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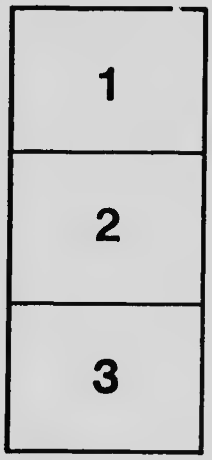

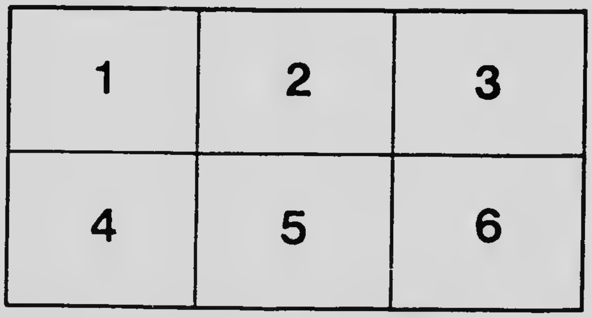

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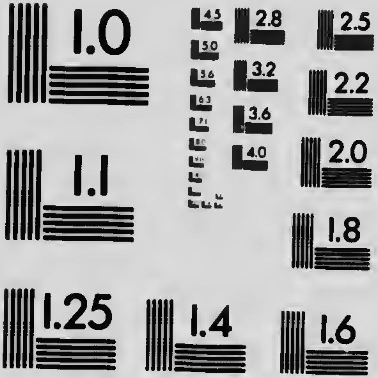

ONTARIO AGRICULTURAL COLLEGE

BULLETIN 124.

NATURE STUDY

OR

STORIES IN AGRICULTURE

BY

MEMBERS OF THE STAFF

OF

The Ontario Agricultural College, Guelph.

PUBLISHED BY THE ONTARIO DEPARTMENT OF AGRICULTURE,
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All of the illustrations in this Bulletin signed J. B. are from drawings made for the purpose by Mr. John Buchanan, B.S.A., a graduate of the Agricultural College. The two illustrations on pages 9 and 25 are from drawings loaned by *The Weekly Star*, Montreal.

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BULLETIN 124. DECEMBER, 1902

Ontario Agricultural College and Experimental Farm.

NATURE STUDY.

James Mills, M.A., LL.D.

Most people look at many things which they do not see, and hear many sounds to which they pay little or no attention. There are, for instance, many intelligent Canadians who have been looking at ash and elm trees all their lives, and they could not describe the bark, leaves, or general appearance of these two kinds of trees, so as to distinguish one from the other. They have also, no doubt, noticed half a dozen or more

Fig. 1. What birds are these?
What trees are these?

species of birds in their fields or lawns from year to year, and have heard them sing very sweetly, and yet have little or no knowledge of most of them,—their color, markings, songs, or habits.

The aim of nature study is to interest men and women, and especially boys and girls, in the natural objects which they look at, handle, taste, or smell from day to day, in order that they may acquire the habit of observing closely, and so get all the pleasure possible out of their surroundings in life, and find their daily duties less irksome, and gather information that will be helpful to them in overcoming difficulties and in working for a share of the necessaries, comforts, and luxuries of life.

The materials for nature study are everywhere,—the soil, the plant, and the animal; and the judicious study of soils and soil formation, or useful and troublesome plants, or noxious and beneficial insects—first, as objects of beauty or interest in themselve. and afterwards as things which are useful or troublesome to man—opens up a field of unending pleasure and profit to the average boy or girl.

The eyes, ears, and other organs of sense in children are wide awake and keenly attentive; and the one thing needed is nature-loving, well-trained, competent teachers in the Public Schools, to direct and develop the love for natural objects which is so strong from infancy to twelve or fourteen years of age.

One of the best aids—in fact the ever-necessary handmaid—of nature study is drawing. Nothing contributes more to exact and reliable information, say in the study of plants and insects, than an attempt to draw a representation of the object or organ under examination. All parts and the arrangement of parts, with every angle, curve, and peculiarity, must be noticed and represented in some way; and I regret to say that there is nothing in which our Canadian teachers and schools are more deficient than in this important branch of elementary education. Boys from England are far more proficient in drawing than Canadian boys and girls; and those who have given any attention to the subject, know what excellent work is being done under this head in some of the leading cities of the United States (say Boston, New York, and Philadelphia), where every teacher, in almost every division from the kindergarten up, teaches drawing. The children at school in these cities are taught to describe by some kind of diagram or drawing nearly everything they look at or read about; and the results are very satisfactory, far beyond what one would think possible in a Public School course

Those who have had experience, almost without exception, say that nature study, properly pursued, does not interfere with ordinary school duties. On the contrary, it breaks the monotony of school routine and increases the interest in the regular school studies to such an extent that the most and best book-work is done where a little time is given every week to the examination and study of some portio.. of the great world of nature around us.

This Bulletin is, we think, the first formal attempt in the Province of Ontario to present items of information and simple, common-place incidents regarding natural objects, in the hope of interesting some of our young people, and inducing teachers to undertake such work in the Public and High Schools of the Province. These simple stories are, no doubt, very imperfect; but they constitute a beginning,—the opening up of a very wide and interesting field for observation and study; and with more time and a careful selection of writers according to their special tastes and aptitudes, we may be able to furnish something nearer what is required in this important department of educational work.

A HANDFUL OF EARTH.

PROFESSOR. J. B. REYNOLDS.

"A handful of earth! Dirt! Surely we are not asked to listen to a story about anything so common as dirt! Dirt sticks to our hands and faces, and we are made to wash it off. It clings to our shoes. It gets onto our clothes, it blows into the house, and makes the furniture dirty, and people have to be continually rubbing and brushing, sweeping, and dusting to get rid of it. We should be very glad never to hear of it again."

Fig. 2. A handful of earth—in its place.

I fancy I hear many boys and girls saying this when they see the title of this story of mine. But stay! I said *Earth*, and what you say is about *Dirt*. Earth is very good *in its place*, but *out of its place*, it is dirt. It is out of its place when it is on your hands or shoes or clothes. Then it annoys you and you call it bad names. There are other things besides earth that sometimes get out of place and are called bad names. I have heard it said that *boys and girls* are all very wel. in their place, which seems to hint that they are sometimes out of their place. I have known boys, and girls too, make visits to a neighboring orchard. The owner of the orchard was a mean old fellow, and when he saw the children in his orchard he would say, "Plague on those youngsters: They're at it again." And he would send someone, or go himself, to drive them out, just as you would brush the dust off your hands. But the fathers and mothers of those same intruders thought they were pretty good children, and were proud of them. So with this handful of earth. In its place, that is, in the garden or field, it is of untold value.

Earth is so common and unlovely while "birds and butterflies and flowers" are so bright and beautiful, that all our interest is naturally drawn to these. But we should know that although the soil has no life or beauty in itself, yet it *supports* life, and enables other things to be useful and beautiful.

THE SOIL AND THE ROCK.—Take from the field some fine dry earth. Place a good sized pinch of it on a piece of smooth white paper, and place under this a newspaper or a piece of thick cloth. Tip the whole so as to give it a little slope. Then tap this paper with the finger, and you will begin to see parts of the soil begin to draw away from the other parts. Keep at this, and you will find some of the soil rounding up in little heaps, while the rest scatters over the paper. Roll your pencil forwards and backwards over this last, pressing slightly upon it, and tap again, until no more will round up. Then look closely at the little heaps and the scattered parts. The heaps first formed are made of soil fine as flour. The next lot of heaps have *little grains* like granulated sugar. The part scattered about is sand and lumps. The sand is mostly clear and white, some of the grains sparkling in the sun like diamonds The lumps, perhaps, are made of smaller grains stuck together, and do not look clean-cut and white like the sand. Sand, as you well know, is nothing but small bits of rock. Now, if you hold the little heaps so that the sun shines upon them, you may see, if your eyes are sharp, very small rock-bits among these too. In fact, a large part of all soil is rock. When you come to know geology, you will learn how this rock became broken down into such small bits to make soil. But for the present we are interested in knowing that the soil contains rock-bits of many different sizes.

Fig. 3. A soil separated, showing rock grains of mary sizes.

Fig. 4. Showing the parts that the trees have given to the soil.

THE SOIL AND THE TREE. "But," you say, "many soils are quite dark in color, while most of this sand is clear and white; There must be something else in soils besides sand grains, or it would not be so dark." Quite true; and now we shall see what this is.

Get from the woods, under last year's leaves, some black mold: and after it has become dried, treat it as you did the sample of earth. You will find much the same separation as before; but on looking closely at the heaps and scattered grains of the mold, you will find two important differences: First, the separate grains, big and little, instead of being white as the sand grains were, are all brown or black. Secondly, instead of looking like rock, these, especially the coarser ones, look like bits of wood.

Long years ago, before the white man came to Canada, even before the man hunted over these hills and plains, the trees began to grow upon the soil. Year after year, as the trees grew bigger they drew water and food more and more, from the soil. The trees were wise, however, and knew that, although the rain that fell might keep up the supply of water that they needed, yet there was nothing to replace the food they took from the soil, unless they did it themselves. So they agreed to give back to the soil as much food as they took from it. Every year, the maples and the oaks and the beeches dropped their leaves to the ground. Every tree in the forest now and then dropped twigs and broken branches. When a big tree died and decayed, it also fell to the ground, and lay stretched with its arms spreading wide. Slowly but surely all these things—leaves, twigs and trees,—rotted and passed b into the form of mother Earth. And thus the mold, which you find so common in forests, was made.

