are rather loose, and that the style is sometimes hollow. But, as far as I know, the pollen *never* passes through. Small as it is, it is too large to get through the tiny openings in the stigma, and then, you know, the stigma is sticky and holds it fast.

Here is an interesting state of affairs! The ovule cell is waiting for protoplasm, and the pollen cell is anchored safe and fast at the stigma.

But you may be sure there is a way out of this difficulty.

To begin, the pollen grain has two coats, a tough outer one and a delicate inner one. There are openings, or at least weak places, in the outer coat, and after the pollen has lodged on the moist stigma, the protoplasm inside swells and comes bulging through these weak places. The inner coat is forced out, as though some *extremely* small fairy had stuck her finger through the wall from the inside and pushed out a part of the inner lining. Well, this finger-like part that comes through the wall does not break open, but begins to grow. It grows longer and longer until a tube is formed, a tube so small that only the microscope can enable us to see it.

This tube pushes its way through the stigma into the style; there it continues to grow like a long root, only it *is not* a root, and it is hollow; and the protoplasm from the inside of the pollen grain runs down this tube.

You can guess what happens next. The tube grows and grows; it finds plenty of nourishment in the tissue of the style, which is made of material suitable to feed it. Of course, it grows down the style into the ovary, because the style opens into the ovary.

When it reaches the ovary it finds its way to an ovule, and goes in at a little door which the ovule keeps open for it.

Now, you see, there is an open path between the pollen grain and the ovule, and the protoplasm from the pollen grain runs down the tube and enters the ovule. Here it passes out of the tube by breaking through the delicate wall, and unites with the protoplasm of the ovule.

Thus the ovule is fertilized. It is nourished and strengthened, and at once begins to grow into a seed.

Meantime the shell of the pollen lies on the stigma, a little dried-up, empty thing. Its work is done. Thanks to the bee or the butterfly or some other flower-loving friend, it has been taken to the right place, and all that was living in it, its protoplasm, goes on living in the little ovule.

The pollen grains the bees carry home have a very different fate. They are crushed and soaked and kneaded with honey and fed to baby bees.

But the flowers are willing the bees should have some to live on, and so each flower makes thousands more than it needs. You see, if it did not give the bees something to eat, they would not come and they could not live on honey alone; they, too, need the protoplasm in the pollen to nourish them.

Some kinds of flowers use their own pollen. They do not need the bees and do not want them. So they keep their pollen shut up tight and do not make any honey to coax the bees to come. But nearly all flowers wish to have other pollen than their own. And this they can only get by the help of other people's wings, as they have none of their own.

THE POLLEN.

WHAT does the pollen do?

It helps the ovule change to a seed.

It feeds the bees and the wasps and the flies.

But above all, it helps the ovule change to a seed.

THE ANTHERS.

ANTHERS, anthers, full of pollen,
Cunning cupboards of the bee,
Stamen flour amply hiding,
What have you for me, for me?
What have you for me?

Pollen have I, plenty of it,
Pollen for my darling bee;
Pollen every day I blossom
For my bee, but none for thee,
For thee, none for thee.

OVULE CELLS.

You will be glad to know that the little ovules at the heart of the morning-glory and of all other flowers are single cells.

They have an outside wall and are filled with protoplasm.

When a pollen cell is formed from the inside of the anther, it separates and is no longer connected with anything. This is not the case with the ovule. It is fastened to the ovary by a little stem, for it will stay there and grow; and it must have a way to get food from its parent plant. It gets the food through this little stem.

You know what happens when the flower opens.

The bees bring pollen, and the protoplasm of the pollen joins that of the ovule. As soon as this happens the ovule begins to change. We say it *grows*. It gets the food to grow on from the mother plant through the little stem which is fastened to the inside of the ovary.

The protoplasm in the ovule first divides and makes two cells instead of one. These two cells do not entirely separate from each other. They stay together to do their work. Soon each of them divides into more cells. These cells again divide, and this continues until a great many cells are formed. Meantime the ovule has increased in size as well as complexity, and its cells do several different kinds of work. In the morning-glory, for instance, some build a hard outer wall about the young plant; this is the seed-case. Other cells form two little leaves; others make a little stub of a stem. So the change goes on until the single-celled ovule becomes a many-celled seed with a young plant rolled up under its walls. If you open a morning-glory seed you can see this little baby plant, only you will have to soak the seed first to soften the food that is stored about the young plant.

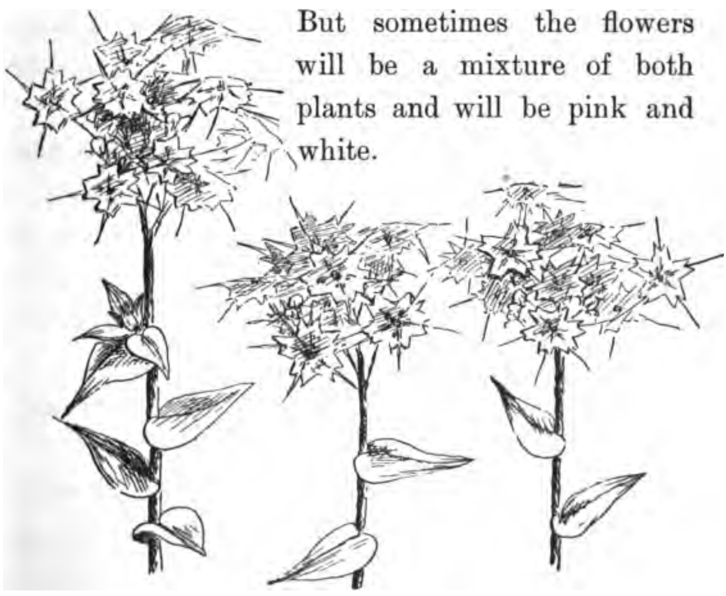
The cells made this food to nourish it, and it stays dry and hard until the rain moistens it in the spring, when it gets soft, like boiled starch, and is then ready for the little plant to use. When the ovules grow on one plant and the pollen comes from another, the seeds will contain the protoplasm of two different plants.

Now protoplasm remembers the plant it came from, and tries to make the new plant like it.

The ovule protoplasm tries to make the seed remember the plant it grows on, and the pollen protoplasm tries to make the pollen remember the plant it comes from.

So if the pollen comes from a plant bearing white flowers, it wants the seeds to grow into white-flowered plants. But if the ovules which fertilizes it grow on a pink-flowered plant, they try to make the seeds grow into pink-flowered plants. Now what happens? Very likely some of the flowers will be white and some of them pink. Some will take after the plant the pollen came from and some after the one the ovule came from.

But sometimes the flowers will be a mixture of both plants and will be pink and white.



The ovule is the mother part of the plant and the pollen is the father part, and sometimes the seed-children take after the mother, sometimes after the father, and sometimes after both.

This is very strange and we cannot quite understand it. How can the protoplasm remember the exact shade and color of the plant it came from? How can it make seeds that grow into plants just like the old plants?

Protoplasm, you are a great, a very great mystery!

By knowing about pollen and ovules we are able to help form a great many lovely new flowers and fruits.

We get variegated flowers by fertilizing a flower of one color with pollen from a flower of another color.

When we do this we must cover over the plant with a piece of netting just before it blossoms, so the bees and butterflies cannot get ahead of us and fertilize the plant. Then we must put a bit of pollen from one flower on the stigma of the flower we want to experiment with.

We must always use the pollen from the same kind of a plant, however.

It would be of no use to put nasturtium pollen on a morning-glory stigma, for instance, for it could not affect the ovule in the least. The protoplasm knows in some way its own plant and will not fertilize any other.

This is a very good thing, otherwise we might have a funny mixture of all sorts of plants.

Many delicious fruits have been produced by fertilizing one plant with pollen from another.

New varieties of grapes and berries are constantly obtained in this way.

If you live on a farm or have a garden, you might try to develop some new kinds of berries or fruits. You might not succeed, but it would do no harm to try.

CHLOROPHYLL.

Chlorophyll is plant green.

That is what the word means.

We are so used to seeing green leaves that we think very little about it.

It probably never has occurred to most of us that the green coloring-matter of plants can be of much importance. Yet it is one of the most important things in the world.

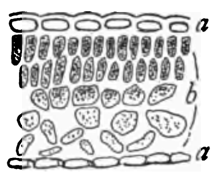
Like many other things, it is not what it seems. It is not merely a dye as one might suppose, but much more than that.

We cannot really see what it is without a microscope, and when we look at a piece of green leaf through the microscope we are surprised to find the leaf is not green at all.

It is colorless like glass, but in the cells just behind the skin cells we see little roundish green bodies packed away. These are the chlorophyll grains, and when there are a great many of them close together they show through the skin and make the whole plant green.

The skin protects them, you see, and yet it is transparent and allows the light to get to them, which is a matter of great importance to the chlorophyll grains, for they are hard workers, but cannot do a single thing without sunlight.

Chlorophyll grains lie just behind the skin cells in all parts of the plant that look green. The cells they lie in are often long with their short ends towards the skin. Leaves contain several layers of chlorophyll cells. The inner ones are not long like the outer ones, and do not contain so many chlorophyll grains. In the illustration, *a*, *a* represent the upper and lower skin and *b* the cells containing chlorophyll. The under side of a leaf usually has fewer chlorophyll grains in its cells, for the light is not so bright there, and chlorophyll needs plenty of light.



Sometimes the cells in the middle of a leaf, that is, halfway between the upper and lower surfaces, have no chlorophyll at all.

Now what *do* you suppose is the work the chlorophyll grains have to do?

You never could guess, so I may as well tell you at once. If it is not making sugar, it is something very like it. To begin at the beginning, which is a long way from sugar, but which will certainly bring us to it, I must tell you that these little round green chlorophyll people have a strong attraction for carbon dioxide, which you know is a gas and is always found in the air. You know, too, we breathe it out as an impurity. Probably you did not know it had anything to do with sugar, but it has a very great deal to do with it.

The chlorophyll grains attract carbon dioxide as strongly as a magnet attracts bits of iron. The carbon dioxide in the air goes through the pores in the leaf skin, right through everything to the cell where the chlorophyll lies. You know carbon dioxide is made of carbon and oxygen. The plant needs a great deal of carbon, for nearly all its hard parts are made of it. Wood for one thing is nearly all carbon.

As soon as carbon dioxide comes where chlorophyll is, the chlorophyll, which of course is chiefly made of protoplasm, tears it to pieces. It pulls the carbon away from the oxygen and the oxygen rushes out through the pores back into the air. But the carbon stays behind.

You see oxygen is a gas and carbon is a solid. When carbon and oxygen unite in a certain way, they make another gas, our carbon dioxide.

It is very queer that carbon should have the form of a gas when united with oxygen, and I cannot explain it here. You must just remember that it is so.

When the oxygen flies away into the air again and leaves the carbon behind, the work of the chlorophyll has but just begun. Raw carbon is of no use whatever, — no more use than carbon dioxide, which we know is good for nothing to the plant or else the chlorophyll would not tear it to pieces.

But if the chlorophyll can only get a little water, something worth while will happen. This it can always do, as the roots take good care to send it plenty.

Water, you know, is made of two gases, hydrogen and oxygen, united together.

Here, you see, gases unite and make a liquid. Well, chlorophyll has a way of its own of uniting the carbon it took away from the carbon dioxide with the hydrogen and oxygen it gets from the water and forming a solid, which the plant cannot live without.

Now what do you suppose this new solid is? Probably you *never* could guess.

It is *starch*, just *starch!*

Chlorophyll makes starch out of carbon, hydrogen, and oxygen.

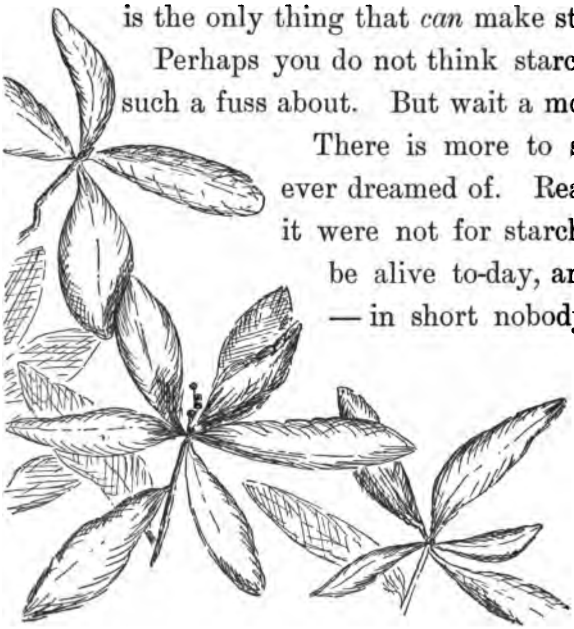
Sometimes it makes sugar and oil out of them, but its work is most generally starch-making.

The carbon, you remember, it gets from the carbon dioxide of the air, and the hydrogen and oxygen from the water the roots send it.

The strangest thing about all this is, chlorophyll is the only thing that *can* make starch.

Perhaps you do not think starch worth making such a fuss about. But wait a moment.

There is more to starch than you ever dreamed of. Really and truly, if it were not for starch you would not be alive to-day, and I would not, — in short nobody would.



All our lives depend upon starch. So when we come right down to the truth, our lives depend upon chlorophyll, because that makes all the starch there is in the world.

You do not think our lives depend upon starch? Wait and see.

Chlorophyll makes starch. Never forget that as long as you live. Forget your own name if you want to, but do not forget that chlorophyll makes starch.

You see starch is the raw material of which plants are made.

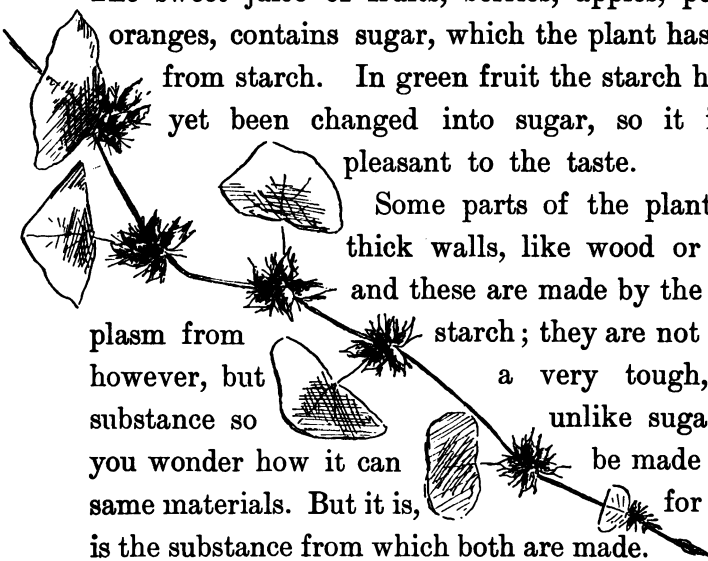
After the chlorophyll has made starch, the starch is dissolved, or *melted* you would likely say, and so is carried all over the plant in the sap. Some parts of the plant change the starch into sugar; for sugar is made of the same things as starch, only in it the carbon, hydrogen, and oxygen are put together a little differently, just as you can make several kinds of cake from flour, butter, sugar, milk, and eggs by stirring them together differently and mixing them in different proportions.

You cannot make cake without flour, sugar, eggs, and milk, and usually butter. But if you have these ingredients you can make a great many kinds of cake.

Starch is the material of which the plant makes a large part of its substance.

Some parts of the plant that need sugar make it from the starch, and we find more or less sugar in all plants. There is, as you know, a great deal in the nectar of flowers, but other parts of the plant need it too, so sugar is a matter of importance to plants as well as to people. But sugar, remember, is made generally from starch, no matter in what part of the plant we find it.

The sweet sap in the sugar maple is made from starch; so is the sweet juice of the sugar beet and of the sugar cane. All the sugar we use, excepting that in homeopathic pills, is made from starch. The sweet juice of fruits, berries, apples, peaches, oranges, contains sugar, which the plant has made from starch. In green fruit the starch has not yet been changed into sugar, so it is not pleasant to the taste.