It is this *vegetable matter*, or humus, that makes soils dark. It is the most valuable and enriching part of the soil, and so nearly all the best soils are dark. The virgin soil of Canada, that is, the soil before it was cultivated or cropped, wore a thick coat of rich brown mold over the sand-grains below. Through many years of plowing and cultivating, these two parts—the humus and the rock—have become mixed together, just as you found in the earth you examined. Wood and leaves are not the only sources of humus. Straw, roots, grass, and clover, if left on the land, will finally become humus.

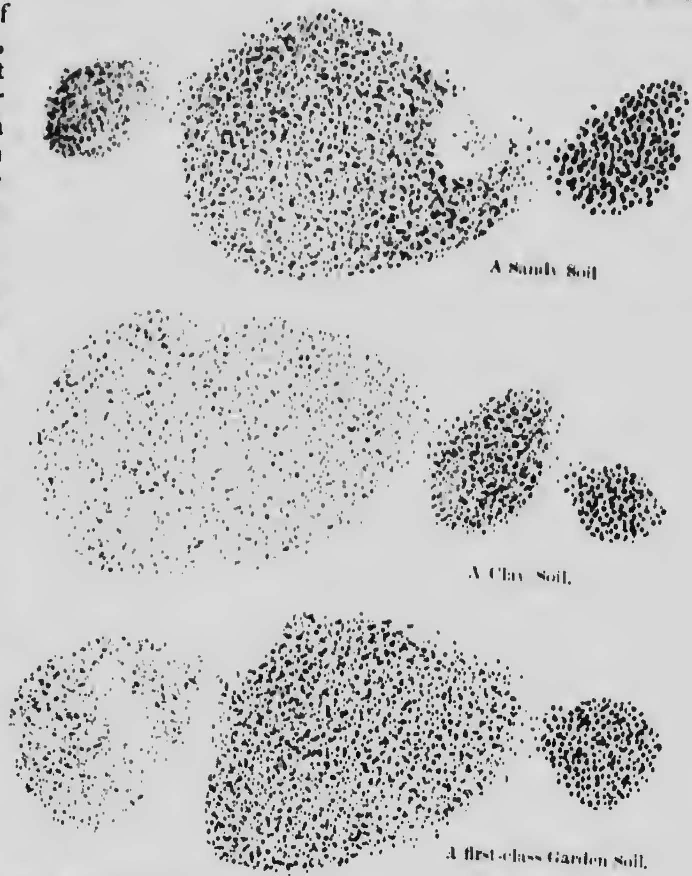


Fig. 5. Showing soils, each separated into fine, medium, and coarse grains.

THE SOIL AND THE RAIN. It was a dry hot summer day. In the fields, the corn and clover leaves hung limp and lifeless. In the gardens, the flowers bent their heads, and had hardly strength enough to put forth their buds. There had been no rain for many days, and the plants had had very little to drink but the dew that gathered on their leaves at night. So they were all very thirsty.

That night the rain fell in a long, heavy shower, upon the fields and gardens. On the steep hillsides it fell, and ran down in torrents to the river below. Upon the gravelly knolls it fell, and trickled quickly down, down, deep into the ground among the gravels and coarse soil-grains, and most of it was soon out of sight and out of reach. It fell, too, upon the clay field, where the soil-grains were all so small and close together that the rain could not find a way between them, and so the rain stood, like little ponds and rivers, in the pits and ruts over the field. Lastly it fell upon good soil, and slowly it soaked away down to the roots of the clover and the corn and the flowers, and down past the roots to a safe storehouse below. Next morning what a change! Even the crops on the hillside and on the gravelly knolls looked fresh and bright. They had kept enough of the rain for one good drink at any rate. On the clay field, the clover stood in danger of having too much of a good thing, for little patches of water were still to be seen here and there. The good soil seemed almost dry again. The corn leaves had straightened out, and every plant in the field was holding its head up straight and strong.

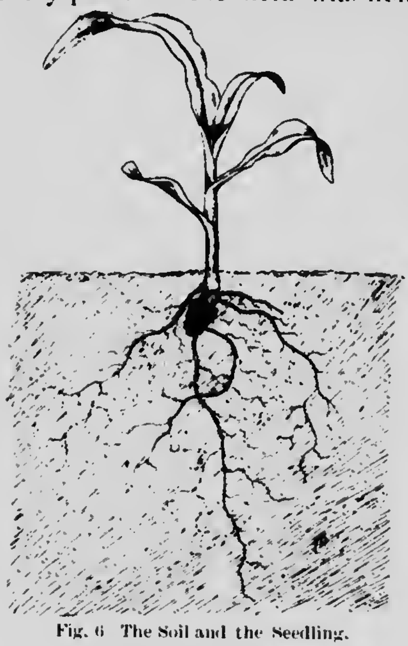


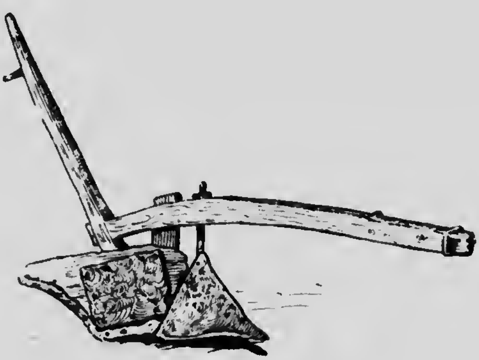
Fig. 6 The Soil and the Seedling.
"The earth all about the roots becomes a scene of life and activity"

A few days later, and again great changes. The hillside and the gravel patch were in as bad plight as ever, — dry and parched. The wet clay soil, in the hot sun, had dried and baked and cracked, squeezing and breaking the tender roots. The heavy rain and the hot sun had done bad things for this soil, and for its litttle nursling plants. But on the good soil, the crops had flourished ever since the rain. As soon as the plant roots and the sun haddrunk up the moisture at the surface of the ground, the roots sent to the storehouse below the message for more water. The ready soil-grains below the roots began to hand the water from one to another up through two, three, and four feet, to keep the roots supplied with plenty to drink. And so, while the ground above was dry and dusty, the rain that had fallen into the good soil many days before, was still kept on tap, and handed out from below when called for.

THE SOIL AND THE SEEDLING. In every seed there is a possible plant, which will produce many other seeds, food for man or beast. But before the plant can come to life, the seed must be placed in earth. What sort of earth bed does the seed like best? Soft, and moist, and warm. Soft, that is, free of lumps, and fine, and mellow, so that the earth may lie snug and close to the seed; moist, so that the seed may swell and burst, and set the young plant free; warm, so that the little plant may be nursed into life.

Imagine now, the little seedling just peeping above ground, and sending its thread-like roots down into the soil below. If it is a hard cruel soil, as too many are, it cares nothing for its little nursling, and will very likely let it die. But if it is a kind, good soil, it becomes very fond of the little plant and does all it can to make the nursling thrive. The earth all about the seedling becomes a scene of life and activity. When the plant wants water,—and it is a thirsty little creature,—the sand grains begin to hand the water from one to another till it reaches the little roots. As the water passes by, the humus grains hand out a supply of food and put it into the water. The earth above the roots is all day long drinking in warmth from the sun's rays and handing it down to the roots. When the winds blow and try hard to tear the little plant out, the soil-grains cling hard to the roots and hold them fast in their place. So, you see the soil has all to do with the roots; what it does is out of sight, and therefore, often out of mind. Yet it is well to remember that the usefulness and the beauty of the grass, and shrubs, and trees come in great part from the earth about below their roots.

The flowers, still faithful to the stems,
    Their fellowship renew;
The stems are faithful to the root,
    That worketh out of view;
And to the rock the root adheres
    In every fibre true.—*Wordsworth.*



The wooden plow of the early settler.

THE STORY OF PLANT ROOTS.

PROFESSOR MELVILLE CUMMING.

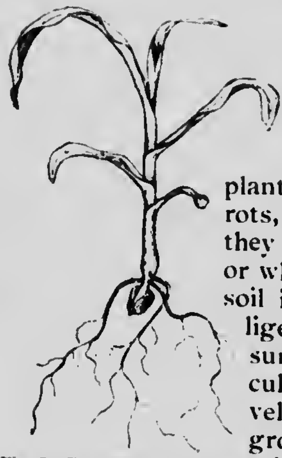


Fig. 7. Corn Seedling, showing leaves, stem, and roots.

Pull up a plant, and you will notice three distinct parts—the leaves, the stem, and roots. The stem and the leaves are the parts above the earth; the roots, the part that is buried in the earth. To the farmer, the roots, being the part in the soil, are in many ways the most important part of the plant. Sometimes he grows such roots as turnips, carrots, and beets for his own use, and then, of course, they are very important; but even when he grows hay or wheat or corn, he can do so only by preparing a good soil in which the roots may grow. With all his intelligence he cannot affect the sunshine and the air which surrounds the stem and leaves; but he can by good cultivation so improve the soil that the roots can develop in the very best way, and by improving the growth of the roots he can improve the growth of the other parts of the plant. Since we are going to study the plant from the farmer's standpoint, we will dig down into the earth and see what we can of the roots of plants.

What are the roots in the ground for? They hold the plant in place. Have you ever walked against a heavy-blowing wind and felt its force, sometimes so strong that you could scarcely stand up? If you have, you can in part imagine the force with which the wind sometimes blows against a tree that is ten or fifteen times as big as you are. The roots of a large oak or maple or pine tree must be very securely fixed in the ground to stand the great strain from such winds; and although most of the plants grown on the farm are very much smaller than trees, yet even they must be very securely held in the soil by their roots.

Not only do roots serve as anchors, but also as the feeding and drinking organs of plants. Plants, as well as animals, must have food and water in order to live and grow; but, unlike animals, they have more than one mouth through which to take in food and drink. By means of their roots they take in all the water they need and all the food which the soil can give them. However, plants do not get all their food from the soil. Part of it they get from the air, and the leaves are the mouths for this food. It will be very interesting, a little further on, to see why these two feeding organs, the leaves and the roots, are so differently formed.

Yet another purpose do roots serve in the life of some plants. As you all know some plants, called annuals, live only one year. Others, called biennials, live two years; and still others, called perennials, live many years. Plants belonging to the last two classes must have some means of storing up food for the winter months. Perennial plants, such as trees and shrubs, generally develop strong stems and branches and store up food in them. But the stems and branches of biennials and some perennials die in the autumn, and these plants store up food for their future use in their roots. Some of these with which you are familiar are the carrot, turnip, beet, parsnip, burdock, blue weed, and dandelion If you pull up any of these in the fall, you will notice that, just next the stem, they have a large thickened root, from which smaller roots branch off. This thickened part of the root is packed full of food to be used by the plant the next spring. Often the farmer takes advantage of such plants and, instead of leaving the roots in the earth for the plant's use next spring, pulls them up in the fall and uses them for himself or for his cattle. Many of you, no doubt, have helped to gather in turnips, carrots, and beets. Some time, when you have a chance, leave a few of these in the ground and see what becomes of them next summer. Before passing on, I will give you a question to think about. Would you take the same means of destroying biennial and perennial weeds as you would of destroying annual weeds? Some common biennial and perennial weeds are burdock, blue weed, chicory, thistles, plantain, and dandelion.

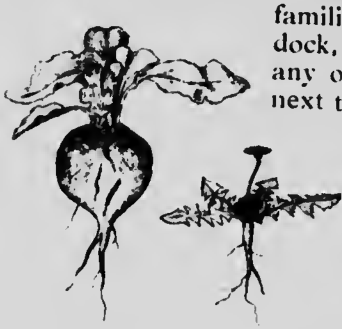


Fig. 8. The roots of the turnip and dandelion.

These, then, are the three uses of roots: 1. To hold the plant in place; 2. To absorb food and water; 3. To act as storehouses of food for the future use of the plant.

Now, there is one thing I must ask you to notice before going any further, and that is, that not all parts of a plant beneath the earth are roots. Some plants have stems growing in the soil; and many people mistake these stems for roots. How many of you, for example, would call the potato a root of the potato plant? It is not, however; and if you will compare a potato with a carrot, which is a true root, you will notice some points in which they differ. You have often noticed the "eyes" of a potato. You will not find any such "eyes" in a carrot. These eyes are buds just the same as, though looking a little different from, the ones you have noticed on the stem and branches of a tree. Besides, if you look very closely, you will find little scale-like leaves just beside the eyes. These, however, soon rub off and you may not be able to see them. And then, if you carefully pull up a potato plant on which the potatoes have begun to form, you will find that the branches on which they are borne are not branches of the root but of the stem, appearing just above, that is, in the axil of a leaf. True roots do not bear these buds or leaves, and they never start in the axil of a leaf. The potato is simply the swollen end of a branch of the stem and is called a tuber. Examine in the same way the Canadian thistle, and couch

Fig. 9. Showing the eyes of a potato.

or witch grass, and see if all the underground parts of these are roots or if some of them are stems.

You have all tried to pull plants out of the ground; and in doing so, you have noticed that some pull up quite easily and others with much difficulty. Pull up, for example, a corn plant or an oat plant and then pull up a burdock or a clover plant. Why is it so much easier to pull up the corn or oat plant than the burdock or clover plant? If you will dig down into the earth you will see that the clover and burdock plants have a long main root extending deep down into the earth, and that other smaller roots branch off from this at different depths and extend out into the earth in all directions, whereas the oat and corn plants have no such main root, having only the smaller roots extending out from the base of the stem. Hence the oat and corn plants are much more shallow-rooted than the clover or burdock. If you will pull up a number of plants you will find some like the corn and others like the burdock or clover, some with very deep and others with very shallow roots. This is one of the many reasons why a good farmer grows different crops and not always the same crops, or, as it is called, follows a "rotation of crops" on the same field from year to year. One year he may grow deep-rooted plants, and these will feed upon the food that is deep down in the earth, and the next year he will grow more shallow-rooted plants, which will feed in another part of the soil; and thus the plants are not so likely to use up all the food from any one part of the soil.

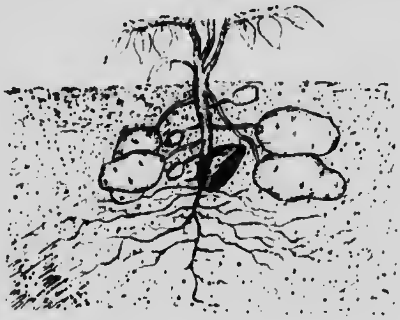


Fig. 10. Showing the tubers arising from the stem and quite distinct from the roots of the potato plant.

This main root, which you noticed in the clover or burdock is called the primary root. The smaller roots growing from the primary root are called secondary roots These in turn may branch, producing third or tertiary roots, and so on until the whole root system of the plant is formed. When the primary root is very much larger than the secondary roots, as we have already seen in the beet, carrot, turnip, and dandelion, it is called the tap root. In the case of the corn or oat plant, you will not have noticed any primary roots. As a matter of fact, if you were

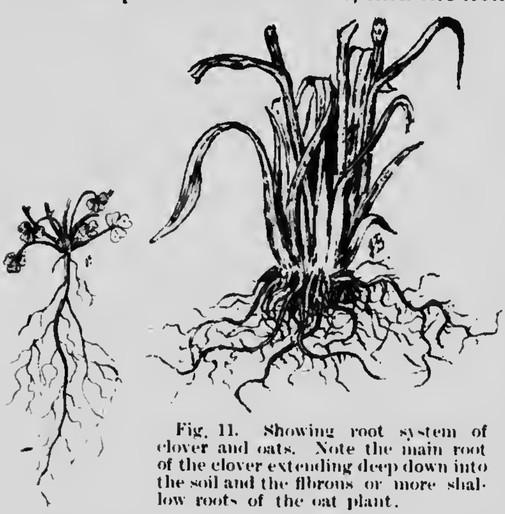


Fig. 11. Showing root system of clover and oats. Note the main root of the clover extending deep down into the soil and the fibrous or more shallow roots of the oat plant.

to notice the very early growth of one of these plants, you would see a primary root which, however, soon disappears and is replaced by secondary roots springing partly from the base of the stem and partly from the lower joints of the stem. These roots are sometimes called adventitious roots.

But not only will you notice differences in the length of roots in different plants, but you will notice differences in the same plants in different soils. Sow some beet seed in a soil that is not deeply loosened up, and notice how much shorter the roots are than those grown from the same kind of seed sown in a deeply-loosened up soil. This shows you why farmers in growing such crops as beets, turnips, and carrots always cultivate and loosen up the soil as deeply as possible.

Fig. 12. Showing adventitious roots of corn.

Again, trace out the roots of a plant, such as grass, grown in a soil that remains wet for a long time in the spring, and then do the same with a similar grass plant grown in a soil that dries out earlier in the spring. You will find that the roots of the grass grown in the drier soil, have extended down much more deeply into the earth. The reason for this is, that roots are no fonder of cold water to live in than you are, and therefore in a cold wet soil have to spread out very near the surface. In the drier soil they strike down deeply. Now watch the effect when the dry summer days come. The plant on the soil that was so wet wilts away, because its roots are all near the surface and cannot reach down to the water below, whereas the plant in the drier soil, unless the weather becomes very hot and dry, can grow easily, because its roots are down deep in the soil near the water that lies there. Do you not see from this one reason for underdraining fields?

Once more, trace out for a little way the roots of a grass grown in what farmers call a rich, mellow soil, and then do the same in a soil that is poor in plant food. You will find that the roots in the rich soil have branched very much more than in the poor soil. This is because of the large amount of plant food in the rich soil. Have you ever seen people trying to make a lawn? If you have, you will have noticed that, in some soils, the grasses remain in separate tufts and do not mat into a good sod. These are the poor soils. But in a rich soil you will have noticed that in a very short time, not more than a year or two a good close sod has formed, on which you can easily play croquet or tennis or other games. This is because the roots have developed so much more thickly in the good soil, and thus have produced a better growth of grass, and have become more closely matted together, making a firmer sod.