Some parts of the plant need thick walls, like wood or bark, and these are made by the protoplasm from starch; they are not sugar, however, but a very tough, firm substance so unlike sugar that you wonder how it can be made of the same materials. But it is, for starch is the substance from which both are made.

There are other things in the plant besides starch, and there are things which are not made from starch; for instance, there are acids and minerals of different kinds and there is protoplasm, but the greater part of every green plant is formed from starch.

Some plants make more starch than they need at once, so they store it away for future use, just as people raise extra supplies of wheat and corn, and store them away until they want them.

The potato plant, for instance, stores a large quantity of starch in the potatoes underground. A potato is nearly all starch, and the sweet potato stores up sugar as well as starch in its underground parts.

The potatoes have a reason for this, and, if let alone, would use up the starch and sugar another season; but we do not let them alone, as you know. We too need starch, and so we dig up the potatoes and eat them instead of leaving them for the plant.

A great many plants store up starch in their seeds that the young plant may have food enough to start growing. All our grains do this. Wheat, rye, oats, barley, rice, corn, and all other grains are only the seeds of plants which have been stored full of starch. Peas and beans are also starch-filled seeds. Cabbages store food made from starch in their big thick leaves. Beets store sugar and other starch-food materials in their thick roots; so do carrots and parsnips and turnips. Onions store it in their bulb leaves underground.

You begin to see now how important starch is

to our lives. Nearly all the vegetables and grains and fruits we eat are composed almost entirely of starch or the materials of starch. Even meat is made from starch, for what do the animals we kill for meat live on?

Why, plants of course, and chiefly the starch they find in plants.

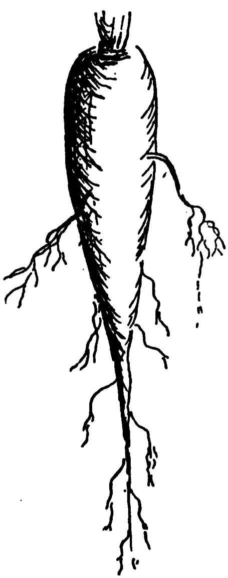
So now we are just where we started, — we see we really do owe our lives to starch, and we owe starch to chlorophyll, so of course, we owe our lives to chlorophyll. I wonder if we shall think of this next time we look at the green leaves everywhere in the fields and woods.

I wonder if these green leaves will not look more beautiful than ever when we think of the work they are doing.

ROOT CELLS.

Roots do their work underground as a rule.

You might prefer not to be a root, if you had your choice; you might prefer to be a leaf or a flower.



I have never heard that the roots complained of their work, however. For one thing, it is easier. All they have to do is to hold the plant fast, suck up juices from the earth, and in some cases store away food material,—that is, if they are regular, well-behaved, everyday, underground roots.

Sometimes, however, roots come out of the ground and do all sorts of things,—cling to walls and hang in the air and perform in other unroot-like ways; but these are not what we are talking about. We are talking of roots, such as those of the morning-glory and nasturtium and geranium, which stay underground and behave themselves.

Since it is dark where they live, they have no chlorophyll grains, and do not have to make starch. They merely use up the starch that comes to them from above.

Since they are not blown about by the wind, they do not need complicated, stiff, supporting tissues like tree trunks. On the whole, they are rather a simple people. They are made of cells, of course. But there are not so many kinds of cells in them as in the stems and leaves.

They have skin cells, but no pores. Out of their skin cells grow their most interesting and important parts. These are called root hairs. They are made of cells lying next each other, like other hairs, but they do all the sucking up of food materials for the whole root. These root hairs draw the water and other food out of the soil for the use of the plant, and the rest of the root only stores it up and conducts it to the stem and leaves above and anchors the plant to the ground.

The root's work as an anchor is important, as you can imagine.

Just suppose that plants had no strong roots twisting around stones and bits of earth underground and holding them fast ! What a time there would be whenever the wind blew.

Even a light breeze would be worse than a cyclone at present, for it would send the wheat in the wheat-fields flying before it.

All the plants would go hurry-skurry wherever the wind blew — excepting the morning-glories and others that were twined about trellises or fences or rocks; and even they would be blown all out of shape.

And when a strong wind came, if the trees had no roots to anchor them *they* would go hurry-skurry in the direction in which the wind blew, even if they were balanced so that they could not fall over; and we should see the forests sliding about the country and probably right on our houses, knocking them down, so we would not be able to have any houses, but would have to live in caves. It is a very good thing for us that the plants are held fast by their roots.

Well, the root hairs do the most important work of the plant after all. It is they who go poking their noses through the soil, and with their cells draw up water and potash and nitrogen and sulphur and iron and many other things which have become dissolved in the water. They are even able to dissolve rocks and such delicacies for themselves.

Now a growing root tip is a very delicate thing.

You could not expect it to go pushing its tender tip through the hard earth without some kind of protection. And it does not: it wears a cap. This cap fits over the tip of the root and is hard. The cap is not alive, that is, the outside of it is not. The growing part of the root tip is just behind the cap.

The root tip grows by adding on new cells and so pushes the root cap ahead of it. The hard root cap finds its way between the particles of earth and so opens a channel for the growing root tip behind it.

The cap wears off on the outside the way the bark does on a tree, and, like that, is continually renewed from the inside where the cells are alive.

SKIN CELLS.

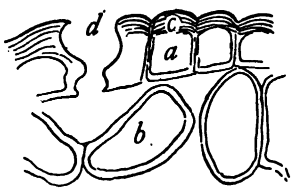
SKIN covers over and protects what is underneath. It is thin compared with what it covers, but it is important, as we discover when we lose a piece of our own skin. A fluid substance or even blood oozes out, and the spot where the skin is off is very painful.

Plants have a skin too, and it does for them what our skin does for us. It is tough and protects the soft inner parts and keeps the sap from oozing out.

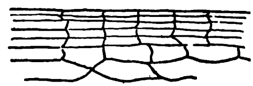
Skin, of course, is built up of cells. These cells generally lie close together, touching each other, except at certain spots, where there is an opening.

Skin cells are usually long and wide, and their outer walls, as you would expect, are thicker than the inside walls. The protoplasm builds up hard material on the outside to protect the rest of the leaf or stem. Leaves and young stems and roots and flower parts all have skin.

The skin is alike in all in a general way, just as all houses are alike in a general way. They all have a roof, walls, partitions, doors, and windows, though these are of different sizes and arranged differently in different houses to suit the needs of the people who live in them. So with plants. The skin cells are different in size and shape and thickness in different plants to suit the needs of the plants, though in all there is a general resemblance.



Here is a row of skin cells (*a*) with other cells (*b*) back of them. See how thick the skin cells are on the outside (*c*). They are very tough there too. *d* is an opening between two cells, and all is magnified several hundred times.



Sometimes there are several layers of skin cells where the plant needs a particularly thick skin ; *a* in the illustration is an example of such a skin.

But it would not do to have an air-tight skin, even for a plant.

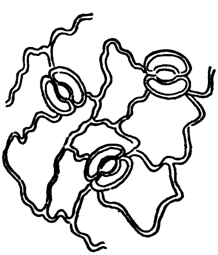
Our own skins are full of holes, or pores, as you know, to let out the extra water and other waste materials in what we call perspiration. The plants need such an arrangement as much as we do. So in their skin we find pores. You see the plant needs a great deal of water. The water is used in making the substance of the plant. It is also used in the sap to carry food about from place to place. Sap contains a great deal of water in order that it may flow easily. This water cannot all be used by the plant, and when it comes up from the roots in the sap a large part of it has to be got rid of by the leaves.

If the skin were solid, the water could not escape. But you know what protoplasm can do.

If the skin needs pores, it will make them. And this is how it does it.

If you peel off a bit of skin from the under side of a leaf and put it under the microscope, you will see something like this.

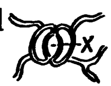
The round forms are the pores. The crooked lines between are the edges of the cell walls, and you are looking at them right through the outer wall of the skin, which is transparent like glass, otherwise you could not see the edges of the partitions.



Let us look at these pores, or stomata as we must call them, if we want to talk like botanists.

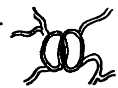
One of the stomata is called a "stoma"; stoma comes from the Greek and means a "mouth," or "opening." These little mouths, or stomata, are made of two cells lying close together. These cells reach through the skin into an open space back of it.

There are open spaces between many of the inner plant cells, and there is always one behind a stoma. There are very few spaces between skin cells, excepting, of course, the openings between the two cells of a stoma. The two cells which make a stoma are called "guard cells," because they guard the opening into the plant.

They are shaped, you see, something like half-moons. When the plant is full of water these half-moons swell  up and their edges are drawn apart — so.

This, you see, makes an opening (x) into the plant. This little mouth through the skin opens into the space back of the skin, and this space connects with other spaces all through the plant. Through these stomata all parts of the plant can communicate with the outer air. The extra water and other waste materials pass out through the open stomata and air and other gases pass in and out.

Now, if the air outside is very dry and the earth is dry so that the roots are not able to send up much water, these wise little guard cells do not swell up and separate.

They are too good gatekeepers for that. They straighten out, their edges meet — so —  and the opening is closed.

Now the water cannot so readily escape and the plant will not wither so soon. In dry climates the stomata are often surrounded by hairs which prevent too rapid evaporation; these hairs are often thick enough to make the plant look woolly. In fact, many plants have hairs upon those parts of the leaves where the stomata are found; they not only prevent too rapid evaporation, but also keep the rain or dew from getting into the stomata and closing them up. They hold off the water so that it cannot wet that part of the leaf.

There are a great many stomata on one leaf, — on some kinds as many as thousands to a square inch.

Usually, among land plants, there are more on the under side of the leaf, and in very dry places all are on the under side. The sun shining on the upper side would often cause too great evaporation, so the stomata are found underneath. In very hot, dry air there will be a little evaporation, even when the stomata are closed.

But when we come to look at leaves that lie on the surface of the water, like water-lily leaves, of course the stomata are all on top, as that is the only part of the leaf the air can reach.

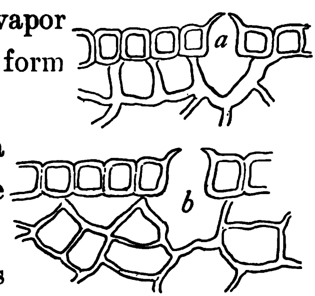
Many water plants have their stomata above, for you see there is no danger of their water supply running short.

It is very important for a plant to keep its pores open and it is quite ingenious in contriving ways to do this. Perhaps hairs are most frequently used.

They often cover the under side of the leaf where the stomata are thickest, or are found in lines along the leaf, when the stomata are distributed in this way.

But, you say, rain cannot get to the under side of the leaf. No, but dew can. Dew wets the under side of the leaf quite as much as the upper side, for dew does not fall, as some people think, but is deposited all over the surface of a cool object like a leaf, for dew is nothing but the vapor in the air which is deposited in the form of water at night.

To see better how the stomata work, here is a side view of one closed (*a*) and one open (*b*).



Stomata, you see, are the doors

to the plant through which things pass in and out. Not only water goes out through them, but also other waste substances, such as oxygen and carbon dioxide.

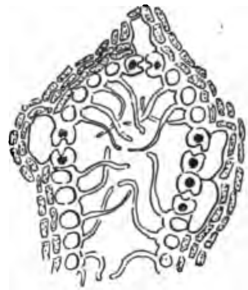
You must not suppose because so many things go *out* at the doors that nothing goes in; for air passes in and also carbon dioxide.

Carbon dioxide passes out from the plant and in from the air! That seems curious, but you must remember the plant has to use its stomata for both lungs and mouths,—lungs to breathe out impure air, which contains carbon dioxide, and mouths to take in carbon dioxide, which is one of its principal foods.

Besides stomata, plant skin has other kinds of special cells. These other cells form hairs or prickles or scales or glands. The hairs, prickles, and scales form on the outside of the skin, as you can see by the illustration.

On the side of a regular skin cell the protoplasm builds a small cell; this grows long and divides and makes two; these may again divide, and so on until the plant has as long a hair as it needs. Sometimes the hair is made of but one long cell.

Hairs, as we know, protect the plant from too great evaporation and from changes of temperature; they also keep the dew and rain from settling in the stomata and filling them up so they cannot do their work.

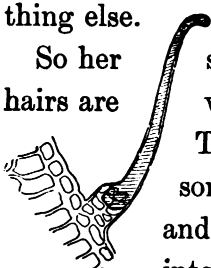


Here is a picture of four stomata, growing about a hollow filled with hairs. These hairs prevent the outside water from running in and wetting the stomata.

Prickles and some kinds of hairs and scales protect the outside of the plant from animals. When the animals bite the plant, these things stick into their mouths and they are glad to let it alone.

If you want to be sure that prickles and hairs protect the outside of a plant, go take hold of a nettle!

Madam Nettle does not wish to be taken hold of nor eaten nor touched by cows or sheep or anything else.



So her skin has hairs on it that sting. The hairs are very sharp and they are hollow. There is a poisonous juice inside, something the protoplasm has made; and when the sharp end of a hair sticks into your finger, the little turned-up end breaks off, and the poisonous juice gets into the wound and irritates and causes the finger to swell a little.

There is a way to take hold of a nettle so that it cannot sting. The little poison-filled hairs all point *up*, as you see in the picture. So if you stroke the nettle or draw your hand over it from root to tip, it cannot hurt you. Your hand presses the hairs flat against the stem and they cannot stick into you.

Sometimes hairs branch and make a thick network, like felt, over the leaf. They do this in the mullein, and here is a picture of mullein hairs very highly magnified.

Prickles and scales are made of cells as hairs are.

All parts of the plant above ground and sometimes the roots are covered with skin, but only the parts above ground are covered with hairs or prickles. Some plants are abundantly supplied with these protections; others manage to get along without them.

Plants very often have glands in their skins. These glands are merely cells which take certain things from the sap and pour them out on the outside of the plant.

Glands secrete their fluids inside the skin cells, and these fluids finally break through the outer wall of the skin cell and so get to the surface, or else they pass through stomata specially provided for them. They sometimes cover the surface of the plant with a sticky substance, as is the case with young birch twigs.

Glands also secrete the gum or resin which covers up the winter buds and keeps out the rain, and which makes the young leaves of the cherry shine so.

Some plants secrete wax which covers leaves or stems or fruits. Bayberry berries are covered with white wax, of which fragrant candles can be made.

Bayberry grows abundantly all along the New England coast, and friends of Thoreau used to make these fragrant candles as Christmas presents. Whenever Thoreau went to visit them, he insisted upon having a bayberry candle to go to bed by.

The *bloom* on cabbage leaves and on plums and other fruits is made of tiny scales of wax.

Wax is a very good substance to keep the plant dry. You may be sure the plant knows this and often uses it about the stomata. You see, the object is to

BAYBERRY.

allow water to pass freely *out* of the stomata by evaporation, but not, as a rule, to pass *into* them. So the clever plants often have wax instead of hairs as a protection to the stomata. It would not do at all to let the stomata get closed up, so they are always protected in some way. Sometimes little projections grow out of the skin, close to the stomata. The raindrops fall upon these little knobs and stay there, instead of settling down into the stomata. You see, the pegs are *very* small, and when the rain falls on them there is a layer of air below them which the water cannot displace, and which prevents it from going any farther.

If you want to know just where the stomata are situated in a leaf, plunge it in water, then shake the drops off and notice what part of the leaf has not been wet. Wherever the leaf is dry, there are the stomata. In many plants, as, for instance, the jewelweed, it is quite impossible to wet the leaf. Soak it in water for an hour, and when you take it out it is dry! The parts that cannot be wet usually have a silvery, glistening appearance. Put the leaf in water and notice where it glistens; there are the stomata, — sometimes all over the under side of the leaf, sometimes in lines or patches, sometimes on both sides of the leaf.

Wax, gum, and resin are not the only things plant glands secrete. There are the glands in the flower cups that secrete nectar. In some plants this breaks through the delicate plant skin and runs into and fills up the little hollows or horns we call nectaries. In others the nectar is provided with stomata by means of which it can escape from the interior of the plant.

You may be surprised to learn that the flower is not the only part of the plant that can secrete nectar!