Now, we have observed a lot of different things about roots. Let us look a little closer at them and see what we can learn about the way in which they push through the soil, how they hold so firmly to it, and how they absorb water and plant food. You have already discovered how very difficult it is to pull up all the roots of a plant without breaking them. When I tell you that the roots of some clovers have been traced down 30 feet into the earth, and those of some trees 100 feet, you will quickly see that it is not very likely that you have ever seen all the roots of a plant. So if you would know all you could about them, you should grow some plants in your own rooms. Take some bean, pea, radish, or other seeds and place them between folds of moistened black cloth or flannel. Be sure to keep the cloth moist. In a few days the seed will have germinated and the stem and roots will each be an inch or two long. Now notice that, about a quarter of an inch from the tip the root is covered with a fringe of delicate whitish hairs. So delicate are they that if you touch them you will destroy them. These are known as root hairs and they are the feeding organs of roots. It is very difficult to see them in a plant pulled out of the soil, because they have been destroyed by the pulling out. However, if by the greatest care, you can pull out a plant without destroying them you will find these little root hairs near the tips or new parts of all the roots. As the roots grow, the root hairs keep falling off the older parts and new ones grow on the newer parts. Hence you will see that it is at the ends of their roots that plants take in food and water from the soil, and that the older parts merely serve to carry these up to the stem. How many of you have ever watered trees growing on your lawn or in the garden, and in doing so have poured the water just close to the trunk or stem of the tree where the old parts of the roots grow? If you have, do not forget the lesson you have just learned; and the next time you water trees, pour the water a little further away from the stem or the trunk, so that it may quickly soak in to where the tips of the roots are growing.

Fig. 13. Showing root hairs on seedling of a bean plant. (a) natural appearance; (b) some magnified.

Take one of the little bean plants when the root is about ¾ of an inch long, and make small marks upon the root about 1/16 of an inch apart with a pen dipped in India ink. Wrap the bean in damp cotton wool, allowing the marked root to be free. Fill a small bottle with water and place over its mouth a piece of card board with a hole in it. Hang the bean plant through this hole leaving the root free in the water. Allow it to grow in a dark place two or three days. Take it out and notice the position of the marks on the roots. You will find that the marks near the tip are now at unequal and greater distances apart, whereas those farther back are little changed in position. This shows you that the region of growth is near the tip of the root. This is of great importance in the root growth of plants, because it gives the roots the power to push their way in and out among the particles of the soil,

Fig. 14. Showing at (a) the marks on the root of the bean plant. (b) The same marks after 2 days, thus showing the region of growth.

even into the most difficult places. You have noticed that roots are very pliable—easily bent or twisted; in fact, not unlike threador cord. If the region of growth were some distance back from the tip, the root would have the same trouble pushing its way through the soil that you would have if you were to try to thread a small needle by holding the thread two or three inches back from the end. I may also tell you, because you cannot see it without a strong microscope, that each root tip has a sort of cap or cushion of cells which protects the true living part of the root in its act of pushing in and out among the particles of soil. Thus, you see, the little roots by being so pliable, by having their growing regions so near the tip, and by having these protecting caps, are well fitted for growing in the soil. If you carefully lift a young wheat or other plant from the dry earth, you will notice that each rootlet is coated with particles of soil. These stick closely to the root, and it takes much shaking, and even washing, to remove all of them. Thus you see how closely roots, by means of their fibrous branches and root hairs, come into contact with the particles of the soil in which they grow, and hence they have every chance to get all the food the soil can give them, and, besides, become so securely fastened in place that it is almost impossible to pull some plants out of the earth. You remember that in the very first part of our story we wondered why roots should be so different from leaves, which are also feeding organs of plants. You see now that if roots were shaped like leaves they could never hold so closely to the particles of the soil.

Fig. 15. Showing the protecting cap of a root.

Fig. 16. A young seedling wheat plant pulled out of dry earth to show how intimately the roots come in contact with the particles of soil.

Roots are certainly wonderfully adapted to their life in the soil, and, although there are many other interesting things you might learn about them, yet I think you have learned enough this time to make you take a greater interest in even such things as roots; and, I hope also, to make you take a greater interest in the way in which farmers prepare the soil for the roots to grow in.

THE STORY OF A GRAIN OF WHEAT.

C. A. Zavitz, B.S.A.

A grain of wheat is very small. It is much smaller than the smallest clay marble that I ever made or that I ever saw. In fact it is so small that a little ant is able to carry it from one place to another. Boys and girls greatly enjoy making clay marbles. They can become very much interested also in trying to make grains of wheat out of clay and water. Even with the greatest of care and the best of success, however, only artificial grains of wheat can be made in this way. No person, either young or old, can make a real grain of wheat; yet a real wheat grain is of much greater value and is of far greater interest for the boys and the girls to examine and to study than even the prettiest artificial grain of wheat which was ever made. Allow me to tell you a few of the many interesting things about a genuine living grain of wheat.

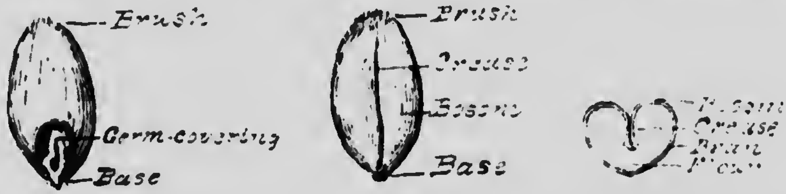
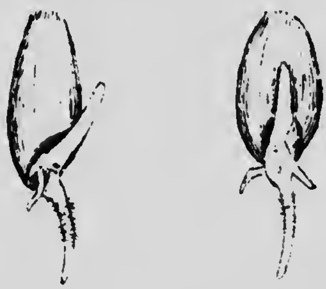


Fig. 17. Back view. Front view. Cross section.

An average grain of wheat is about one-quarter of an inch in length, and one-half as wide as it is long. The hairy end is known as the brush and the opposite end is usually called the base. Along the front side is a well defined crease or furrow extending the entire length of the grain. This crease should be narrow and not very deep. The portion on either side of the crease is called the bosom, which should be large, plump, and rather smooth. The backs of some grains are curved and those of others are actually humped Most grains have a slightly wavy appearance along the central part of the back, but some are so plump that the wavy appearance is scarcely noticeable. There is still another part to be mentioned, and that is the rough portion near the base and at the back of the grain. This is the covering to the embryo, or germ, or seed proper. The embryo itself can be readily examined if you first soak the grain of wheat in water for about a day, and then carefully remove this covering. A grain of wheat is made up of three principal parts,— the bran, or skin; the endosperm, or flour; and the embryo, or germ. The grain should be plump, the skin thin and nearly smooth, and the germ fairly prominent.



Side view. Back view.

Fig. 18. Grain of wheat sprouting, four days in ground.

The great difference between a grain of wheat and a marble of clay lies in the fact that the former has life, and the latter has no life. Nothing can be done to induce a marble to grow. This is not so with a grain of wheat. As long as it is kept in a dry condition, it is simply sleeping. When it is placed in the ground at the right season of the year and surrounded with the proper amount of moisture, heat, and air, it soon awakens. A great change takes place in a very short time. The grain

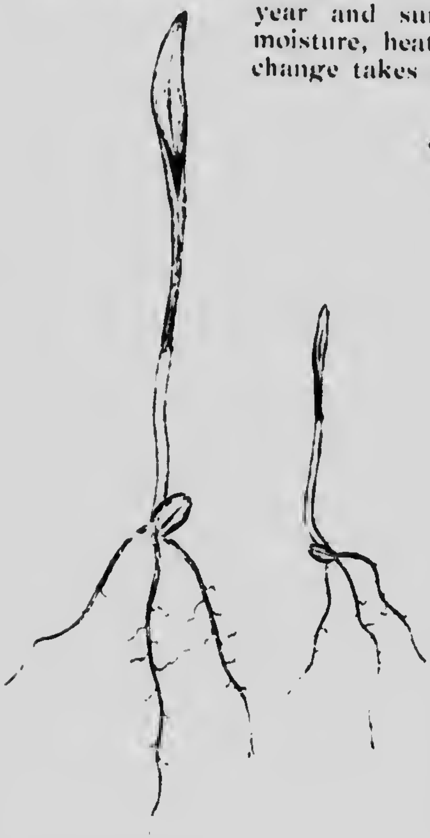


Fig. 19. Plants produced from grains of wheat of different sizes, nine days after planting.

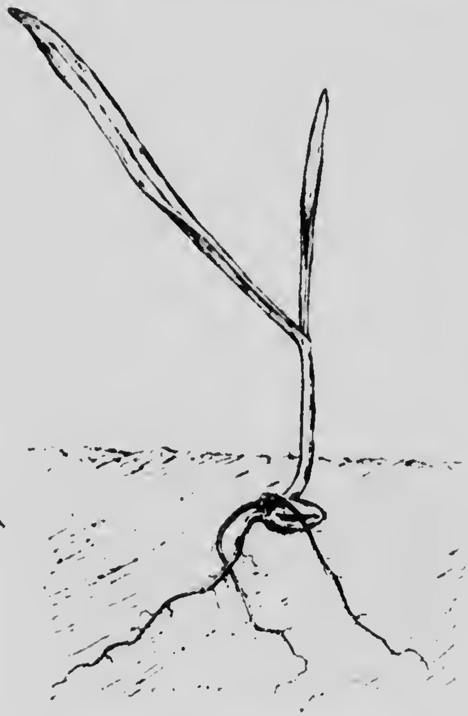
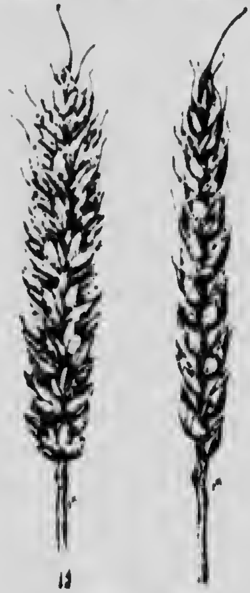


Fig. 20. Young plant of wheat, thirteen days after planting.

absorbs water, the embryo swells and begins to grow, and in a few days a young plant is produced.