In some plants the stipules do it, and in some even the stems.

This is not to call visitors to the flowers, but perhaps to keep them away. Where ants trouble the flowers, certain kinds have invented this very clever way of stopping the unwelcome visitors. They do not want the ants to take the honey from the flowers, so they secrete honey on the leaves or stems, and the ants take that instead of traveling on to the flowers.

Of course each living skin cell contains protoplasm. The protoplasm lies in a thin layer against the walls and builds, builds, builds, until the skin is thick enough.

When a good thick wall has been built, the protoplasm passes out through tiny openings in the inner wall into the inside cells, where it goes to work doing something else. The skin cells are then empty of protoplasm; they are only filled with air, and we say they are *dead* cells. Their hard walls are a good protection to the plant. In stems there is often a layer of thick cells behind the skin cells which also protects. These are called cork cells.

All very young plants have their stems covered with living skin.

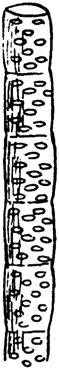
Older plants, particularly woody ones, have their stems covered with the tough, dead skin. And trees have finally a thick layer of dead cork cells. In tree trunks the skin cells have disappeared entirely. The skin protected the young shoot; then its empty cells finally peeled off, as the cork cells formed underneath and made a thick bark. The bark then does the work of the skin. It protects the stem. It becomes very thick sometimes, as layers are constantly added beneath. The outside of the bark keeps peeling and scaling off.

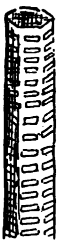
Of course there are no stomata in bark. We find them only in the living skin. Bark does not need stomata, as it does not regulate the water supply. The young green parts of the plant do that by means of their covering of living skin. Living skin is usually transparent like glass.

It is tough and yet transparent. You see, the light must get through it to the cells which lie behind it.

There is usually no green color in skin. Sometimes there are other coloring materials, though not as a rule.

The living skin covers the leaf or stem or other part of the plant like a window of tough glass. Even where the skin is several cells thick, the light can pass through, just as it can through thick glass.






TUBE CELLS.

THE top of a tree is a long way from the roots. Yet the leaves must have food from the roots, and the roots must have food from the leaves.

It is not an easy matter to move all this food material up and down, you may be sure.

I wonder how *you* would manage it?

Why, you say, if I had to raise sap from under the ground to the top of the tree, I should certainly build some pipes and have a pump at the top.

That is the way the plant has decided. So pipes there are, plenty of them,—pipes or tubes of many sizes and shapes.

You know how cells grow, lying next each other. Well, tube cells are long and contain protoplasm in the beginning. They lie end to end. But, you see, it would not be very easy for the sap to pass through *millions* of cell walls on its way up.

So when the protoplasm has built a row of cells with good thick walls, it passes out through thin places or openings it has left in the walls. The end partitions between the tube cells are thin and break away, and lo and behold! we have a long, strong tube with nothing in it but air. Up this tube the sap creeps or down it the sap runs. A great many of these tubes, which are as fine as hairs or much finer in some cases, are needed in a plant. They run all through the stems and out into the leaves. They are collected into bundles, and form part of the veins and the framework of leaves. I do not know what the plant would do without them.

But what makes the sap run *up* the tubes?

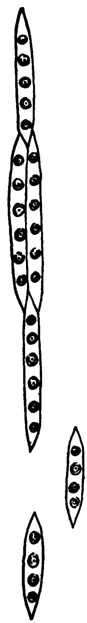
Now you are asking questions! It took a long time for people to find that out, for there is more than one reason why the sap runs up.

For one thing, the root cells keep drawing in water and other things, and the fluid already in is pushed up by that behind; so there is a sort of pump at the bottom of the plant, you see, — a force pump. The sun shining on the leaves and stems evaporates the water above, and the water below then easily takes its place; so there is a sort of suction pump at the top.

Then the tubes are so *very* fine that the fluid in them tends to move up, just as water will soak up into a towel if the fringe happens to get into the water; for you know that if you hang a towel so that the fringe dips into a basin of water, after awhile the whole towel will be wet, as a result of what we call capillary attraction. For all these reasons the sap creeps up the stems through the tubes the cells have made.

Every plant has these tubes, from the tiniest weed in the garden to the tallest forest tree. Although so small, they are often very prettily marked by lines and dots.

STRENGTHENING CELLS.



PLANTS need something more than cells of working protoplasm and something more than tubes, just as we need móre than flesh and blood vessels.

We would be in a sad plight if we had no bones to keep us in place, and plants would be in a sad plight if they had no — well, not exactly *bones*, but something to serve the same purpose.

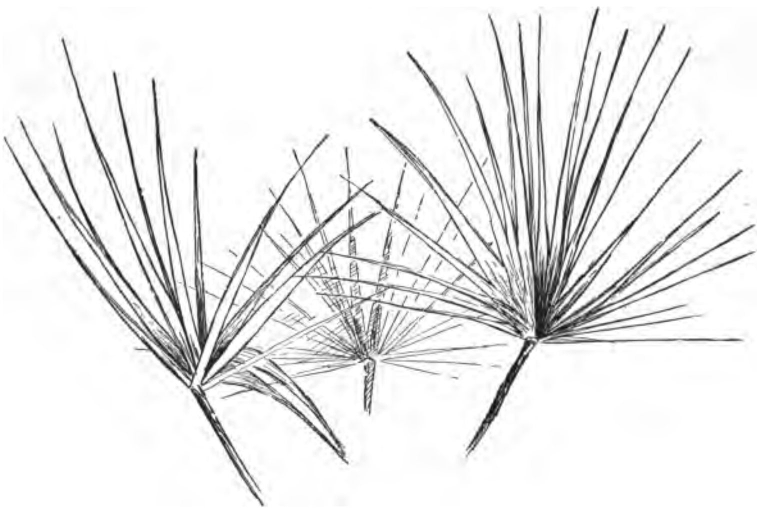
Think of the weight a tree has to bear. You could not *begin* to lift the crown of a large tree, yet the tree trunk has to hold it up in the air. Not only that, — it has to hold on to it when the wind blows, which is a much harder task. Even small bushes and tender garden plants have quite a weight to bear and quite a task to keep their leaves and stems from being blown away. They could *never* hold on to them if it were not for the wood and other tough cells they have, — never in the world.

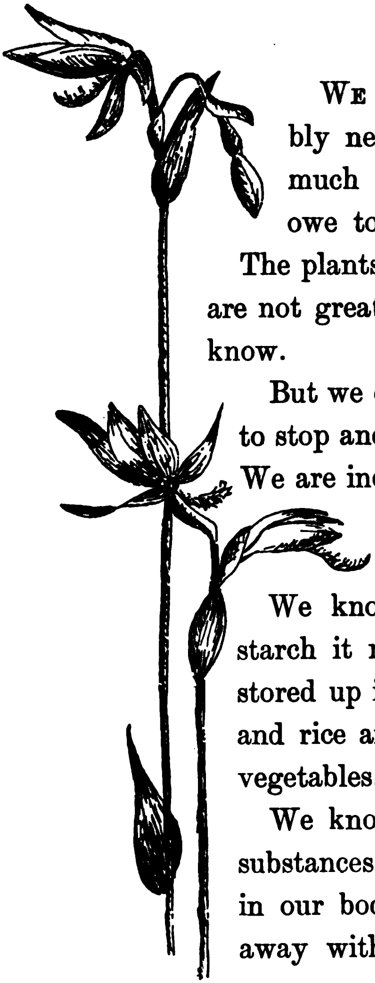
These wood cells and other tough cells are made by protoplasm, of course.

The protoplasm builds them very much as it does the tube cells, long and slender, as you see in the picture at the beginning of the chapter, and then when the hard, tough walls are all done, the protoplasm slips out and leaves the strong framework of tough fibres to do its duty. This framework is not only strong, it is elastic, so it can bend easily. If it were not, the first strong wind or the first thing that happened to bend the plant would snap it off short.

You cannot break wood easily, and, if you do succeed, it always bends more or less first. Some wood bends more easily than others, as you know. A willow twig can be tied into a knot, it bends so easily.

Nearly all land plants have these stiffening cells. They run out of the stems down into the leaves and help make their framework of "veins." The tubes and the strengthening fibres run along in bundles side by side. You see this saves space. If the tubes and strengthening fibres each took a different road, that would not leave much space for the chlorophyll and other working cells. But all the tubes and fibres are closely packed together and run lengthwise through the stem. All around these long fibres are placed the other cells which are not long and do not form tubes or fibres. Most of those other cells in the leaf contain chlorophyll. They contain protoplasm, and do the work of transforming food materials into plant material.





WE AND THE PLANT PEOPLE.

We live and the plants live. Probably neither we nor the plants spend much time thinking about what we owe to each other.

The plants are excusable for this, for they are not great thinkers, at least so far as we know.

But we owe so much to them, we ought to stop and think about it once in a while. We are indebted to them not only for the food we eat, but for the air we breathe.

We know about chlorophyll and the starch it makes, and how this starch is stored up in potatoes and wheat and corn and rice and all sorts of food grains and vegetables.

We know, too, how the roots suck up substances from the earth which we need in our bodies, and how they are stored away with the starch or sometimes by themselves. We know, in short, how all the food we eat is made first or last by the plants. Not only do we owe our food to the plants, but all animals do.

You see, animal cells are not able to take carbon dioxide and water and ammonia and other gases and minerals and work them up into living cells.

The plants have to do this for them; and then the animals eat the plants, for animal cells are able to work starch and sugar and plant protoplasm over into animal protoplasm, which can build all sorts of animal cells. So all the animals in the world get their food from the plant world. If the plants were to stop living, all the animals in the world would soon starve to death. The word "animals," you know, means every living thing that is not a plant; in this sense flies and bees and oysters and caterpillars are animals as well as dogs and cats and such large creatures. Last of all, we ourselves are animals.

So the animal world would be in a sad predicament if anything should happen to the plants.

But there is more to thank the plants for than food. That is a pretty large item certainly; but what do you think of having to thank them for the air we breathe as well? Yet this we shall have to do if we begin thanking them at all.

You know about oxygen, of course. It is one of the gases that make up the air; and I may as well remind you that air is composed principally of oxygen and nitrogen gases,—about four times as much nitrogen as oxygen, but the oxygen is the most important to us. We do not use the nitrogen in the air at all probably. It serves the purpose of diluting the oxygen, which would be too strong for us if it were not mixed with nitrogen. But what we do use is the oxygen.

That goes into our lungs, and some of it does not come out again. It passes into the lung cells and from them into the blood, and is carried by it all over our bodies to all the millions of cells.

We need a great deal of oxygen, and if the supply should be cut short we would die.

All animals need oxygen; even the worms in the ground and the fishes and oysters in the water must have it. So great quantities are being used up all the time.

Now, you know, when the plants pull carbon dioxide to pieces, they keep the carbon and return the oxygen to the air. In this way we get it to breathe.

But there is more than this to the matter in hand. We are all the time breathing out carbon dioxide as an impurity; so are all the millions upon millions of animals in the world.

The air might in time contain enough carbon dioxide to kill us if there were not some way of getting rid of it. You know what that way is.

The plants use it up. So by giving oxygen into the air and taking out carbon dioxide, the plants keep the air fit for us and all animals to breathe.

But there is more than this we have to thank them for.

They shade the earth and regulate the rainfall and the water supply.

Where forests grow there are always streams of water, and the large water courses are kept full the year round.

The Mississippi River depends upon the far-away forests for its broad stream.

The spreading crowns of the trees shade the earth and prevent the water which falls as rain or dew from evaporating rapidly. It collects into streams and flows through the land, keeping the earth fresh and beautiful.

More than this,—large forests cause the rain to fall and the dew to collect. Their leaves condense the moisture in the air and cause it to fall as rain or be deposited as dew.

When people recklessly cut down the forests in a country, the water courses dry up, and even the largest rivers are affected.

When the spring rains fall over a country whose trees have been cut away, the water rushes down the little streams all at once and causes a terrific flood in the large rivers. It soon drains away; then the rivers fall lower and lower until they nearly dry up. This state of affairs is a great calamity, because the people can no longer raise crops on the land near where the old forests stood, for it is parched and dry months at a time.

Moreover, boats laden with coal and grain and all sorts of things can no longer pass up and down the rivers, because the water is too low.

People ought to think of these things and not destroy too much forest land. After awhile we shall have to go to work and plant trees instead of cutting them down or burning them; but it takes a long time for trees to grow, and a wiser way would be for us to take care of those we have.

You have heard a great deal about plants eating and the good they do us by eating the carbon dioxide in the air. They take this in through their leaves, and you remember they take in all their other food materials — water, nitrogen compounds, sodium, potassium, magnesium, and many other substances — through their roots.

But they do more than eat; they also breathe.

They breathe everywhere over the surface of their bodies where there are stomata or where the skin is not too thick for the air to penetrate it.

And I must tell you they breathe just as we do, — that is, they take in air, use the oxygen, and give off the carbon dioxide.

It seems rather inconsistent of them to take in carbon dioxide as food and throw it off as a waste at the same time, but that does not trouble *them;* they do not care whether they are consistent or not. And it is true they take in carbon dioxide and give off oxygen, and take in oxygen (in the air) and give off carbon dioxide, in one breath as it were.

You see, it is different parts of protoplasm at work that does this; one part — that in the chlorophyll bodies — is attracting carbon dioxide, breaking it up, and casting out oxygen. Other protoplasm in the cells outside the chlorophyll bodies attracts and uses the oxygen, while the carbon dioxide comes to the stomata from different parts of the plant as a waste material, just as it comes to the cells of our lungs to be cast out.

So plants, by breathing, make the air a little impure, but they destroy or break up so much more carbon dioxide than they make that on the whole they act as powerful purifiers of the air.

When we think of the great forests of the tropics, all overgrown with luxuriant vegetation, we may remember that those tangles of vines and trees and strange growths are our friends no less than the grass and bushes in our dooryard.

For there is a carrier always at work bringing the pure air to us and carrying away the impure air which we create. This carrier is the air currents. The great winds sweep about the earth, bearing the oxygen from the forests to the crowded cities, and sweeping away the carbon dioxide from the cities to the fields and woods. The winds, too, stir up the water where the water plants and fishes live, and help keep it full of air for the things in it to breathe; the tides and currents help, so as far down in the water as there are living things, you may be sure there is air for them to breathe. There would not be air enough for you, because you need so much; but for them there is plenty.

Swirling around the earth go the winds, carrying the oxygen to the people and the carbon dioxide to the plants, for the plants are as glad to get the carbon dioxide we breathe out as we are to get the oxygen they give off.

And we are glad, when we come to think about it, that we are able to give them something in return for all they give to us.

You see, we need each other,—plants and people, and the winds are friends to us both.

WHAT ARE THE FLOWERS MADE OF?

I THINK flowers are "made of sugar and spice and everything nice." At least, if it is not that, it is something very like it, as I have good reason to believe.

What flowers and all other parts of the plant are made of depends upon protoplasm; and if protoplasm can make sugar and spice and build up flowers that way, we should like to know it.

We *do* know about sugar and how the little green chlorophyll people run their starch factories in all the green parts of the plant,—under the skin of stems sometimes as well as of leaves, for wherever a stem is green, we may be sure chlorophyll is at work making starch in it. And we know how the protoplasm in the different cells changes the starch into sugar.

We know, too, how wood and other tough substances are made of starch.

But there is something else in plants as important as starch and very different, — the protoplasm. Protoplasm itself is not made entirely of starch; it requires materials not found in starch.

These materials are nitrogen, sulphur, and phosphorus.

Nitrogen is the most important, and this the plant gets chiefly through the roots.

Nitrogen is found in the earth combined with hydrogen and other substances. The protoplasm tears to pieces these nitrogenous substances which the roots suck up, and so enables the plant to take the nitrogen.

The other two substances which the protoplasm needs, sulphur and phosphorus, the plant gets partly from the air and partly from the earth.

Sulphuric acid exists in *very* small quantities in the air and goes in through the stomata, attracted, no doubt, by the protoplasm inside. But other sulphurous and phosphorous compounds are taken up by the roots.

So we see protoplasm is complicated. It contains carbon, hydrogen, oxygen, nitrogen, sulphur, and phosphorus united in a very complicated way.

Although protoplasm itself is made only of carbon, hydrogen, oxygen, nitrogen, sulphur, and phosphorus, it can make use of a great many other things. When the protoplasm of certain cells wants to build hard, tough walls, it uses potash and soda or even silica, which you know glass is made of. Just draw a blade of sedge grass through your fingers if you want to feel the silica in it. You will probably cut your fingers, but that will help make you remember about silica. Then the protoplasm uses iron to color the petals and other parts of the plant. It uses magnesia, too, and salt and lime and a number of other materials for building walls or making dyes or something else.

Every material in our own bodies is found in plants, and sometimes the plants have materials that we do not have.

Of course materials are put together differently in plants from what they are in us. When Mother Nature combines her carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, magnesia, iron, and all the other things to make a plant, she does not go to work as she would if she were going to make an animal.

Just what the difference is it would be difficult to tell, but there *is* a difference.

Plants contain a good deal of sugar as a rule, and if you remember cloves you will admit that at least *some* flowers are made of spice, for cloves are the dried flower buds of the clove tree.

Cinnamon is the bark of a plant, and if you are acquainted with orange trees you will be willing to say they are "made of sugar and spice and everything nice," for the whole tree, wood, bark, stems, leaves, flowers, and fruit, is fragrant and spicy.

Oil is another common substance in plants, and it is made from the materials of starch which, as we know, are carbon, hydrogen, an doxygen; cotton-seed oil, olive oil, and castor oil we are all familiar with.

All nuts contain a great deal of oil, and the skin of a fresh-picked orange is so full of it that it runs down our fingers when we cut the orange.

All the things in a plant — starch, sugar, oils, spices, wood, bark — everything is made by the wonderful protoplasm in the cells.

Starch and the food taken up by the roots pass through all parts of the plant by the sap tubes, and as the sap goes along, each living cell draws into itself the substances from the sap that it needs, and these it combines into the things it wants to make. Some of the cells in an orange skin, for instance, attract out of the sap the materials to make the fragrant, stinging oil that fills the fresh skin, while other cells attract the materials to build the white cottony covering inside the outer skin, and so the cells in each part of the plant take out what they need to build with.

WHAT BECOMES OF THE FLOWERS?

Early in the spring the snowdrops and crocuses peep out, and then they go away.

We do not think much about it, for other flowers have come in their places.

Spring beauties and bloodroots shine in the woods, and then they go away. But the mandrakes have come with their umbrella leaves, and then the columbines and roses ask for a welcome.

After awhile we can find no more mandrakes and columbines, only yellow apples and brown seed-pods.

Jack-in-the-Pulpit jumps up quite early in the summer, and then we cannot find him, only in the late summer we sometimes come across little clusters of bright red berries lying on the ground.

We would scarcely suspect them of having any relation to Jack, yet they are his berries. But what has become of Jack?

In the autumn the rose leaves fall off, and there is left only red stems and red berries.

The morning-glory vine wilts and turns black at the first frost; it sinks to the ground and we see it no more, or else its stems linger brown and hard for a time, but in the end it all disappears. What has become of it?

And the nasturtiums — what a wreck the frost makes of them! The leaves are wilted and black; the stems, too, are soft and lie flat on the ground.

Why, you say, the frost has killed them. But that does not at all tell what has become of them. Besides, the frost did not kill the snowdrops and crocuses and bloodroots and spring beauties nor Jack-in-the-Pulpit nor the umbrella leaves of the mandrakes. Yet they are all gone. All we can find of Jack and the mandrakes are red berries and yellow apples. Not a sign of the snowdrops or spring beauties or crocuses is left.

If you will just step down with me under the earth a few inches I will show you something.

Make believe you are a gnome or a fairy and can see as well in the dark earth as anywhere else and come along. Now look about.

Did you ever dream of anything so cunning in all your life? Everywhere and everywhere old mother earth is packed full of little white and brown bulbs.

There they are as snug as peas in a pod, thousands of them, in every direction as far as you can see.

And besides these bulbs, there are thick, fleshy root stems, red and brown and yellow, everywhere and everywhere. Do you want to know who they are?

They are our little friends of the early summer, — snowdrops and crocuses and spring beauties and dogtooth violets; mandrakes, too, and Jack-in-the-Pulpit.

These bulbs and thick roots are full of plant food; and this is where the plant has gone to. It has curled up, so to speak, in these bulbs and roots and gone to sleep till next spring. Then it will wake up. It will hardly wait for the snow to go off before it pushes out a bud. The snowdrop does not wait, but sometimes blossoms right under the snow. In a few days the woods that looked so dead and bare are as gay as you please. That is because the plants sleeping in the bulbs and thick underground stems have waked up. They have eaten the rich food stored up there and have grown like magic. Up into the sunshine they spring; they wave sweet flowers; they call the little insects that have ventured out to come and taste their nectar and bring them pollen.

Their leaves are green and delicate, but they work hard, for the plants have used up the food in the bulbs or in the thick underground stems, and the leaves and roots must make new bulb material or store away more food in the thick underground parts.

It is spring, and the air is moist and warm. It rains often, and the plants have all the water they need.

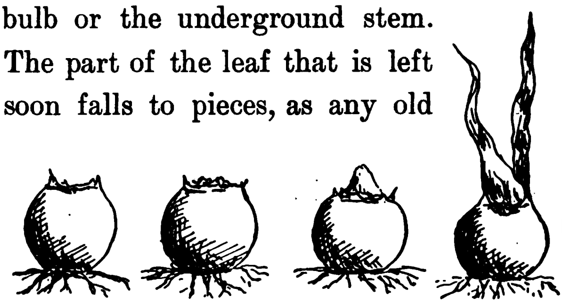
What fun it must be to come out in the world! What joy to unfold bright flowers in the shadowy woods! They dance on their stems and ripen their seeds; before the slow roses have thought of opening their eyes, the bulb people and the underground-stem people have done all their work of growing. The seeds are ripe and ready to be scattered; new bulbs are packed full of plant food, and fresh food is stored in the thick underground stems. The bulb people and the underground-stem people have had a good time.

They were up early in the summer and saw the sweet, fresh world; their leaves worked hard, and their work is all done now.

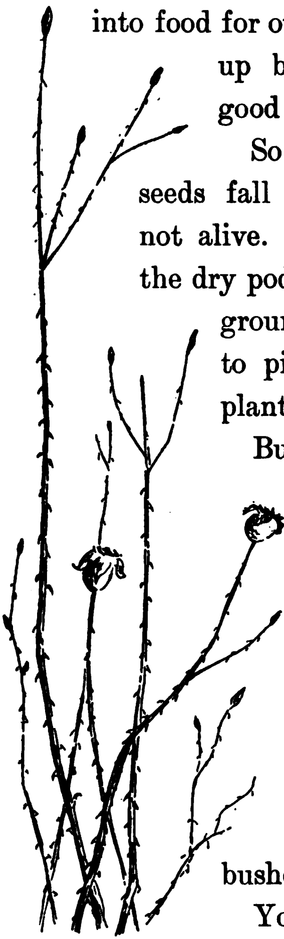
They are tired and want to sleep. They fear the heat and dryness of the summer. They do not want to be crowded by the other plants that are beginning to look out everywhere.

"We will go to sleep and let the other plants have our places; we have had our share of the air and the water and the dear sunshine," they seem to say. "We have caught the sunbeams and stored them away in our bulbs and roots, and we will now rest."

So they go to sleep. They open the channels from the leaves to the bulbs and the underground stems, and then all the living part of the leaves passes quickly down into the part that lies underground. There is only left the hard framework of the leaves. This is not alive; it never was alive. The living part of the leaf built it for a house to live and do its work in; now the house is empty: the living part has run down into the bulb or the underground stem. The part of the leaf that is left soon falls to pieces, as any old



abandoned house will do. It falls on the ground; the rain soaks it, and it crumbles apart. It changes into food for other plants. It is not lost; it is taken up by other plants and again built into good plant material.



So it is with the seed-pods; when the seeds fall out, the part that is left behind is not alive. All the living part has gone out of the dry pods down into the bulbs or the underground stems; and the pods, too, crumble to pieces and make good food for other plants.

But the seeds are alive. They lie in the earth and wait for the time to come when they may wake up and make new plants with young bulbs or thick underground stems.

But how about the roses? Do they not die in the fall? Why, what are you thinking of? Do they not wake up next spring and cover their stems with leaves and flowers? Dead bushes could not do so.

You see how it is. The leaves work all summer long. They store up food in the roots and the stems. When the frost comes and pinches them, they know it is time to stop work and go to sleep for the winter. They have roots down in the ground. And now you know as well as I do how they manage it.

When the leaves have done their work and fed the flowers and the stems and the seeds, and when the stems and the roots are stored full of food, the leaves stop working. The green little cells that made them so bright all summer go away; the living part of the plant and the rich juices find their way into the roots and stems. Only the dead frames of the houses that the living parts of the leaves built in which to do their work are left. They are dry and lifeless; they never were alive. The living protoplasm has left them and unhinged them so that they soon fall off.

You know what becomes of them. They change into a great many substances. The little particles in them let go of each other and unite with other particles. In this way gases are made which go out into the air, but some parts are solid minerals which the roots took out of the earth to build the frame of the leaves. All these minerals fall back into the earth for the roots to use again next year.

So you see the leaf frame simply changes back again into the gases and minerals of which it had been made by the leaves and the roots.

As the protoplasm withdraws from the leaves of the rose bushes and of many other plants, particularly the trees, the resting time of the plant is announced by the most brilliant colors, the result of certain changes going on within the leaf. These bright colors that make our autumn woods so entrancing are not dependent upon the frost, as many think, but upon certain changes going on within the leaf itself as it ripens, just as fruit, when it ripens, takes on glowing colors. The bright autumn leaves are ripe leaves getting ready to fall. Why do you suppose leaves fall? It is better that they should; the sooner they fall, the sooner they will be converted into leaf mould to feed other plants. So the plants have a way of gathering their ripe harvest of leaves.

The falling of the leaf is not an accident, nor is it dependent upon the wind; when the time comes, the leaves go down, wind or no wind, though doubtless the wind helps them. When they are fully ripe, the leaves let go! The cells that connect the leaf stem with the branch shrivel and shrink until the leaf is entirely separated from the parent plant; when this happens, the leaf falls. The ripe leaf is less juicy than the young leaf; its juices have departed and left the stiff, lifeless framework and the hardened skin, with the emptied cells beneath, to find their way to the earth.

But while the trees and bushes, the bulbs and underground stems store away the living part of the plant, what about the morning-glories and nasturtiums? They do not send their living part into roots or stems, for they do not grow again another year. What now becomes of them?

They die, you say. I do not say that. I say they change. Of course the seeds live on. The morning-glory seeds, and the seeds of all the plants that grow wild in a climate like ours, are not hurt by the cold.

You very well know that some of the life of the plant is folded up in the seeds. But the vines and leaves seem to be hurt by the cold. They fall limp to the ground. They change. The little particles of which they are made let go of each other; they unite with other particles in new ways. They float off in the air as gases.

These gases are carried about by the wind and meet new plants, which build them into their leaves and stems.

Part of the particles in the frosted vine do not become gases; they let go of other particles and sink down as minerals, to be taken up by plant roots another season. Other parts lie on the earth in the form of rich vegetable mould, which is also taken and built into new plants. So when our morning-glory or nasturtium vine disappears, it is not lost; it has only changed its form.

Instead of being a nasturtium, its particles may find themselves built into a dozen different plants.

So what we call death is only change. Not an atom of any plant is lost.

Besides, if no plants changed back again into gases and minerals, there could be no growth and no flowers in the world. There would be no material to make new plants, and no room for new plants to grow.

There would be no room for seeds to sprout and no need of seeds, so the plants, which never do anything that is not necessary, would not make any seeds; and if there were no seeds, there would be no flowers. What a dreary earth it would be if plants never changed — if they never, as we say, died! The same old plants living forever, — no flowers, no opening buds, no tender spring green, no bright autumn colors.

It is good that the plants die, or change, as I prefer to call it.

NOTHING BUT LEAVES.

After all, that is what a rose is, — nothing but leaves; and what a violet is and a lily and a nasturtium and a honeysuckle and all the flowers you can name.

You do not believe it? That is because you know so *very* little about leaves. When you know more, you will believe it, see if you do not.

Perhaps when you know where the flowers came from and how they came to be flowers at all, you will change your mind about several things. Anyway, there is one thing you do know, because you have studied geography and about the stars and about the earth's crust and all that.

You know that once upon a time there were no flowers in all the round old earth. You do *not* know it? Why, of course you do. You know that once upon a time there was no life on the earth, at least not what we call life now. It was so hot *nothing* could live, not even a salamander, which they say lives in the fire, although, of course, this is not true, and it could no more live in the fire than you could.

Well, we are told that once the earth was about as hot as the sun is now,—just a mass of blazing gases and melted rocks and metals.

You would not have known it if you could have seen it, and, what is more, you would not have wanted to see it; you would have been afraid to come near enough.

You could not have found Lake Michigan on it nor even the Atlantic Ocean nor the Rocky Mountains, and the reason you could not have found them is, they were not there. There was no Lake Michigan and no Atlantic Ocean and no Rocky Mountains.

You see, they had not been made yet. All the water and minerals were bubbling and seething and whirling around in the most awful storms. You would have wanted to get as far from the earth in those days as you possibly could; not even the North Pole was cool enough to rest upon with any comfort.

This went on for a few millions of years probably, but the earth was all the time getting a little cooler, until it got so cool that things began to harden and the dry land to appear. But mother earth was in a state of terrific excitement even then, and every once in a while would heave such a sigh that an earthquake or volcanic eruption would break forth. But as old earth, or young earth I suppose it was then, grew older and calmer, it settled more and more into its present form. It got so cold and old after awhile that it became wrinkled, like the skin of an apple in the late fall. You know how that is. Only mother earth was a very large apple and her wrinkles were very deep, and in fact they made the great mountain ranges.

You need not believe all this unless you want to, but it is true,—that is, the wise people, who know more than you and I ever will, say so.

But what has all this to do with leaves?

It has as much to do with leaves as the fire in the stove has to do with the boiling of the tea kettle.

Of course, while the earth was in this overheated state, nothing could grow on it. But it kept getting cooler and cooler, until at last life began to appear. Just exactly what this first life looked like I do not know. Nobody does, because, you see, nobody was living then to tell about it and write it down. But very likely queer mushy plants were the first to come along, and they were about all leaf. So far we may be pretty sure.

After awhile plants with stems and leaves grew up and flourished.

They were queer enough, no doubt, for there are pictures of some of them which the rocks took and kept for us, and people often break open a rock nowadays and find these old plant pictures.

They are what we call fossils, and now I have no doubt you know all about it; if you do not you will some day,—that is, if you care to.

From what the rocks tell us, and for other reasons, we feel pretty sure that the earlier plants had only leaf and stem, but no flowers. And the very first leaves were not like the leaves we see in the woods and gardens about us, for they were probably large and mushy and had no veins to speak of. If you had picked one up it would have been flabby and squashy, and you would have been glad to put it down again. But nobody ever did pick one up, because nobody was there.

The earth was not ready for us yet. It was all soft and swampy or hard and cheerless, and we had to wait until these queer pioneer plants gradually changed into other plants and made the earth fit to live on.

But these flabby old friends of ours went to work with a will to get things in shape for us to come. Their green leaves and stems, where they had any, ate the gases in the air and stored them up as plant material. Then they died. They did us as much good by dying as by living, for only part of their substance went back as gases into the air; the rest went into the ground and began to make soil for other plants to grow in.

So Mr. Flabby Leaf was a very good life starter.

One thing we are quite sure of, and that is, these earlier plants did not have any seeds. When new plants came from the old ones, they merely sprouted out from the leaves or the roots, the way a certain fern that grows in Fayal and other places does to-day. It is fun to raise this fern in a window box and watch the young ferns sprout out of the edge of the leaves of the old fern. After they get two or three tiny green leaves and the cunningest little curled-up frond, just like a big fern, off they tumble down to the ground, where they strike root and grow as calmly as though they had come the regular plant way and sprouted from a seed.