The little plant at first obtains its food from the starchy part of the grain. As soon, however, as it sends its roots into the soil and its leaves into the air, it obtains its food from outside sources. The little, fibrous roots get food from the soil in the form of liquids, and the green leaves get food from the air in the form of gases. With the proper conditions, the plant makes a wonderful growth ; and, as time passes, we observe the formation of several long, slender, upright stems, with a very interesting and peculiarly arranged head on the top of each.

An average head of wheat is about three and a half inches in length. It is made up of a large number of spikelets which are arranged alternately along the stalk. Each spikelet usually contains three flowers. The flower is small and is enclosed by two glumes, which afterwards form the chaff. These glumes are sometimes blunt and sometimes elongated into awns or beards. The very interesting little flower, therefore, cannot be seen except by opening up the glumes, which



Front view. Side view.

Fig. 21. Head of wheat, natural size.

Fig. 22. Spikelet of wheat. Wheat flower.

can be readily done by means of a sharp knife or a pin. A small magnifying glass will greatly help in examining the various parts of the flower. The flower produces the seed which at first is very small, but which grows rapidly and ripens in three or four weeks after the formation of the flower.

As the grain ripens, the leaves turn brown and wither, the stems or straws change to a green or lightish yellow color, and the glumes become dry and harsh. From the one seed which was planted, we have obtained a well ripened plant, which is ready to be cut, harvested, and threshed, and will furnish us with straw, chaff, and grain, all of which are useful.

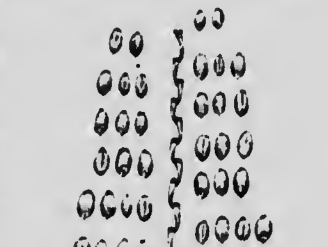


Fig. 23. A head of wheat divided into three parts: (a) the grains; (b) the chaff, and (c) the centre stem.

I have touched on only a few of the points in connection with the life history of the wheat. The germination of the seed; the feeding of the plant; the growth of the leaf, the stem, and the head; the arrangement of the flower; the production of the grain, – are all subjects which are very interesting and worthy of a person's close attention and careful study.

In view of the importance of the wheat crop, a large amount of experimental work has been done at the Ontario Agricultural College in order to glean information which may be of value in increasing both the yield and the quality of the wheat of Ontario. The results of these experiments have been published in bulletins which have been distributed among the farmers from time to time. Upwards of 300 varieties of wheat have been grown side by side on the College plots. These varieties possess many variations, and may be classified according to the time of sowing, as fall and spring; according to the structure of the chaff, as bearded and bald; according to the composition of the grain, as hard and soft; and according to the color of the grain, as red and white. There are other classifications also, but the ones here mentioned are the most common. Certain varieties of wheat are particularly well adapted for special purposes; some for the production of bre . others for macaro .i, and still others for pastry, biscuits, breakfast foods, etc. For making flour, both the red wheats and the white wheats are used; but for the other three purposes, the white wheats are used almost entirely.

For the very best results in crop production, a selection of the most desirable plants from a field of the best variety of wheat should be made. From the grain obtained from these plants, none but the fully-developed, well matured, plump, sound grains should be used for sowin , with the object of producing grain of high quality to be used f ed in the following year.

As we grasp the meaning of the little verse

"Little drops of water,
Little grains of sand,
Make the mighty ocean
And the beauteous land,"

we can better realize how it is that the little grains of wheat make up the world's production or about two and a half billion bushels, or of Ontario's production of about twenty-five million bushels annually.

Let no one despise the little grain of wheat, but rather let everyone give honour where honour is due, and gladly acknowledge its high position in the vegetable world.

THE STORY OF A LOAF OF BREAD.

PROFESSOR ROBERT HARCOURT.

Every one has seen and handled a grain of wheat. Each little grain is a store-house filled as full as it can be. In each of these little store-houses is everything that is needed to make our bodies grow. Some parts are useful in making bone, some in forming flesh, and some in forming fat, while others are useful in keeping up the heat of the body, and in giving us power to walk and run. Each grain of wheat contains everything that is necessary for all these different purposes. This is one reason why wheat is worth so much money and why we grow so much of it. The people over in England do not grow enough wheat for their own use ; so we grow some for them and send it across the ocean in big shiploads

While we use a large amount of wheat, we do not like to eat it until it has been ground and made into flour. Long ago, when people first began to grind wheat, they crushed it between any two flat stones that happened to be near at hand. A little latter they kept two flat stones specially for the purpose, one of which was fixed in the ground while the other was turned on it Methods of grinding in pioneer days are illustrated in Fig. 30. When treadmills, windmills, and, later, water-wheels came into use, the grinding was done at mills by men who understood how it should be done. But in all these ways of grinding, all the different parts of the wheat were left together in the flour. Later, the millers found a method of sifting out the coarser parts.

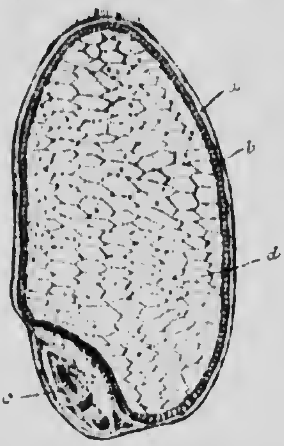


Fig. 21. Longitudinal section of wheat grain. (a) outer coverings ; (b) aleurone cells ; (c) germ ; d Endosperm, the part of the wheat from which the flour is made.

The grinding of the grain and the sifting of the flour have gradually been improved, until to-day we have mills covering acres of ground, and making thousands of barrels of flour each day. In these mills, they are able to separate the different parts of the wheat, and can make ever so many different grades of flour.

You naturally ask : What is the difference between their various grades of flour ? Are they not all made from the same wheat ? Yes, they are ; but to understand the difference, we shall have to learn something about the different parts of a wheat grain. If we cut a wheat grain through from end to end, and place it, properly prepared, under a microscope, which is a wonderful instrument that makes things look larger than they really are, we shall see something like that shown in Fig. 24. If we were to cut the wheat crosswise, it would appear as in Fig. 25.

Around the outside of the grain, as you see in the picture, there are several thin coverings. Underneath these, there is a row of cells tightly packed together, called the *aleurone* cells. These outer layers and the row of cells taken together form the greater part of the bran. The little egg-shaped part at the bottom of the first picture is the germ from which the sprout starts when the grain commences to grow. The remainder of the grain, known as the *Endosperm*, is made up largely of starch and gluten. From a miller's standpoint, this part of the grain is by far the

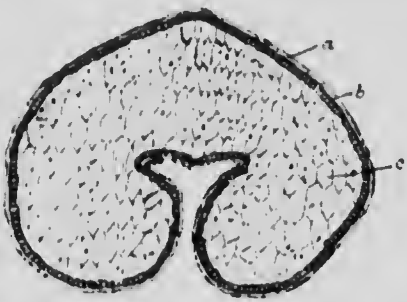
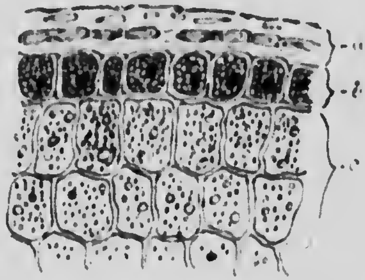


Fig. 25. Cross section of a grain of wheat : (a) outer coverings ; (b) Aleurone cells ; (c) Endosperm, the part of the wheat from which the flour is made.



A part of the section more highly magnified

most important ; for the object of milling is to separate the endosperm from the rest of the grain and grind it to flour.

In the roller-process mills of to-day, the wheat usually passes through six pairs of rollers before the grinding is completed. In the first, the miller seeks just to break the grain into pieces. After sifting, the coarse parts, called the "tailings", are passed on to the next pair of rollers, where they are flattened, and some of the floury substance ground off of them. This is also sifted, and the tailings passed on to the next rollers where the flour is removed. After the wheat has passed through all the rollers in this way, the flattened pieces are almost entirely free from flour, and are classed as bran. Figure 26 is a picture of a piece or "*scale*" *of bran.* In all such methods of grinding wheat, the centre part is rubbed off first ; and, being free from bran particles, it makes very white flour. This forms the grade of flour known as "patent." That got by grinding closer to the bran is known as the "baker's" grades. Still closer grinding forms the low grades of flour. Generally speaking, the more bran particles there are in the flour, the lower it is graded. The outer part of the wheat, nearly all of which goes into the bran, contains much more bone making material than the flour. Because of this, some say that the "patent" and "baker's" grades of flour are not so good as the flour made by the old stone process The Graham flour is supposed to be all of the

Fig. 26. A cross section of a piece of bran : (a) outer covering of the wheat ; (b) aleurone cells ; (c) endosperm. Notice that the endosperm has not been all ground off from the bran.

wheat ground into flour; but it is hard to grind the bran so fine that it will not have a bad effect on man's digestive system. To overcome this, there has been invented a machine which peels off the outer coat of the wheat grain. The remainder is ground, and is known as "entire wheat flour." Such flour is always dark in color, because the gem is ground with it; but it contains more bone and fat producing material than flour made in any other way.