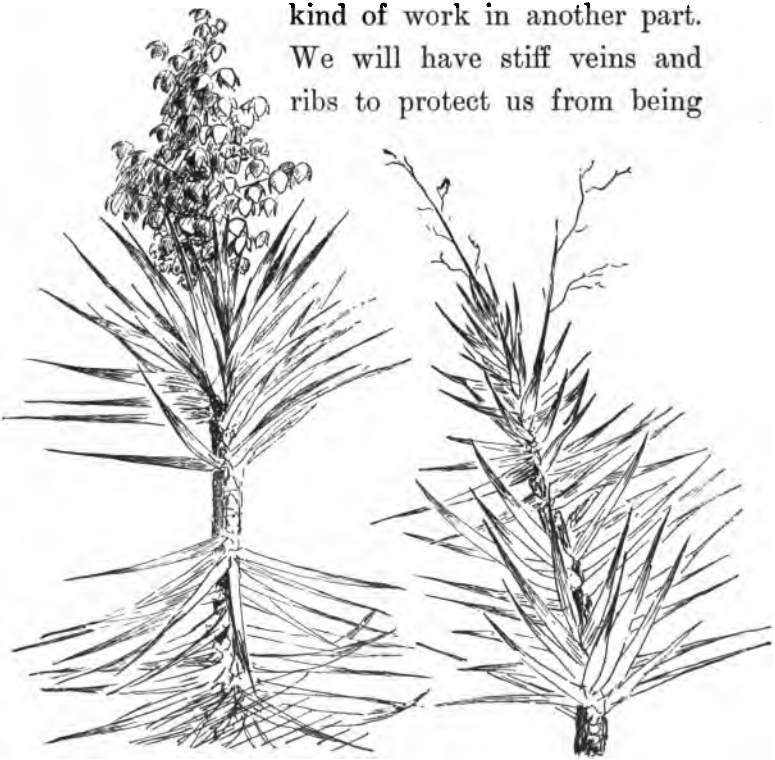
They do come the regular way the very early plants did, instead of coming the way modern plants do, for in some such way the earlier plants, no doubt, reproduced themselves.

They had no flowers and no seeds. Leaf and stem did it all. You see, these first plants were simple people, not complicated at all, and so each part of the plant was able to do all its own work. But after awhile the plant world became more complex; the earth grew drier, for one thing. The first plants lived in the water, no doubt, and so everything was much easier for them; at least they could always get plenty of water, which is a matter of great importance with plants.

No water, no plant. Then, too, the earth cooled more and more, and from being uniformly warm and moist, which was just the best conditions for plants to live without taking any trouble about it, the air was sometimes colder and contained less moisture.

So the plants that grew on the land had to invent ways of getting and keeping an extra amount of water, and even those that lived in the water had to look around and find a way of protecting themselves against changes of temperature.

As the earth grew cooler and drier, and the changes from hot to cold at the different seasons became more marked, the plants that grew on the prairies and mountain sides, where it was very hot and damp at one season and very dry or very cold at another, had to find ways to protect themselves against these changes. So the leaves and stems began to be a little more particular about their work. The leaves may have said, "We will do one kind of work in one part of us and another kind of work in another part. We will have stiff veins and ribs to protect us from being



blown to pieces, and we will have our sap flow through veins, instead of soaking all through us everywhere. And we will have a thick skin to breathe through and to protect us from the sun when it is too hot."

So some lived on the hot plains with small, thick, hard leaves, and others lived in the damp shady woods with large, thin, tender leaves.

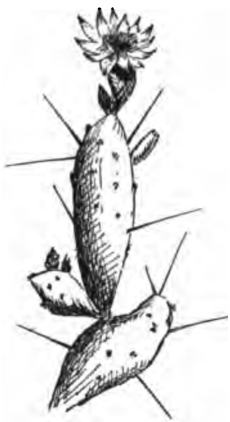
Thus, you see, there came about a division of labor. Not all at once,—oh, no! but so gradually, so very gradually that, had you been watching these plants grow from year to year, you could no more have seen any change than you can see a blade of grass grow to-day, although you know it *does* grow. Perhaps the plants on the edge of a swamp were the first to change.

Perhaps the water receded and so gradually left them higher and drier. As they got less water, they would have to do one of two things,—change to suit the new state of affairs or give up trying and die. Very likely a good many died; the water may have receded too rapidly, or they could not see just how to change. But others did see, and they stiffened their flabby leaves with ribs and veins and made for themselves a thicker skin, and so lived on. They survived because they were the fittest to survive. And now you know the meaning of that very celebrated saying, "the survival of the fittest"; whatever plant or animal can adapt itself the best to the place it lives in is the fittest, of course, for that place, and so it survives or lives on.

No doubt, in those early days, new plants grew out of the old ones just anywhere, the way the baby plants grow out of the leaf of the Fayal fern I told you about.

But as life grew more and more difficult, as the plants had to contend with too much heat at one time and too great cold at another, with now a season of moisture and now one of great dryness, their leaves, as you know, began to change and divide up the work. A part of the leaf breathed for the plant; another part ate for it; another part protected it. Nor was this all. Some leaves did one kind of work and some another, as time went on.

When animals came upon the earth they ate the plants, and so the plants had to partly protect themselves to keep from being entirely destroyed. Thus some plants changed part of their stems or leaves into sharp thorns, as we see to-day in the hawthorns and cactuses. Some, like the mullein, covered their leaves with a disagreeable wooly substance that stuck to animals' mouths and made them avoid the plants. These wooly coverings served two purposes, — regulated evaporation and protected from the attacks of animals. Some, like the aconite, manufactured a poisonous, disagreeable juice, while others, like the nettle, clothed the stems with stinging hairs.



There are many, many ways by which plants have changed their leaves and stems in order to protect themselves from being eaten, and all this came about very, very gradually.

While these things were happening, other things were happening too. Wherever there is life there is change. Living things keep changing all the time.

The little fern that drops from the leaf of its parent is, in a general way, like the parent, but it is not exactly like its parent; it is *itself* and has some peculiarities of its own. You see, it changes a little from the parent form or, as we say, varies. Every living thing has this power to vary within limits. No doubt, the power of variation was much greater in early times, and animals and plants were able to change much more then than now.

As time went on, things sort of settled down, as it were, and stopped changing so rapidly.

But way back in the early ages the plants changed a good deal. And all they had to work with, you will remember, was just stem and leaves,—not another thing. But that was enough. They could change stem and leaves into thorns, as we know, and they could do something else. They could change leaves into pistils.

When the leaves divided their work, some plants devoted certain of their leaves to the task of making new plants. Ferns show this up to this very day.

Look at a clump of ferns in the woods any time in the middle of the summer or later, and you will see that some of the fern leaves have little dark spots on their backs. Sometimes these dots are on their margins, sometimes on the ribs, and sometimes scattered everywhere over the back of the leaf.

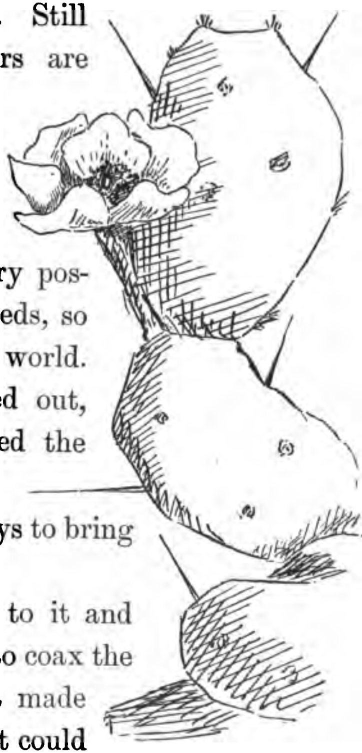
These dots are little cups filled with a fine dust, which falls on the ground and finally gives rise to more ferns. It is sometimes called fern seed, but the bits of dust are not exactly seeds. In the end they answer the same purpose, however. Well, suppose one of these fern leaves with the dots growing on it should curl over backwards until its edges met, and suppose the little grains should become true seeds, then we would have a very good ovary with the ovules inside.

Fern leaves do not act in this way; they are too old-fashioned. But some of the leaves in flowering plants do. They just roll up into a pistil, with young plants, in the form of seeds, growing inside.

And to this day that is all a pistil is,—a leaf, or a whorl or circle of leaves, rolled together, with seeds growing along the inner part. Of course, in time, these pistil leaves changed very much, and to-day we find all sorts of pistils, and by just looking at them, we would never suspect they were leaves or ever had been. And they are not leaves any more, and they themselves never have been leaves; but long ago the pistils of their ancestors were leaves or parts of leaves, and they have inherited and improved upon these pistil leaves, as a boy improves upon a willow twig and makes it into a beautiful carved whistle that does not look at all like a willow twig, and yet that is just what it is at heart. So you see, one of the most important parts of the flower is, after all, "nothing but leaves."

After seeing how the pistil, with its seed-children, is modified leaves, you will not be surprised to learn that stamens, too, are merely modified leaves. Anyway, whether you are surprised or not, that is just what they are. Tender little leaves folded a part of themselves together into little rooms or cells, and on the inside of these cells the pollen grains grew.

Now the plant was all fitted out. It had flowers, not very beautiful ones, to be sure, as they had nothing but pistils and stamens. Still they were flowers, and flowers are flowers whether they are bright or not.



Pistils and stamens were enough at first. But times change. Each plant tried every possible means to make strong seeds, so it could live in the crowded world. It did not wish to be crowded out, you see. So when it discovered the value of cross-fertilization, it began, so to speak, to invent ways to bring this about.

The insects with wings came to it and brought it pollen, so it learned to coax the the insects to come oftener. It made quantities of pollen, so the insect could eat what it would and still leave enough for the plant.

It, no doubt, had several rows of stamens, as a wild rose or a cactus flower has to-day. But it soon found out a good use to put some of these stamens to.

It wanted the bees to see and come, so it changed some of its stamens into petals.

The anthers ceased to grow, and they and the filaments spread out broad and bright. So, you see, petals, too, are nothing but leaves,—very much changed leaves, true, as they were first leaves, then stamens, and then petals, but that does not prevent their having come from leaves after all.

If you want to see how it is done, look at a water lily next time you get a chance.

Unless it is a very unaccommodating lily indeed, you will be sure to see stamens changing into petals.

Some of the inside petals are small with an anther at the tip.

Of course flowers do not go through all these changes every time they bloom now. They used to way, way back, when things were in a general state of change, but after awhile they found out just how to do it, and so out of the tiny buds at once made pistils and stamens and petals and sepals.

For sepals, too, came from stamens. The plants made all these new forms out of the materials of their leaf buds and wrapped them all together into a flower bud; so when this opened, there were the parts all ready to go to work without any more shifting around.

The calyx was ready to protect, the corolla to call the bees and butterflies, the stamens to make pollen, the pistils to make ovules.

Sometimes flowers forget and go back to the old ways of doing things; and if we are lucky enough to find such a flower, we can see just how it happened.

Sometimes roses behave in this peculiar way, and the flower goes back to leaves.

I used to know a bush whose roses did that. The pistils were leafy and also the stamens, and sometimes a branch grew right out of the middle of a rose as it does out of a leaf bud. Of course it was a very ugly-looking thing, neither flower nor leaf, but it was very instructive.

What do you suppose double flowers are?

Very often they are only flowers whose stamens have changed into petals.

A double rose has fewer stamens than a single rose, and sometimes *all* the stamens are changed, and the rose has not a grain of pollen to help itself with. What becomes of its seeds? It does not have any, as a rule. Where flowers become very double, the vitality goes to make petals instead of essential organs, as stamens and pistils are called, and such flowers often set no seeds.

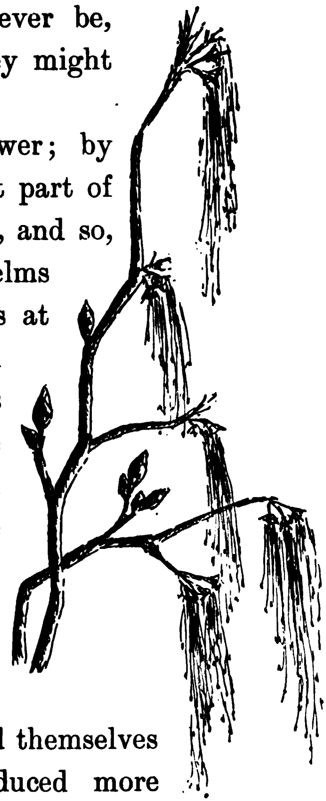
Then how do they continue the life of the race?

Sometimes simply because somebody takes care of them. Almost always double flowers are cultivated ones. People take them and tend them, give them rich soil to grow in, water them, and, if necessary, keep them warm. Such plants seem to grow lazy and helpless, as rich people who pamper themselves a great deal always do. They have all they want without any effort of their own, and so they cease to be self-supporting; they cannot even raise their own children, but live and die seedless. Such plants, if left to themselves, would quickly die, as they would be crowded out by sturdier growths, or else they would change their habits at once and become good seed-setting, industrious plants once more, with a tendency to stop having double flowers.

There are one or two things about corollas that I am sure you would like to know. One is, how did the flowers manage to change stamens into corollas? Another is, how did they manage to give them such bright colors?

About corolla-making, — if you are determined to know that, you will have to take yourself off to that far-away time when there were no flowers. Then, in course of time, while changing about and trying to get fitted to their surroundings, the plants, as you know, rolled some of their leaves into pistils and stamens. But still they had no petals.

The pistils and stamens were flowers, however,—as much flowers as they would ever be, no matter how much corolla they might develop.



A corolla does not make a flower; by this time you know the important part of a flower is the pistil and stamens, and so, even to-day, some flowers, as the elms and some maples, have no petals at all. When such maples are in bloom, you will see gay fringes decorating the trees. This fringe is made of the long pedicels with the stamens at the end. The stamens swing in the breeze, and the pollen is blown to the stigmas which are often in flowers on different trees.

Now, as plants grew and adapted themselves to their surroundings, they produced more seeds than could by any chance find room in the earth to grow. So every little seed that fell had to fight its way with a host of other seeds and plants. A defective seed or a weak one would stand no chance at all. The others would crowd it out. We know how that is in a garden. The delicate flowers have to be helped or the strong weeds would kill them. We pull up the weeds and let the flowers have the whole garden to themselves. But in the woods and fields each plant has to take care of itself and struggle up as best it can.

This fight of the plants for a place to grow in is called the struggle for existence. Now, whatever would help a plant in the struggle for existence would, of course, be of great benefit to that plant. As we know, cross-fertilization is a very great help; it makes stronger and better seeds, and the plants whose seeds were regularly cross-fertilized would be the ones to survive.

Where pistils and stamens are forming, there is a great deal of nourishment brought to that part of the plant, and substances are being changed there. Very often sweet juices are present. Long ago when insects, in flying about, smelled these sweets they doubtless would go and eat them, and they would also eat the pollen. As they went from flower to flower looking for food, they would carry pollen sticking to their legs or bodies, and so would sometimes fertilize the flowers.

The seeds from such flowers would be strong and would have the best chance to survive. The plants that grew from these seeds would also inherit the tendency to secrete sweet juices near the flower.

In probing for sweets, the insect would irritate the parts it touched, and this would cause an extra flow of sap there and very likely the manufacture of more sweet juice; so the nectary came to be developed.

You can understand how this might be by recalling how the skin of your hand changes when you first try to do some new and hard work, like rowing a boat.

After you have rowed a little while your hand is blistered. The constant rubbing of the oar in one place has irritated it, just as you can imagine the tongues of the insects rubbing against the delicate flower tissue would irritate it. Wherever a place on the skin is irritated, the blood flows to that spot; and so in the plant, where it is irritated, there will likely be a collection of sap. After the blood has flowed to the place on your hand which was rubbed by the oar, the spot becomes red and inflamed and pains you, and finally the skin separates in the form of a blister and a new skin forms underneath; and if you keep on rowing, your hand does not keep on blistering, but actually makes a new kind of skin to protect the rubbed places, and what we call a "callous" or hard spot is formed. The skin is many times thicker here than elsewhere, and was formed on purpose to protect the place. So we can understand how irritation might change a plant organ and in time form a nectary.