It is very difficult to determine the exact quality of a flour; but there are certain general rules by which a good bread flour may be judged quickly. It should be white with a faint yellow tinge, and it should fall loosely apart in the hand after being pressed. When put between the teeth, it should "crunch" a little; or when rubbed between the fingers, it should be slightly gritty. As flour is prepared, possibly there is no one point which determines its quality so much as the amount of gluten it contains. Some one asks: "What is gluten?" Have you ever made

3 2 1

Fig. 27.—Loaves of bread made from equal weights of flour: 1. From Manitoba wheat; 2. From Wild Goose wheat; 3. From Michigan Amber wheat.

gum by chewing wheat? Nearly all children in the country h e. The gummy part is gluten. If you have ever tried to make gum from oats, barley, or corn, you have failed; because these grains do not contain gluten. It is because wheat contains this substance that it is so much used for bread-making. If you take a little flour and add enough water to make it into a stiff dough, and allow it to stand for an hour, and then take it between your fingers and knead it in water, you will see the water get white with the starch that is separating from the dough. Continue the washing until the starch is all removed. What remains is gluten. Notice how tough and elastic it i

Some varieties of wheat contain more gluten than others. There is also a great difference in the quality of glutens: some are tough and can be pulled out like a piece of rubber; others are soft and break when pulled. The wheat which contains the most gluten of a good, tough elastic quality, will make the best flour for bread-making. For this reason, what are known as Spring Wheats are usually better than those known as Fall Wheats. To illustrate this point, flour was made from three kinds of wheat—Michigan Amber, one of our best winter varieties; Wild Goose, a very hard Spring variety; and Manitoba, No. I, hard. These flours were made into bread and a loaf of each lot was photographed. The same weight of flour was used for each loaf. Fig. 27 shows the difference in size of the loaves. Manitoba flour made the largest loaf, because it contained more and better gluten than the others. Millers call a flour which contains good gluten, "strong," and one that contains poor gluten, "weak."

Fig. 28.—Loaf of bread made from normal flour from which part of the gluten had been removed. Note the big cracks up through the loaf, from which the gases escaped without causing the dough to rise.

Now that we have learned something about flour, let us see if we can learn something about the changes that take place when it is made into bread. If you have ever tried to wet flour with water, you will have noticed how hard it is to get the flour all wet. That is because the flour is so very fine. One of the main objects of making the flour into bread before it is eaten is to separate these fine particles, so that the digestive fluids of the stomach may more easily mix with them. The baker commences by mixing the flour with water. He also puts in yeast, or something which will produce the same effects, and mixes it all together so thoroughly that the water and yeast come into contact with each little particle of flour. When the paste, or dough, containing yeast, is set in a warm place, the yeast begins to "work," as we say, and the dough to "rise." The yeast causes changes, one of the principal results of which is the production of a gas. This gas, in trying to force its way through the dough, comes into contact with the tough elastic gluten which spreads out and holds the gas in so as to form little bubbles, and thus causes the dough to rise. In

Fig. 29.—Loaf of bread made from normal flour.

this way, the fine particles of flour are separated from one another. The tougher and more elastic the gluten, the better the dough will rise, and the lighter the bread will be. This is where good gluten is valuable.

Take a slice of bread and examine it carefully. Notice the little openings or holes in it. These little holes were formed by the gas being held in by the gluten as just described. If too much yeast is added to the flour, too much gas will form, and the openings will be very large, or the gas may even spread out the gluten so far that the walls of the bubbles will break. If the gluten is all or partly removed from the flour, the dough will not rise, because there is nothing to keep the gas in, and we shall have a loaf like that shown in Fig. 28 and 29.

After the yeast has worked enough, the dough is put into a hot oven. Here the heat kills the yeast and causes the gas to expand and stretch out the walls of the little bubbles, or pockets, which it formed between the particles of dough, and changes some of the water into steam, thus raising the loaf still more. The heat on the outside of the loaf converts some of the starch into *dextrin*, a gummy substance with a sweetish taste. This is why the crust is sweeter and tougher than the centre of the loaf. The harder the loaf is baked, the darker the color, through the changing of some of this dextrin into caramel, which is a form of sugar. Some bakers moisten the top of the loaf with water, or water containing a little sugar, to develop caramel, and to give the loaf a darker and richer color. Both dextrin and caramel are soluble in water; and, therefore, they are easily digested. This explains why the crust of bread and toast are sweeter than the soft interior of the loaf, and also why they are more easily digested.

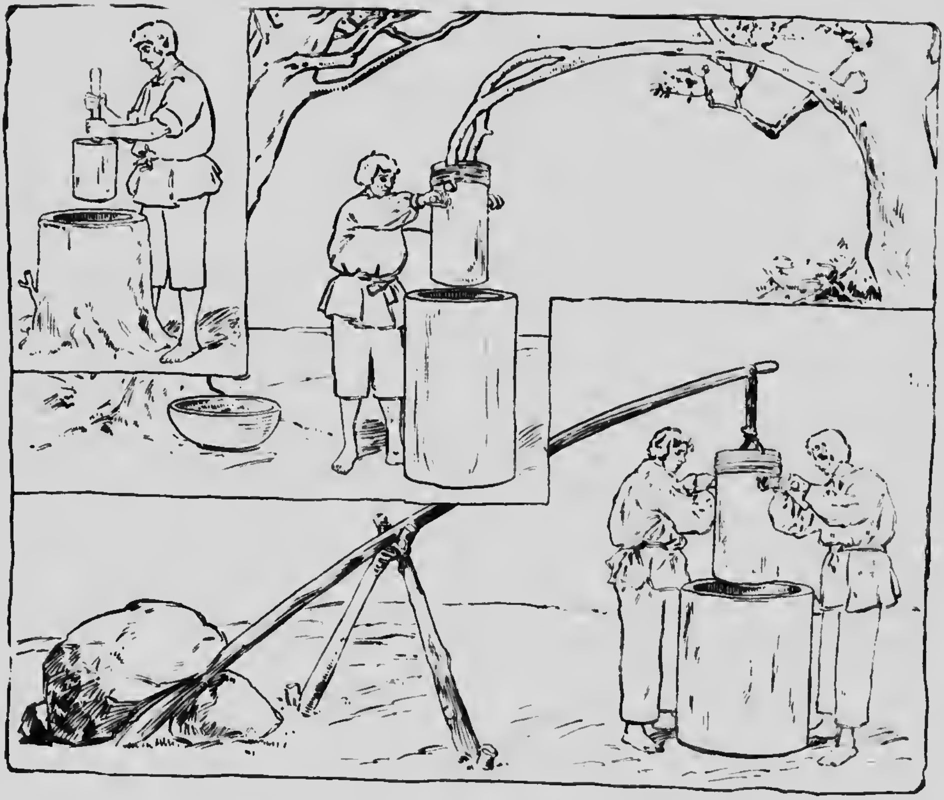


Fig. 30. In Pioneer days.

THE STORY OF THE YEAST PLANT.

PROFESSOR F. C. HARRISON.

We have all heard of yeast, but perhaps, not very many know that yeast is a plant—a very different plant, however, from what we usually see. It has no stems, no leaves, and no roots; it is not even green; it is so small that a single plant cannot be seen by the naked eye. In order to see it, we must use a powerful magnifying instrument, called a microscope. If we examined a yeast plant by means of a microscope, we should see that full grown plants were round, oval, or egg-shaped, and so small that 5,000 of them placed end to end would be about an inch long. Figures 31 and 32 will give some idea of the shape of this plant, and convey a hint as to its size, as the illustrations are photographs of yeast plants magnified 1000 times.

Most of us eat bread every day; but only few of us stop to think that we are indebted to the yeast plant in a large measure for the flavour and digestibility of the "Staff of Life." The baker kneads, or mixes, his flour, water, and yeast and then leaves it in a warm place, which favours the growth of the yeast. In a very short time, the yeast begins to grow by feeding upon the sugar in the flour, and in so doing changes the sugar into alcohol and a gas, commonly called carbonic acid gas, which is familiar to us all in ginger ale and other aerated drinks.

The gas formed from the decomposition of the sugar by the yeast plant in the dough, is unable to get out, owing to the sticky nature of the kneaded flour It is held in small bubbles, the form of which can be seen on looking at a piece of bread, the small holes being the spaces which are made by the gas bubbles in the dough. The heat in the oven acting upon these bubbles causes them to expand, or grow large, and thus pusnes the particles of flour apart, so that the loaf when baked is much larger than the piece of dough before baking.

The alcohol, a liquid formed, as stated above, by the yeast plant acting upon the sugar in the flour, may be smelt, if an opening is made in the dough when it has risen; but most of this substance is evaporated, or driven away, by the heat in baking, and only a very little of it is retained in the bread.

Thus we see that by the action of the yeast the particles of flour are divided and subdivided, giving a large surface for the digestive fluids to act upon when the bread is eaten; and for this reason, bread is more digestible than cakes made with baking powder or sour milk and soda.

The use of yeast for making bread is very old. We know that the Jews were acquainted with the use of "leaven," or yeast; for we read that Lot "did make them a feast and did bake unleavened bread."

And the use of yeast for making wine is even more ancient; for we learn that Noah, the second father of mankind, planted a vineyard and made wine.

The Chinese also knew of the use of yeast for bread and wine making; for about the year 2000 B.C. Ching Noung, a Chinese philosopher, taught the Chinese the art ot husbandry, and the method of making bread from wheat, and wine from rice.

In the process of wine making, the grapes, as soon as they are picked, are carried to a suitable vessel and there pressed. The juice of the grape, called "must," together with the skins, is then placed in a large vat; and the yeasts, which are always present on the surface of ripe fruit, begin to grow, and in their growth produce alcohol and gas. This production of alcohol is called the first fermentation; and when it is nearly over, the wine passes through a strainer into a cask to undergo the second fermentation. This cask fermentation lasts for several months, and during this time flavouring substances are formed which give the aroma, or *bouquet*, to the wine. The high price of certain wines is due to the excellency of their aroma, which is largely a product of the yeast-plant.

Sometimes injurious forms of yeast get into wine, and cause wine diseases. One of the commonest is a yeast-like plant which changes the alcohol into vinegar, and gives the wine a sour, or vinegar, taste.

Cider and perry may be regarded as the wines of those districts in which the grape does not flourish. Cider is the juice of the apple fermented with yeasts that are naturally present on the surface of the fruit, and perry is the fermented juice of the pear.

Barley, yeast, and hops are used in the making of beer. The barley is allowed to germinate, or sprout, in order to change the starch of the kernel of the barley into sugar. This material, extracted by means of hot water, is the food in which the yeast plant grows and produces alcohol and carbonic acid gas.

Fig 31. Full grown yeast plants greatly magnified, the natural size being only one-thousandth-part of the size shown in the figure.

Other substances are used to give flavor to the beer; but the essential part of the maki g is the changing of the sugar solution into alcohol by means of the yeast plant.

Special varieties of yeasts are used to make different kinds of beer, as ale, lager beer, etc.; and, as in the case of wine, disease-producing yeasts very often appear and produce a cloudy, or turbid, liquor, which is disliked by those who use such drinks.

From a study of the changes in bread, wine, etc., we see that the yeast plant, in order to grow, requires a proper supply of food, which should consist of a mixture of nitrogenous substances, a certain amount of carbon (usually supplied in the form of sugar), and also mineral matter. About 20 per cent. of water is also necessary, and a suitable temperature, between 60 and 90 degrees Fahrenheit. If these conditions are present, the yeast-plant is able to live, grow, and produce other yeast-plants.

The yeast plant consists of a single cell, which, at a certain stage, sends out a bud from some part of its surface, which gradually increases in size This bud may or may not remain attached to the parent stem. If it does so, and the old stem continues to send out more buds, a mass of cells is soon formed ; but, if each cell as it grows produces a bud, a long chain of cells is formed.

Under certain conditions (moist surface, plenty of air, favorable temperature, and strong cells), small round bodies from two to eight in number are formed inside the old cell, which are called *spores*. These may remain dormant (that is quiet or asleep) for a considerable length of time, but will germinate when placed in suitable food. They are usually more resistant than the cells in the growing condition. Even the

Fig. 32. A wine yeast, showing spore formation,—magnification, 1 000 diameters. From 2 to 4 spores may be seen in most of the cells.

ordinary cell lives for a considerable length of time when it is kept dry ; and the dry yeast cakes, which are sold for bread-making purposes consist of dried yeast cells mixed with starch or ground corn.

There are several hundred varieties of the yeast plant, possessing different properties, as there are many varieties of apples ; and as some kinds of fruit are better than other kinds, so some varieties of yeast are more suitable for use than others.

Yeasts of different varieties are used in the manufacture of liquors, such as beer, whisky, wine, cider, etc., and any of these yeasts could be used in bread making ; but some would require twelve to fourteen hours to raise the dough to the same extent as another would in seven or eight hours. Figure 33 shows that some varieties of yeast produce more gas than others. Thus, the variety in number 1 tube would be more valuable for a baker than the one in number 3 tube, because it produces more gas; but this variety would not be suitable for other purposes,—say for the manufacture of wine.

In the same way, a yeast used for the making of champagne would not be suitable for making beer; and such is the influence of the yeast on the flavour of the product, that very good imitations of certain wines may be made by growing in apple juice the yeast taken from the wine.

1 2 3

Fig. 33, Fermentation tubes containing flour and water
1. With addition of a distillery yeast.
2. " " brewery yeast.
3. " " dried cake yeast.
Note, in the right arms of the tubes, that there is more gas in 1 than in the others, showing the more energetic working of the distillery yeast. For the same reason, there is more gas in 2 than in 3.

The injurious yeasts are also quite numerous. Besides those we have already spoken of, we might mention those that produce bitterness, not only in wine, but occasionally in milk and cheese. These yeasts grow in milk, feeding upon the milk sugar, changing it into other compounds, and giving rise to an unpleasant bitter taste, which affects, not only the milk, but the cheese made from it.

THE STORY OF A POUND OF BUTTER.

PROFESSOR H. H. DEAN.

Mrs. Boss and her neighbors agreed to hold meetings throughout the winter, when not busy. They also decided to discuss buttermaking at the first meeting, and this is what a m[illegible] understands cow talk heard them saying :

MEETING No. 1. The first to speak was Mrs. Brindle. She said that it was her candid opinion that all his talk about "pedigrees" and "butter-blood" did not amount to very much. She thought that if her owner would look around he could find, among her friends plenty of good cows for making butter, which had not any papers to show their breeding. For her part, she considered that blood was of no account. What she wanted was a cow that could *do* something.

Fig. 34. Holstein.

Mrs. Black - and - White, known in higher cow circles by the name of Mrs. Holstein-Friesian, or Mrs. Holstein for short, said she considered that it was better to give a large flow of milk, so as to have plenty of skim-milk for the calves and pigs, as well as what is used for buttermaking.

Some of the other cows thought that there was too much to handle to get a pound of butter from such milk. Mrs. Canadian said that some poor farmers could not raise enough feed to satisfy the appetite of the previous speaker, and she believed that a small cow, which is a small eater, is best for a poor man.

Fig. 35. Shorthorn.

Mrs. Shorthorn, who also belongs to the high class in cow society, argued in favor of the cow that gives milk to drink, and butter to eat ; and if not satisfied with that, her owner could turn her into beef. Some of the members remarked that combined machines never work so well as special ones.

Mrs. Ayrshire said that, as the discussion was on butter-making, she had little to say, though some of her relations were just as good for butter as any cows.

Miss Jersey and Miss Guernsey both spoke at once, and stated most positively that milk rich in fat could be most profitably turned into butter. Such milk made butter with the golden color, and the firm texture in hot weather. They also said that it did not cost the owner so much for the feed to make a pound of butter, and pointed to "official tests" to prove their statements.

Fig. 36. –Jersey.

At this point the other cows began chewing their cuds so vigorously that it was thought advisable to adjourn the meeting.

No. 2 At the next meeting, it was resolved to discuss "feeding for butter," and the only speaker on this occassion was Old Mrs. Lineback, who had many years of experience "browsing" and running around straw-stacks in winter, and eating in fence corners and along dusty road-sides in summer. She had also tried these new-fangled feeds, called silage, gluten meal, cotton-seed meal, and the like, but her experience was that there was nothing equal to good, sweet June grass for making butter. When the grass is short and somewhat dry, she advised feeding green peas and oats, or a small quantity of sweet silage, together with bran and oats. In winter, clover hay, sweet silage, mangels, bran, oats, and peas make excellent foods for producing butter. She would also emphasize the importance of plenty of pure water and salt as aids to digestion, and necessary for a good flow of milk.

With these statements, all agreed, and there was no further discussion.

No. 3. – The third meeting was a sort of "indignation meeting." The chief speakers on this occasion were Miss Jersey and Miss Guernsey. They both protested against being awakened from a pleasant nap at half-past four on a winter morning. So far as they were concerned, they did not see any reason for their owner waking his wife and children from a sound sleep at that hour, then tramping to the stable with a lantern, whose bright light hurt their eyes very much, and *they were sure it was spoiling their beauty*. They would much prefer having their owner not awaken them before daylight, as they did not believe it wise to be eating in the dark when they could not see what was going into their mouths. The quantity

Fig. 37. Guernsey.

of milk in their udders never hurt them, if it was a little longer time between night's and morning's milking. They had also observed that whenever the Hired Man had to attend to them and do the milking at five o'clock in the morning, he was usually in a bad temper. He pinched their teats, and sometimes hit them with the stool, which made them feel cross and they did not give so much milk, nor did they put so much fat into it. Mrs. Holstein and Mrs. Ayrshire said, in their case if they were not milked at regular hours and the same number of hours apart, that the milk in their udders hurt them, and they would enter a strong protest against the views expressed by the previous speakers. When, however, they gave less than two gallons of milk a day, they said it did not make so much difference to them about milking exactly the same number of hours apart

FIG. 38.—Ayrshire.

Mrs. Tidy-Cow said she would like to make a very strong complaint against being milked in stables where the air was foul, where she could not keep herself clean, and against owners who made no effort to improve the cow-houses in winter. She had found that it was better for the person, when milking, to wipe the udder and teats with a clean, damp cloth, before commencing to milk, and to milk with dry hands especially in winter. She believed in milking quickly, milking out clean, and kind treatment at all times, especially while milking, as this caused the cow to give more milk.