But how about petals, you are asking. Well, imagine yourself in those old times when plants made their first flowers out of pistils and stamens only.

These primitive flowers were probably not very showy. Primitive flowers means *first* flowers,—flowers that lived way back in the beginning of plant life.

They had no petals, but they secreted juices which the insects liked. Those early insects were queer fellows, too, not very much like our insects, except that they were fond of sweets and liked to eat the tender parts of the flowers, just as our insects do to-day. They ate nectar when they could find it and did not disdain pollen, which, it is to be feared, they sometimes ate, anther and all; and, what is worse, they in all probability frequently dined on pistil, which was very bad for the plant.

Now imagine one strong plant secreting a good deal of nectar. The insects would be likely to eat this and let the pollen and pistil alone, only in getting to the nectar, they would be apt to dust the pistil with pollen from another plant which they had been visiting and would also brush off some pollen against their bodies.

Thus the strong plant with the abundant nectar would be cross-fertilized and would keep its pistil unharmed. It would be very likely to develop good strong seeds that would grow and again bear strong flowers with plenty of nectar. Now, remember the essential organs — that is, stamens and pistil — seem to find it a little easier to change than other parts of the plant; so it would not be surprising if in time some of the stamens were to become different. You see, the insects in visiting the flowers would irritate them more or less walking over them and clinging to them, and they would be likely to undergo change for this reason; and if it happened that in some flower a row of stamens got too full of sap to know what to do with themselves and so spread out a little broader and more leaf-like and kept their yellow stamen color or bleached-out white, that flower would be seen far and near and the insects would go straight to it, for insects have the sharpest kind of eyes for seeing bright colors a long way off. You see what would happen; all the flowers whose stamens had done so would be abundantly cross-fertilized,— that is, all their seeds would get fresh pollen from another strong plant, and the plants growing from these seeds would inherit the tendency of their parents to form petal-like parts from some of the stamens. The flower could well afford to lose part of its stamens for this purpose. Of course as time went on, these stamens, which were half petals, might develop more and more in the direction of signals,—that is, might become more and more perfect petals, finally losing all trace of their old life as stamens.

Of course no one can say that is just the way it came about, but it is likely that in some such way it happened, for there are proofs of it which you may like to read when you grow older.

So, you see, flowers *are* nothing but leaves after all,—very much changed leaves, to be sure, but yet just leaves.

Sometimes when plants and animals have changed into a new form, they change back again. We know some plants which once had petals but which have again lost their petals and gone back to a form which has no petals. Such backward changes we call retrogression, and it is sometimes difficult to find out whether a flower with no petals is a primitive form which for some reason has not changed or whether it is one which has changed and gone back again. Usually, though, we can find traces of petals and sepals in flowers which have retrogressed.

You see, a flower depends upon its surroundings for its shape. If its surroundings (and of course this includes its insect visitors) are such as to favor its growth in the line of petals, it does so. But if for some reason it becomes easier for it to grow and be fertilized in some other way, perhaps by making abundance of light pollen which is blown by the wind, as in the maple trees, then it may gradually lose its petals, as it depends less and less on insects and more and more on the wind for cross-fertilization. Nothing in life stands still; it is always moving,—going on or going back. And this, we know, is just the same in human life.

We cannot stand still; we must keep growing wiser and stronger and better, or else we must do the opposite.

SIGNS OF OTHER TIMES.

In the beginning flowers seem to have had their petals all separate from each other. Some do still, and these we call polypetalous, because "poly-" means many, and they have many petals. But other flowers, like our morning-glory, have no separate petals; all are grown together into a tube with a bright border.

But this tube and border tell us a little story if we are able to hear it.

They tell us of the time when the morning-glory had several petals. More than this, they tell us just how many it had. If we were to guess we should probably say five, because it seems so fond of the number five, with its five nectaries, five nectar guides, five stamens, and five sepals.

If we guessed five we should guess just right. There is no doubt but that once upon a time the plants from which our morning-glories are descended had five separate petals. The morning-glories themselves manage it differently now, but it took them a long time to do it. They were working away, long before the great pyramids of Egypt were built, to get their five petals united into one piece. But it is done, and they have learned how to twist the flower up tightly in the bud and then unroll it in all its glory.

They never have five petals now, but they still bear traces of it.

Look at the little notch on the border, halfway between two nectar guides. Does that tell us anything?

Count the notches. Five, you see.

Look at the line that runs from the notch down to the bottom of the flower.

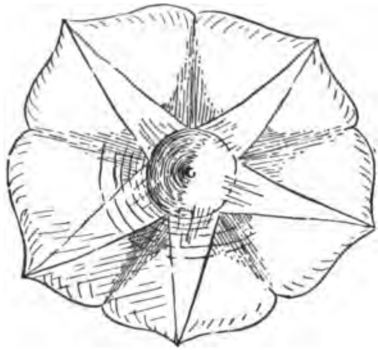
The corolla looks as though it had been folded along those lines. You can easily see five long creases ending in a notch. The flower *is* folded along these lines in the bud, but we think the lines have yet another meaning.

Carefully tear the corolla down the lines; you see, a very little pressure does it. Now we have the corolla in five parts, like five petals, only it is so weak it can no longer hold itself up. Once upon a time we think it grew this way, with five separate petals, only the petals stood up then, for they must have been stiffer and perhaps were not so long. It was long, long ago, oh, very long ago, that it had its five petals. Then the edges of the petals began to grow together, and they kept on doing this until, in course of time, the whole length of each petal had grown fast to the next one, all except that little tiny spot where the notch is.

We are glad our morning-glory kept this little notch and the line where the sides of the petals grew together, for that is what tells us the story of long, long ago when all the petals were separate.

When finally they were grown together, the corolla did not need to be so stiff, for its shape helped to make it firm, and then it no longer used good material to make stiffening for the petals, for that would have been a waste of plant sap, and plants do not like to waste materials. When they find they can get along without something they have been used to having, they stop making it. Life is too short and too precious to waste a bit of it. Our flower only kept the stiffening in the corolla along the paths where it wished the bees to go to its honey cups and where, when folded, it could best protect the bud.

The morning-glory, you see, is as wise as it is beautiful.



WHY ARE THE FLOWERS SO LARGE AND BRIGHT?

WHY are the flowers so large and bright?

We cannot say that they were always so. It is probable they were not. But good Mother Nature has watched over them as they came upon the earth, and she has lovingly made them so large and bright.

How could she do this? Let us see. Here is a tangle of plants. They all bear flowers and all set seeds. Some are stronger and more beautiful than others. The seeds fall to the ground. Those from the strong and beautiful plants are larger and stronger than the others. After a while the seeds sprout. Not all do this, however. The very weakest do not sprout. Dear Mother Nature has other work for them. "You are not suited to struggle in the earth with the strong seeds, dears," she whispers and lays them to rest. They do not wake up; the materials in them change. These materials let go of each other; they depart from the seed; some as gases float off in the air; others as minerals sink in the earth. The gases and the minerals are not lost. They join some other plant and help to make it strong.

"It is better to help another than to try to grow yourselves," Mother Nature whispers to these little seeds that could not sprout. And they are happy. They are glad to change into gases and minerals and help another plant to grow.

Many of the seeds sprout, but not all grow up and blossom. There is not room in the earth for all the seeds to grow; there is not food enough in the air to feed so many. Mother Nature with her kind eye looks over the growing plants.

She smiles and shakes her head at those trying to grow in shady places.

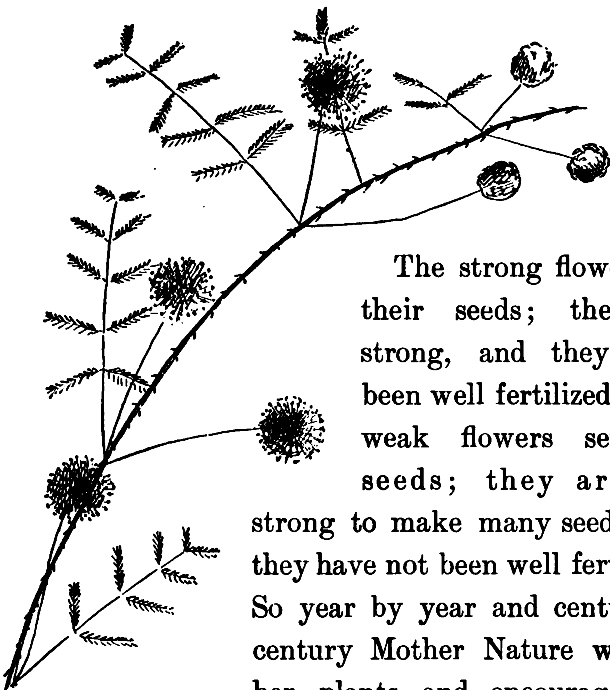
"No, dears," she whispers, "there is other work for you to do." Then the shaded seedlings do not try any more to grow into plants. They give up the materials they have collected to the little brothers and sisters who have started in the good ground and the sunlight.

They fade away, but they are happy, for they, too, are doing their work. The materials in them let go of each other. They change into gases and float off in the air, or to minerals and other substances and sink to the ground. These gases and solid substances pass into other plants and help make them strong.

"It is better to help another than to do poor work alone, dears," Mother Nature whispers, as she lays them to rest.

Then she visits all the weak plants, and all those in poor soil or in too much light or too much shade, and lays them to rest. Their materials go to nourish the strong plants, who are doing good work in the world and growing in beauty. Not all the plants that live to blossom are good alike. Some are better than others, but Mother Nature lets them grow if they are strong enough and can find food. At last the blooming comes. The flowers do their best. The strong ones make large, bright flowers full of color and full of sweetness. Mother Nature smiles at them and is pleased. The weaker flowers do their best; they are not so bright nor so large. Mother Nature smiles at them, for she loves them, too, and she will tell them what to do. The bees come and fly to the brighter flowers; they have rich, abundant pollen and rich nectar. The bees know this; they do not care so much for the duller, smaller flowers.

When the bees do not come, Mother Nature whispers to the little flowers, "Never mind, dears, there is work for you to do." So they are happy, though their ovules get no pollen and they set no seeds. They are happy to do the work dear Mother Nature has for them to do.



The strong flowers set their seeds; they are strong, and they have been well fertilized. The weak flowers set few seeds; they are not strong to make many seeds, and they have not been well fertilized. So year by year and century by century Mother Nature watches her plants and encourages the strong to grow and helps the weak to find other work.

And this is why the flowers are so bright.

Mother Nature selects those that are to grow and blossom and sends the rest to help them. This is what we call natural selection, and this is what makes the earth so beautiful. Only the best continue to grow; the others are glad to help them.

HOW MOTHER NATURE MAKES NEW FLOWERS.

ONCE upon a time there lived a little plant in a marshy place. We will call it Primus, not because that was the very first form of the plant, for it was not, but because that was its form when we first saw it.

It had five small yellow petals, five small stamens, and an ovary.

When its seeds were ripe, along came a great wind and blew them away from the marsh upon the dry land at the edge.

Poor little seeds, they were out of their familiar wet marsh and they could not grow. But they did their best. Some of them managed to sprout, but soon they found the earth too dry and the sun too hot; so they said, "We will turn to other work; we will help the other plants and not try to grow ourselves."

So they changed into gases and minerals and other substances. But a few of the seeds continued to grow.

They blossomed and bore seeds, but they were not just like the plants in the marsh. Mother Nature had helped them get a tougher skin and taught them how to shut tightly their pores in dry weather, so that the water within them could not escape.

You see, they were already different from their parents, though you might not have noticed it if you had seen them, the difference was so slight. The seeds of these new plants sprouted the next season. They did not have a hard time to grow. They knew just what to do, and the best and strongest of them grew a few hairs to help cover up the pores, so the water would not go out too fast.

It happened to be a very hot, dry season, and all the plants but these hairy ones stopped growing. They changed into gases and minerals and other substances to help the other plants. The hairy people got through the dry season very well. They set a good many seeds, and these seeds sprouted. The new plants remembered about the hairs and had plenty of them. Some were covered all over with a soft down.

And it was well they were, for it was a *very* hot, dry season, and all but the downy ones stopped growing and changed into minerals and gases and other substances to help the others. The seeds of the downy plants blew far over the dry land, far away from the marsh; but they had learned to live in the dry soil, and if you had found these downy people, you would hardly have known they were descended from the smooth, juicy, large-leaved marsh plants. Their stems were hard and tough and their leaves stiff and small. We can no longer call them Primus, they are so changed.

Let us call them Secundus. Secundus had small yellow flowers, like the marsh plants it was descended from. But one day some of the seeds of Secundus blew into the edge of a wood where the soil was rich and the air damp. This just suited the Secundus seeds, and they grew into very thrifty plants indeed. They had so much sap and grew so luxuriantly that their petals were twice as large as was usual with Secundus petals. These fine showy flowers also possessed a great deal of nectar, they had so much sap. Of course the bees came to them, and they were well fertilized. They set many seeds. The next year these strong seeds were able to grow even when their neighbors were not, and the plants that came from these seeds also had large showy flowers.

These stronger plants held their own, you may be sure, and at last there was more of them than of the small-flowered plants. It was well for them this was so, for there came several bad seasons when nothing was just right for these plants. It was cold and stormy, and only the very strongest lived through it. But *they* managed to survive, and their flowers were large and showy.

All the weaker plants with smaller flowers were killed out, and only these large-flowered ones remained. They were *very* different from their ancestors the marsh plants, and we shall have to call them Tertius.

One day some of the seeds of Tertius were blown into a new kind of soil; they sucked up the juices of this new soil, and lo! some of their flowers opened white instead of yellow. It so happened that the white-flowered plants were stronger than the others. The bees liked them, too; for, being so strong and full of sap, they made plenty of honey. So these white-flowered ones increased in numbers very greatly. At last only the white ones could be found; the yellow ones had gradually given way before them until no yellow ones were left.

So we will call the white-flowered people Quartus.

Quartus lived a long time, each year bearing seeds, the strongest and best of which grew up and bore flowers.

One day some of Quartus' seeds were blown into a hot, sandy place; this almost killed them, but some of them managed to grow.

Their leaves were smaller and stiffer than ever before, but they had a great many of them, and their flowers were large and white. They grew to like the sandy soil, and what they got from it changed their sap in some way so their petals were delicately tinged with pink. The bees liked these pink flowers; perhaps their honey was a little richer; perhaps they could see them better. However that may be, the bees almost deserted the white-blossomed plants and visited the pink ones. So the white flowers set few seeds and the pink flowers many. When the seeds sprouted, the pink ones were the strongest, because in their change of color there was somehow added a change in strength; they were stronger than the white flowers. They grew fast and took the materials from the earth and the air; and when the white flowers saw this, they said, "It is their turn now," so they changed into gases and minerals and other things and helped the pink flowers to grow.

Soon there were no more white flowers to be seen; they had stopped growing, and only the pink ones kept on, so we shall have to call these pink flowers Quintus.

But a great danger threatened Quintus. Cows and goats and sheep bit off their leaves. They ate so much of them that many plants were killed outright. Only the stiffest and hardest were left to blossom and set seed. The seeds of these plants with the stiff leaves and stems grew into other stiff-stemmed and stiff-leaved plants. The cattle browsed the tenderest of these and again left the stiffest. This went on for many years, the plants growing stiffer and harder each year. Some of them got so stiff and hard that they threw out prickles all over their stems.

These prickly ones were not eaten, and in time you would have found them grown into woody bushes with prickly stems.

We shall have to call these Sextus.

Sextus spread all over the sandy plains. Hardly any other plant was to be seen. The strong Sextus seeds sprouted and took the materials in the earth and the air, and the other seeds that happened to be blown among them did not grow; they changed into gases and minerals and other substances and helped the Sextus plants to grow.

One day some Sextus seeds blew upon good, rich, damp soil, and there they sprouted and grew. They had plenty of water, and there were no cattle to disturb them; so those with the fewest prickles were the best off, because they could use the food material to make larger flowers instead of prickles. So the plants with fewer prickles had larger flowers and better seeds, and these seeds sprouted and grew, and the others gave way before them. In the course of time these plants growing on the rich soil lost their prickles, and their flowers were large and very deep pink; in fact, some of them were a bright red.

These bright-red flowers attracted the bees, and so they lived on and set seed. These we must call Septimus.

For some reason some of the seeds of the Septimus flowers developed unusually thrifty plants.

These plants had flowers with petals so full of sap they overlapped, and finally, just because they were so full of the growing spirit, the edges of the petals grew together.

Finally, the flowers with the edges grown together were the most successful. The tube their flowers made kept the nectar for the bees, and the bees liked to go into these red bells. You see what had happened: the flowers were no longer polypetalous. Their petals had grown together; they were gamopetalous. Their corollas formed snug tubes, something like a morning-glory corolla, for the bees.

We shall have to call these people Octamus.

And we will not follow them any farther, only be sure they kept on changing ever and ever. Whenever the seeds fell in a new soil, they had to change or die. The reason they could change so is because no two things are ever just alike, and out of a great many plants some might be fitted to survive in the new surroundings. These would live, and their descendants would be like them, but they would be different from their ancestors.

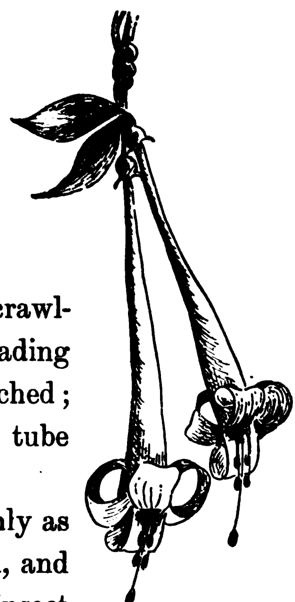
In some such way, no doubt, the many different kinds of flowers have come into existence.

If you ask me for the exact name of our plant that has changed so many times, I cannot tell you, for I do not know.

But that, we believe, is Mother Nature's way of making new flowers.

TONGUES AND TUBES.

A FLOWER tube is a most convenient and safe place to keep stamens and nectar. If it is protected by scales or hairs or a sticky juice, as is often the case, the ants and other small insects are given a gentle but convincing hint to keep out. They might readily infer their presence is not wanted, and though it may hurt their feelings a little, they have nothing to do but obey.



Some flowers like ants and little crawling insects, but they have open, spreading corollas with the nectars easily reached; but you may be sure a flower with a tube is no friend to them.

Its tube says "keep out" as plainly as though it had put out a printed sign, and then a tube is a sign anybody in the insect world can read, no matter what language he may speak or whether he knows his letters.

But tubes are not intended to keep *all* visitors away,—far from it.

They are as much an invitation to one kind of insect as they are a request to "keep off these premises" to another. If you happen to be a large insect with a long tongue, you will be sure to find a welcome in many a flower with a tube. And no doubt, if you are fond of honey and are industrious about collecting it, you will find that the flower whose nectar you like the very best and which you visit the oftenest has a tube just the same shape and size as your tongue; and what is more, it will be in the most convenient position for you to reach it.

It seems to be *your* flower, and no doubt it is, for flowers have a way of making their tubes to fit the tongues of those who love them best. Not that they do *all* the fitting, for no doubt the tongues also grow to fit the flowers.

Of course other insects with similar tongues can get the honey too, and a good many, whose tongues are quite different, can reach more or less of it; but the bulk of the honey is for the favorite visitor. He can reach clear to the bottom of the nectary, and in some cases, where the favorite insect has a very long and very slender tongue, the spur, or tube, will be so long and slender that none but that particular kind of insect can get the honey at all.

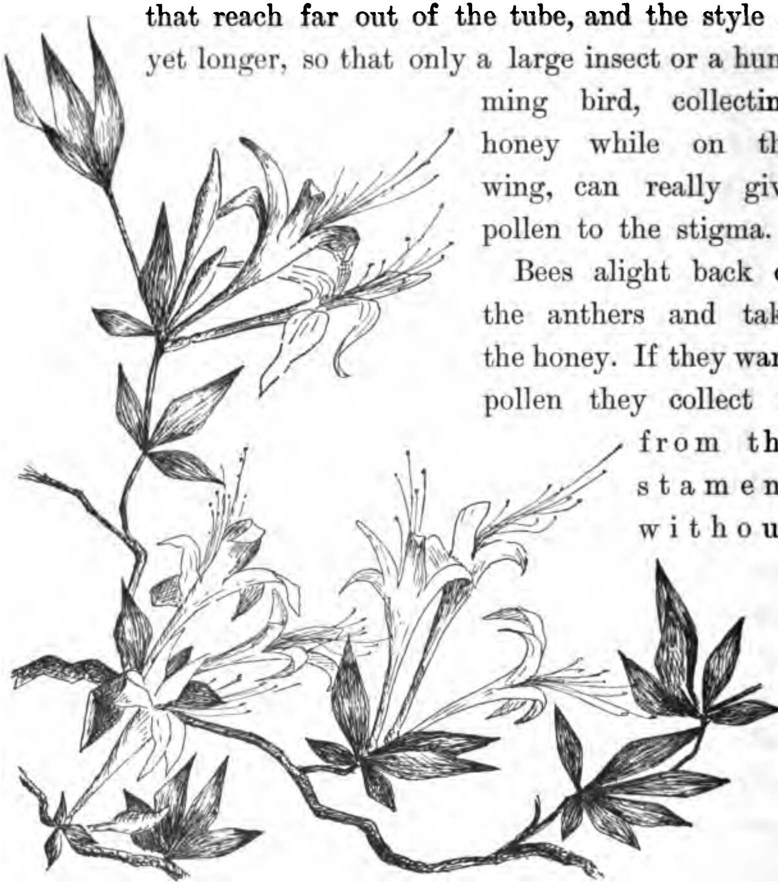
Everybody who lives in New England, and a good many who do not, knows the white azalea, often called swamp honeysuckle.

Swamp honeysuckle and the large night-flying moths are great friends. The azalea has provided honey for the fellows, and protects it, too, against other visitors, all but the bees and humming birds. The humming birds are welcome, and the bees have a way of coming whether they are welcome or not.

If you go just at dark to where the azaleas are blooming, you will not see the moths, but you will hear them. The chief sounds in the woods are the rustling of twigs and leaves in the breeze, the calling of frogs from the ponds, the noises of the insects, and the voices of the night-flying birds. Then all at once there comes another sound,—a steady buzz-z-z that draws nearer and nearer until it seems to be close to your ear. This is the moth come to visit the honeysuckle. And, no doubt, the honeysuckle is glad to feel the breeze of these fanning wings and feel the long tongue enter the tube, for the moth's body touches the out-reaching stigma and leaves there pollen from some other flower whose honey it has enjoyed. From the stamens it detaches pollen grains to carry to another flower; and this, too, no doubt, gives happiness to the azalea, for it makes its pollen, not for its own use, but for the sake of its azalea friends.

You see, the azalea has long, upturned filaments that reach far out of the tube, and the style is yet longer, so that only a large insect or a humming bird, collecting honey while on the wing, can really give pollen to the stigma.

Bees alight back of the anthers and take the honey. If they want pollen they collect it from the stamens without



touching the stigma, except once in a while by accident, as it were. So however much the majority of flowers may love and respect the bee, our azalea has no liking for her. Besides, the bee has a bad habit of biting a hole in the flower tube and getting the honey that way. This would be a thoroughly disreputable performance on the part of any insect, and if bees are not ashamed of it they ought to be.

The azalea does several things for the moth it loves. It may be its beautiful white color is for his sake; anyway, if the flower were not white the moth would not be likely to find it, since he flies abroad after the birds have gone to rest,—that is, in the evening, when it is dark in the damp thickets where the honeysuckle loves to grow. Azalea has a sweet white corolla with a long, slender tube containing nectar that moth or humming bird can reach, but which bees cannot reach. Watch a bee try some time. If the flower is between you and the light, you can see the bee's brown tongue through the flower tube; she appears to be standing on her toes and reaching in as far as she can; she darts out her tongue to its full length, and you can see it wriggling and straining to get to the abundant honey low down in the flower tube. But there is no use trying; the tongue is too short and the tube too long. The honeysuckle tube was not made to fit the bee's tongue, and the bee can get only the outer rim of the honey. Perhaps this is why the bee so often breaks in the back way.

Besides being white, the azalea flowers grow in clusters, which makes them yet more visible in the dusk. They exhale a delicious and far-reaching perfume too, and this is a note of invitation to the moths.

Instead of writing a note on a sheet of perfumed paper, the honeysuckle simply sends the perfume without the paper, and the moth understands the message and knows the white azalea "requests the pleasure" of his company that evening, and he puts on his best manners, since he cannot change his clothes, and goes.

The white azalea is so *very* sweet and so pretty, it would not be strange if other uninvited guests than bees were to visit it. No doubt, the ants and bugs and gnats and flies would be glad to, but the azalea has a very inhospitable way of receiving such would-be guests. All over the outside of the lower part of the white tube and running in a line to the very tips of the petals are tiny white hairs with black tips.

These are azalea's body guard. Each tip exudes a drop of sticky liquid.

Fine, sticky hairs cover the stems and the leaves too; so the unfortunate insect that tries to crawl up to the flower is sure to get wings and legs hopelessly entangled and stuck together.

Only large fellows, like bees, who are strong enough to pull themselves free and clean off their legs, are able to defy this body guard. You will sometimes meet our sweet azalea covered on the outside with little marauders who wanted to steal her honey but could not, because the body guard caught them and stuck them fast.

Not all flowers with tubes have succeeded as well as azalea in keeping their honey for the visitors who can do them the most good. Yet many have tried.

Look at the morning-glory, for instance; it has hairs at the entrance to the nectaries which the ants cannot readily pass, but which the bees can push aside. The openings to the nectary are large enough readily to admit the tongue of a bee, and the distance into the nectar is about the length of a bee's tongue; but there are no sticky guards to preserve the honey, for the bees and small beetles and other tiny insects often crawl into the tube and eat the honey and even devour the flower itself.

Tropæolum has a fine large tube full of rich honey for bees and humming birds. This tube no doubt corresponds to some tongue or bird-bill in her own

EVENING PRIMROSE.

South America. But in our country the bees answer very well. The bumblebee is fond of Tropæolum honey and fertilizes the flower, while an occasional rubythroat may be seen taking a sip.

Jewelweed's horn is a humming bird tube and a bee tube, too. The flowers are so delicately balanced on tiny stalks that wingless insects would not find an easy entrance.

Pelargonium, too, has a tube suited to some long and slim-tongued visitor. In her own native land in far-away Africa she probably loves the butterflies that live there, who also love her, and so they have grown tongue and tube to fit each other. For the flower is not the only one to change: the insect changes to suit the flower at the same time that the flower changes to suit the insect. They grow to fit each other.

Wherever you see a flower tube you may be sure there is somewhere a tongue to fit it.

GLOSSARY.

L. = Latin. A.-S. = Anglo-Saxon.

A.

Acheloüs, *n.* A river god with whom Hercules wrestled. Like Proteus, Acheloüs could change his shape; he became a serpent and a bull, but Hercules vanquished him nevertheless and tore off his horn, which became the horn of plenty.

Alternate, *a.* L. *alter,* another; one following another. Said of leaves standing singly at the nodes of a stem; also of stamens that stand between the petals, and of petals that are placed between the sepals.

Amalthea, *n.* In Greek mythology, the nurse of Jupiter, probably a goat.

Amœba, *n.* From a Greek word meaning "change"; the name of one of the lowest forms of life; a bit of living protoplasm capable of existing as a single cell and of changing its form at will.

Ancestors, *n.* L. *antecessor,* a foregoer; forefathers; those from whom animals or plants are descended.

Animal cells, *n.* The cells or minute divisions which make up the animal body.

Animals, *n.* All living things which are not plants are animals. In the lower forms of life it is impossible to decide whether certain living things are animals or plants.

Anther, *n.* From a Greek word meaning "flower"; that part of the stamen containing the pollen.

Anther cells, *n.* The hollow spaces in the anther where the pollen is kept.

Aristocrat, *n.* From two Greek words meaning "best" and "rule"; one belonging to the best in a community; one among those fit to rule.

Aristocratic, *a*. Like an aristocrat.

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.

Azalea, *n*. The name of a plant. The "swamp honeysuckle" is not a honeysuckle, but is an azalea.

B.

Barb, *n*. L. *barba*, a beard; a tuft of hairs; a sharp point projecting backward from the point of a fish hook or arrow or any other sharp-pointed instrument. The barb prevents the instrument from being readily withdrawn.

Bark, *n*. The outer covering of the stems and roots of woody plants.

Beak, *n*. The bill of a bird; the long, projecting point in the fruit of the geraniums.

Bloodroot, *n*. An early spring flower. A pretty, delicate, white flower opens on a stem that comes up from the ground, and the roots, when wounded, yield a blood-red sap.

Boer, *n*. D. *boer*, a farmer; a peasant; the name of the Dutch colonists of South Africa. They are principally farmers and cattle raisers. They have had many difficulties with the English settlers, in some of which blood has been shed.

Bract, *n*. L. *bractea*, a thin plate of metal; gold-leaf. Used of small, usually thin, leaf-like parts, and often found near a flower or flower cluster.

Bulb, *n*. L. *bulbus*, a bulbous root; an onion; the name of the underground, scale-covered part of hyacinths, etc.

C.

Cactus, *n*. From a Greek word meaning "a prickly plant"; a group of plants which usually grow in dry places and have prickles or thorns instead of leaves. The prickly pear grows wild in northern latitudes, and others, such as the night-blooming cereus, are often seen in hothouses.

Callous, *a*. L. *callosus*, hard-skinned, thickened and hardened. Applied to a hard place on the skin, usually the result of friction.

Calyx, *n.* From a Greek word meaning "to cover"; the outer set of envelopes which form the perianth of a flower. If the perianth has but one set of envelopes it is called the calyx.

Capillary attraction, *n.* The force which causes liquids to disperse through fabrics or tissues. If one end of a towel be placed in a bowl of water, the whole towel will be wet in course of time.

Carbon, *n.* L. *carbo,* a coal; a substance very widely distributed and existing under various forms. Coal is one form of carbon, graphite another, the diamond a third. One atom of carbon combined with two of oxygen form carbon dioxide.

Carbon dioxide, *n.* A heavy gas, found as an impurity in the air. It is breathed out by animals and plants, and absorbed and used as a food by plants.

Castor oil, *n.* The oil obtained from the seeds of the castor-oil plant. Used as a medicine and also in dyeing cotton certain colors.

Cell, *n.* L. *cella,* a small room; a case or cup in which something is held, as anther cell, ovary cell, honeycomb cell; also the protoplasmic particles of which plants and animals are built up.

Candelabrum, *n.* L. *candela,* a candle; a candle stick; any branched candlestick. A candelabrum rests on a post, while a chandelier is suspended. Candelabra is the plural.

Chasm, *n.* From a Greek word meaning "a yawning hollow"; a wide, deep cleft.

Chlorophyll, *n.* From two Greek words meaning "light green" and "leaf," leaf-green; the green coloring matter of vegetation.

Columbine, *n.* L. *columba,* a dove; a flowering plant which gets its name from the fancied resemblance of its petals and sepals to the heads of doves round a dish.

Complexity, *n.* L. *com,* together, *plectere,* to weave; formed by a combination of simple things.

Convolvulaceæ, *n.* The name of a family of plants to which belong the morning-glory and bindweed.

Cornucopia, *n.* L. *cornu,* horn, *copia,* plenty; horn of plenty.

Corolla, *n.* L. *corolla,* a little crown; a garland; the floral envelope within the calyx, very often bright colored.

Cotton-seed oil, *n.* An oil expressed from the seeds of the cotton plant and, when purified, used instead of olive oil.

Crete, *n.* An island to the south of Greece.

Crocus, *n.* An early spring flower.

Cross-fertilization, *n.* The fertilization of the ovules of one flower by the pollen of another.

Cross-fertilized, *a.* Fertilized by the pollen from another plant.

D.

Dew, *n.* The moisture of the air when condensed on any cold surface. Dew does not *fall;* it is formed wherever moisture in the air comes in contact with a substance colder than the air. Hence there may be dew on the under as well as the upper side of a leaf.

Dissolve, *v.* L. *dis,* apart, *solvere,* loose; to separate the solid particles of a body in a liquid; to melt. Sugar dissolves in water.

Double flowers, *n.* All those whose petals are numerous. Sometimes the stamens are changed into petals, as in double roses, and sometimes even the pistils have become petals.

E.

Evaporation, *n.* 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 water from the leaves of plants.

F.

Fayal, *n.* One of the Azores Islands, west of Portugal.

Ferns, *n.* A division of flowerless plants.

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.

Filament, *n.* L. *filum,* a thread; the stem of an anther, often thread-like in form, though it varies greatly; any thread-like part.

Flower, *n.* L. *flos,* a flower; the part of a plant consisting of pistil, stamens, corolla, and calyx. Sometimes the corolla is wanting; sometimes both calyx and corolla are wanting. Since pistils and stamens are the most important part of the flower, an organ containing them only is called a flower. Sometimes a flower consists of only stamens or only pistils, as in some kinds of maple.

Force pump, *n.* A pump in which a liquid is moved by pressure behind instead of being lifted, as is the case in the ordinary pump.

Fossil, *n.* Animal or vegetable forms which have been long buried in the earth and so preserved; the *forms* or traces of animal or vegetable structures which have been preserved in rock.

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. Where a flower has the corolla in the form of a tube it is called gamopetalous. Several petals are believed to be united into one piece.

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.

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.

Great pyramids of Egypt. Three large pyramids at Ghizeh, near Cairo, in Egypt. The largest one is the largest work of man's hands in the world. The pyramids are very interesting structures, and are probably the tombs of the ancient rulers of Egypt.

Guard cells, *n.* The curved cells that guard the entrance to the stomata, or breathing pores, of leaves.

H.

Hairs, *n.* Fine, thread-like outgrowths from the skin of plants or animals.

Halberd-shaped, *a.* Shaped like a halberd, or old-time battle-ax. The bases of certain leaves are called halberd-shaped from their form.

Hawthorne, *n.* A small tree with thorny stems. The fruit consists of small bright red berries called "haws."

Heart, *n.* The principal organ for the circulation of the blood in man and other animals.

Hercules, *n.* In Greek and Roman mythology, a mighty hero, the god of strength and courage. He performed many feats of strength, chief among which are those known as the twelve labors of Hercules.

Honeycomb cells, *n.* The wax cells made by bees for storing the honey.

Hyacinth, *n.* The name of an early spring flower; also of a precious stone.

Hydrogen, *n.* 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 roof tile to shed rain; *imbricare*, to cover with roof tiles; lying over one another, or lapping, like tiles on a roof. Applied to sepals that overlap over a bud.

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. Plants, like people, inherit their characteristics from their parents.

Iron, *n.* A very abundant and very important metal. In small quantities it enters into the composition of plants and animals.

Irritate, *v.* L. *irritare*, to excite; to excite to action. Rubbing irritates the skin and causes extra blood to flow to the spot and thus redden it. Rubbing may also irritate plant tissues and cause an extra flow of sap to the part irritated.

J.

Jack-in-the-Pulpit. The name of a plant that blooms in early summer. The flowers have no corollas or calyxes, but grow clustered together on a long spike. The spike of flowers is surrounded by a large overarching bract.

Juan Fernandez, *n.* An island, west of Chili, in South America. It is said to be the island where Robinson Crusoe lived.

Jupiter, *n.* In Roman mythology, the chief of the gods. The eagle is his favorite bird, and he is often represented with a sheaf of thunderbolts in his hand.

K.

Knead, *v.* To press or squeeze until thoroughly mixed.

L.

Levant, *n.* The name given to a section of country east of Italy and bordering upon the Mediterranean Sea.

Lime, *n.* A substance found in the earth and forming the hard part of bones, and also found in the composition of plants.

Liriodendron, *n.* From two Greek words meaning "lily" and "tree"; a North American tree, also called the tulip tree. Its green and yellow flowers look a little like a tulip.

Lungs, *n.* Two spongy organs in the chest by means of which the air is used to purify the blood in breathing.

M.

Magnesium, *n.* A metal, very abundant in sea water and in the earth's crust. Also found in the composition of animals and some plants.

Mandrake, *n.* A plant with umbrella-like leaves and a yellow, juicy fruit as large as an egg.

Microscope, *n.* From two Greek words meaning "small" and "view"; an instrument which magnifies and renders visible bodies too small to be seen by the naked eye.

Moth, *n.* An insect resembling a butterfly. Moths have no knobs on their antennæ, or "feelers," and butterflies have.

Mullein, *n.* A tall, stout weed with thick, wooly leaves.

N.

Naiads, *n.* In Greek and Roman mythology, water nymphs. Beautiful young goddesses presiding over springs and streams.

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.

Nectar, *n.* The drink of the gods on Mt. Olympus. The honey of flowers.

Nectaries, *n.* The receptacles in which the nectar of flowers is collected; also the gland which secretes the nectar.

Neptune, *n.* In Roman mythology, the god of the sea.

Nettle, *n.* A weed armed with stinging hairs.

Nitrogen, *n.* A colorless, odorless, tasteless gas, forming about three-fourths of the air and necessary to the formation of all living bodies, whether plant or animal.

Nitrogenous substances, *n.* Substances in which nitrogen is one of the constituents.

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.

Octavus, *n.* L. *octavus*, eighth; given in this book as a name to a suppositional plant.

Oil, *n.* From a Greek word meaning "olive oil." An inflammable, greasy liquid extracted from certain vegetables, as olives, cotton seeds, nuts, etc.

Olive oil, *n.* The oil expressed from the fruit of the olive tree.

Orient, *n.* L. *oriens*, rising, as the sun; the East, the part of the horizon where the sun rises; Eastern countries, particularly Turkey, Persia, Egypt, India, China, etc.

Ovary cells, *n.* The cells which build up the ovary.

Ovule, *n.* L. *ovum*, an egg ; a little egg. Applied to the rudimentary seeds of plants, which, upon fertilization and growth, become true seeds.

Ovule cells, *n.* The cells of which the ovule is formed.

Oxalis, *n.* From a Greek word meaning "acid"; a well-known plant, one form of which is called "wood sorrel." It is called oxalis because of its acid juice.

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.

Pelargonium, *n.* From a Greek word meaning "a stork"; a member of the Geranium Family, so called because of the beaked seed-pods.

Petal, *n.* From a Greek word meaning "a leaf"; one of the leaves of a corolla.

Phosphorus, *n.* From a Greek word meaning "Lucifer, the morning star"; a solid substance which is luminous in the dark. It is found in composition in the bodies of animals and plants.

Pioneer, *n.* L. *pes*, a foot ; in military terms, one of a company of foot soldiers who march before an army with implements to clear the way. Hence, whoever or whatever leads or prepares the way for others coming after.

Pistil, *n.* L. *pistillum*, a pestle ; the seed-bearing organ of a flower, composed generally of three parts, ovary, style, and stigma, and called pistil because of its shape, which often resembles a pestle.

Plant cells, *n.* The cells of which plants are built up.

Pollen, *n.* L. *pollen*, fine flour ; the dust or grains of fertilizing material found in the anthers of flowers.

Pollen cells, *n.* The grains of pollen ; each grain is a separate cell.

Polypetalous, *a.* From two Greek words meaning "many" and "leaf." Said of a flower having two or more separate petals.

Potash, *n.* A combination of potassium, carbon, and oxygen. Potash in various forms is found in all plants.

Potassium, *n.* A substance found in combination with other things in the earth's crust, and in the form of potash, an important factor in the substance of plants and animals.

Potato, *n.* One of the edible tubers of the potato plant. The potato is a swollen underground stem, the eyes being the nodes. The potato contains a large amount of starch and is a valuable food. The potato plant is a native of the Andes. It was taken to England from Virginia in 1856.

Prickles, *n.* A.-S. *prica,* a sharp point; small, sharp-pointed growths from the bark of plants.

Primitive, *a.* L. *primus,* first; pertaining to the beginning or origin of a thing. In botany, beginning to take form, applied to an organ or structure that is just beginning to assume form.

Primus, *n.* L. *primus,* first; a name given in this book to a suppositional plant.

Probing, *n.* L. *probare,* to test, examine; examining by means of a long, pointed instrument or probe. The bee or butterfly probes for nectar with its long tongue.

Protean, *a.* Pertaining to Proteus; readily assuming different shapes.

Proteus, *n.* In classical mythology, a sea god who had the power of assuming different shapes. He could become a serpent or a cloud or a bull or anything he chose to become.

Protoplasm, *n.* From two words meaning "first" and "form." A substance resembling the white of an egg in appearance, composed of carbon, hydrogen, oxygen, nitrogen, sulphur, and phosphorus. It is the foundation of all living forms.

Protoplasmic, *a.* Consisting of protoplasm.

Q.

Quartus, *n.* L. *quartus,* fourth; the name given in this book to a suppositional plant.

Quintus, *n.* L. *quintus,* fifth; the name given in this book to a suppositional plant.

R.

Rain, *n.* A.-S. *regn*, rain : the water falling in drops through the atmosphere. Water rises as vapor from the moist earth and the sea ; it is then condensed by coming in contact with the cold upper air, and falls to the earth as rain.

Reproduced, *pp.* L. *re*, again, *producere*, to produce, to bring forth ; produced again, having formed new plants or animals from those already existing.

Retrogressed, *pp.* Went backward.

Retrogression, *n.* L. *retro*, backward, *gradi*, to go ; the act of going backward.

Rhea, *n.* In classical mythology, the wife of Saturn and mother of Jupiter.

Ribs, *n.* The bones that form the framework of the chest in the higher animals ; the timbers that form the framework of a ship ; the stiff fibres that form the framework of a leaf.

Robinson Crusoe, *n.* A story written by Daniel Defoe and published in 1719. The adventures of Robinson are said to have been suggested by the life of Alexander Selkirk, who was shipwrecked and lived for four years on the desert island of Juan Fernandez.

Root, *n.* The part of a plant that usually grows down into the soil, fixing the plant and absorbing nutriment.

Root cap, *n.* The hard cap which covers and protects the growing tip of a root.

Root hairs, *n.* The fine filaments growing from the skin of young roots that absorb the nutriment for plants.

Rubythroat, *n.* The name of the North American humming bird, so called because of the bright red feathers on its throat.

S.

Salamander, *n.* A kind of lizard, formerly supposed to be able to live in the fire.

Salt, *n.* One of the most important substances in the world. It is necessary to the existence of animals and is one of the constituents of many plants.

Sap, *n.* The juice of plants. It is to them what the blood is to animals.

Saturn, *n.* In classical mythology, the father of Jupiter.

Scales, *n.* A.-S. *scealu,* a scale, husk; in botany, a small, rudimentary leaf, scale-like in form. Scales cover the leaf buds and sometimes the flower buds; they also constitute some bulbs.

Scape, *n.* L. *scapus,* shaft, stalk; the long, leafless peduncle which starts from the ground and bears flowers at the top, as in the hyacinth.

Sceptre, *n.* L. *sceptrum,* a staff to lean on; a sceptre; a staff of office; the staff of kingship.

Secrete, *v.* L. *secernere,* to separate; to form from the materials of the sap or the blood a new substance. The organ that secretes is called a gland.

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.

Seed coat, *n.* The outer covering to a seed.

Seedlet, *n.* A little seed.

Sepal, *n.* L. *separ,* separate; one of the separate leaves that form the calyx.

Septimus, *n.* L. *septimus,* seventh; the name given in this book to a suppositional plant.

Sextus, *n.* L. *sextus,* sixth; a name given in this book to a suppositional plant.

Shrub, *n.* A woody, branching plant, smaller than a tree.

Silica, *n.* L. *silex,* flint; a substance found very abundantly in the earth's crust. It is very hard, and when melted forms glass; it is found in solution in some springs and is taken up by certain plants and deposited on or near the surface.

Skin, *n.* The outside covering of an animal or plant.

Skin cells, *n.* The cells of which the skin is made up.

Snowdrop, *n.* An early spring flower cultivated in gardens; it sometimes blossoms under the snow.

Soda, *n.* A compound of sodium, carbon, and oxygen; found in the composition of some plants.

Sodium, *n.* One of the elements of common salt, and also found in the tissues of plants and animals.

Sorrel, *n.* A.-S. *sūr*, sour; a kind of plant with acid leaves.

Sphinx, *n.* In Greek mythology, a monster with the head of a woman, the wings of an eagle, and the claws of a lion; she sat on a rock and proposed a riddle to all who passed and killed those who could not guess it. The Egyptian sphinx has no wings and is not the same as the Greek monster; it is generally placed in rows in avenues leading to temples, and the largest and most famous Egyptian sphinx is the Great Sphinx near the great pyramids of Ghizeh; it held a temple between its paws.

Spring beauties, *n.* Pretty, delicate, and early spring flowers.

Spur, *n.* A pointed instrument worn on the heel to goad a horse; any sharp projection formed like a horseman's spur.

Stamen, *n.* L. *stamen*, thread, string, fibre; the floral organ containing the fertilizing pollen. The stamen, like the pistil, is believed to be a modified leaf.

Starch, *n.* A substance composed of carbon, hydrogen, and oxygen, forming one of the principal elements in plants and necessary as food to animals.

Stiffening cells, *n.* The woody cells and other tough-walled cells that serve to keep the shape of a plant.

Stigma, *n.* The structure at the top of the style where the pollen is received.

Stipules, *n.* L. *stipula*, a stalk, stem, blade; the small, leaf-like appendages at the base of the petiole of leaves.

Stoma, *n.* From a Greek word meaning "mouth-opening"; a small opening in the skin of leaves and young stems leading to the air cavities within the plant; a breathing pore.

Stomata, *n.* The plural of "stoma."

Strengthening cells, *n.* The cells with tough or hard walls that serve to give firmness and support to plant tissues.

Suction, *n.* L. *sugere*, to suck; the process of sucking.

Sulphur, *n.* A solid substance found in the earth's crust in certain places; it is one of the constituents of protoplasm, and although occurring in it in very small quantities, it is essential.

Sulphuric acid, *n.* Oil of vitriol, a combination of hydrogen, sulphur, and oxygen. Sulphuric acid is found in the earth and in the air in very small quantities, and is the source from which plants as a rule derive their sulphur.

T.

Tertius, *n*. L. *tertius*, third; the name given in this book to a suppositional plant.

Thoreau, *n*. Henry David Thoreau, an American author of the present century, wrote a number of delightful books on nature.

Tissue, *n*. L. *texere*, to weave; a woven fabric; the cellular fabric of plant structures.

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 plant, so called because of the shield-shaped leaves, many shields together suggesting trophies taken from the enemy.

Tube cells, *n*. The cells that build up the tubes of plants.

Tuber, *n*. L. *tuber*, a bump, swelling; a thickened portion of an underground stem. The potato is a tuber; it stores up starch for the use of the growing plant.

Tubular corolla, *n*. A tube-shaped corolla. The red honeysuckle has a tubular corolla.

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.

U.

Underground stems, *n*. Stems that grow beneath the surface of the earth and look more or less like roots. They can always be distinguished from roots by the presence of nodes.

V.

Variegated, *a*. L. *varius*, various, *agere*, to make; marked with different colors.

Veins, *n*. L. *vena*, a blood vessel; the blood vessels or channels through which the blood flows to the heart; the stiff, thread-like tubes forming the framework of leaves, petals, sepals, etc.

Vine, *n.* L. *vinea,* a grape vine ; a plant with a stem too long and flexible to stand alone.

W.

Water, *n.* A well-known liquid composed of two parts of hydrogen to one of oxygen.

Wax, *n.* A.-S. *weax,* wax ; a thick, sticky substance made by bees for constructing their cells ; substances resembling beeswax in consistency.

Whorl, *n.* A ring of organs from the same center.

Wood cells, *n.* The cells of which wood is built up.

Morley, M.W. 70838
Flowers and their friends.

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