Mrs. Cow-Curious would like to see a milk-sheet, scale, and test-bottle in every stable, so that she could see what her neighbors were doing.

All agreed that it would be excellent, if each one could know how much milk and butter her neighbors gave in a year. Now that their curiosity was aroused, it was resolved to find out how their milk was made into butter; and, if at all possible, they would go into their owner's dairy, and watch operations.

FIG. 39.—Cream Strainer.

No. 4. -The next meeting was held in Mrs. Busy's dairy, soon after milking As there were no chairs suitable for the guests, each one stood on the floor of the dairy, being careful not to get in the way. It was also agreed that they talk very little during the visit to the dairy, but keep their eyes open and see what was done with the milk which was to be made into butter.

They observed that the first thing which Mrs. Busy did was to strain the milk through two or three thicknesses of cheese cloth and a fine wire strainer, to remove any dirt that might be in the milk.

Some of Mrs. Busy's customers, it was explained to the visitors, liked butter made from cream set in shallow pans, some liked it made from cream raised on deep cans set in ice water, and some would have nothing but separator butter. So all three methods were in use. Mrs. Boss and her neighbors noticed that the milk from Miss Jersey, Miss Guernsey, and Mrs. Canadian were set in shallow pans and deep cans, because the milk from these contained fat in the form of good-sized globules (balls) which rise readily. The milk from the others was all run through the separator, which is a machine with a bowl that revolves very fast, producing centrifugal (flying from the centre) force. The heavier skim-milk is forced to the outside of the bowl, and the lighter cream comes towards the centre. The sweet warm skim-milk is fed to calves and pigs, and the cream is put in a can to ripen (sour), after being cooled to 65 degrees. The visitors noticed that some sour milk (culture) of good flavor was added to the cream, which was for the purpose of producing good flavor in the butter, especially in winter. The cream was then put into a moderately warm place until next day, when it would be ripe and ready to churn.

In the meantime, their owner's daughter, Miss Busy, had washed the separator and the milk pails, and everything was in nice order for the day.

After apologizing for the tracks made on the floor of the dairy, Mrs. Boss and her neighbors went back to the stable, having learned a great deal.

As they were leaving the dairy, Mrs. Ayrshire became excited and switched her tail into the cream can, for which breach of good manners Miss Jersey and Miss Guernsey gave her a very severe look which almost made her horns turn down.

No. 5.—As soon as the morning work was done at the farm house, the churning completed and the butter from the separator cream was ready for market, Mrs. Busy went to the cow-house to finish her explanations; because, as she said, she never could churn and get the butter ready to go to market in time when she had a lot of visitors. Besides, visitors were a nuisance in the dairy, for they were always in the road and were poking their noses into everything.

She began by saying that the milk set in shallow pans must be kept *cool*, and be set in a clean dry cellar, or milk-house, where no bad flavors can get into the cream. In twenty-four hours in summer, and thirty-six to forty-eight in winter, the pans are ready to cream (skim). This is done by running a thin-bladed knife around the edge of the pan to loosen the cream. (Mrs. Line-Back said she had always seen this done with a finger. Mrs. Busy explained that this was not a very clean way to loosen the cream, and that a knife was much better.) The cream is then held back with the knife to allow some skim-milk to moisten the edge of the pan, which prevents the cream sticking to the tin. The cream is then guided into the cream-can with as little skim-milk as possible.

(At this point, Mrs. Brindle interrupted to say that she had always hea· of a strainer skimmer being used for taking cream from pans, but sh ·ould see now that it caused a waste of the cream and was not good ·tice. "We are always learning!"). The shallow pan cream is then ·et in a cool place until there is sufficient for a churning, when it is brought near the stove to ripen (sour) for twenty-four hours.

Cream on deep cans (Creamers) may be removed from either the top or the bottom of the cans. The milk should be set for 12 to 24 hours in summer, and 24 to 36 in winter for the cream to rise on milk set ·leep cans. Mrs. Busy also explained that it is necessary to cool the milk as rapidly as possible to 40 degrees, or not more than 45 degrees as soon as convenient after mi king, by using ice in the water. And, by the way, she said that every person who makes butter should use, not their finger, but a good glass thermometer to find the temperature. The cream is kept in a cool place; and, when there is enough for a churning, it is warmed and ripened in the same way as cream from shallow pans.

Fig. 4— Thermometer.

The ripening (or souring) of ·ream is a very important point, as this largely decides the flavor of the butter. The ripening is caused by very small plants (called bacteria) which grow in the cream. It is important to have the right kind of bacteria seed to put into the cream, so as to get proper plants and proper flavor.

Good seed may be bought, or it may drop into the cream from the air. It is best to buy the seed in pure form at first, then grow the plants in pure skim-milk. Add some of this to the cream at each churning, but keep some to put into fresh skim-milk each time. This you must know is the great secret of nice flavor in butter.

(Mrs Brindle said to her neighbor that she did not take much stock in the "seed" business. She had observed that at most of the places where she had been, the farmer's wife just let the cream take "pot-luck," and most of the time the butter could be eaten; and, if it couldn't, her owner could always trade it at the store for crackers and tobacco.)

Mrs. Busy did not take much notice of this talk of Mrs. Brindle's but went on to explain how to tell when cream is ripe. She said: Use your eyes, and see if it is thick, glossy, and velvety in appearance; use your tongue, and if it tastes slightly sour, it is ripe. Use your nose, and, if it smells pleasant, it is ready to churn.

Churn rich separator cream at a temperature of about 50° to 52° in summer, and 52° to 56° in winter. Cream from cans and pans should be from four to eight degrees warmer than separator cream as a rule.

We must leave the talk about churning until next day, as I hear Tommy calling for his mother.

No 6.—Quietness reigned in the stable next day when Mrs. Busy continued her story of a pound of butter:

The best churn is a simple box or barrel, which is easily kept clean. These new style air-churns and churns with patent dashers are no improvement. First, scald the churn to fill the pores of the wood with water, to prevent cream and butter sticking to it, and then cool with cold water. The cream should be strained through a coarse strainer into the churn to prevent "specks" in the butter. If coloring is used, put it into the cream at this stage. Close the lid firmly and turn the churn at the rate of 60 or 70 turns per minute. Allow the gas to escape through the opening at the bottom of a barrel or box churn for a few times during the first ten minutes. Continue churning until the butter is the size of wheat-grains; then draw the buttermilk off through a strainer.

(Mrs. Boss remarked to a neighbor that she had always seen the butter churned into a lump, or until the dasher would stand on top of the butter, before taking the buter out of the buttermilk in the old dash churn.)

When the butter will not "come," said their Instructor, it is chiefly because the temperature or heat is not right. Cream which is difficult to churn will nearly always "come" after warming to 70° or 74° and churning for half an hour.

After the churning is done, add as much water at a temperature of 45° to 50° in summer, and 55° to 60° in winter, as there was cream at the beginning. Then revolve the churn rapidly for about two minutes and draw off the water. Allow the butter to drain for 10 to 15 minutes; then add fine butter salt at the rate of about one ounce of salt to a pound of butter in the churn; or remove the butter to a lever worker and add the salt. Work the butter gently with a downward pressure, until it is free from moisture on the outside, until it is close in appearance, and until the salt is all dissolved. I wish, said Mrs. Busy, to impress upon you the importance of preparing the butter for market in a neat and attractive manner. Use a wooden printer to mould the butter into oblong prints, weighing one full pound, or a little over, then wrap them in parchment paper, having the name of the dairy neatly printed on the wrapper. Put the butter in a cold place, and send to market once a week in a neat shipping box. In summer, use ice in the shipping box to keep the butter firm. Always send the butter to market with the best looking and neatest person on the farm. *Send none but the finest butter to regular customers, and be very careful of your reputation,* were the last words of the teacher.

No. 7. To-day we shall try to learn what it is that makes good butter, said Mrs. Busy in her last talk. *Flavor* is the most important thing in good butter. Cream which is kept too long (more than three or four days) before churning makes butter which has an "old" flavor. The food which a cow eats also affects the flavor of the butter. Turnips, brewer's grains, decayed silage, and some weeds always taint butter Butter with good flavor should have a pleasant, sweet taste and smell, and should make the person eating it wish for more.

The next point is the grain, or texture, which should not be too hard, nor yet too soft or greasy, or salvy. Butter should spread nicely on bread, and then it is nearly perfect in texture. The color should be even —free from "mottles," white waves, or streaks. Streaks in butter are caused by improper working. It should not be too yellow, nor yet too white for home markets.

The amount of salt in butter should be according to the taste; but it must all be dissolved, and the butter must not be "gritty." This grittiness is caused by using too much salt or by using coarse salt.

The package should be neat, attractive, and stylish, so as to please the eye of the customer.

Such butter will be eaten much more readily than poor butter; and we wish people to eat as much as possible, you know, said Mrs. Busy.

Clean, sweet butter is one of the most easily digested fatty foods, and all persons should have plenty of good butter on their tables.

This finishes our lesson on a pound of butter, and I hope that you now know something about how butter is made, and that you will take more interest in your business of making milk for butter.

Mrs. Boss and all her friends bawled their thanks of appreciation for the instruction given All were of the opinion that if owners of cows would take more interest in them, talk to them as friends, share their secrets with them, and give them more encouragement, as well as more to eat, cows would give more milk, which would make more butter, which would bring more money, which would enable boys and girls to have a greater number of nice things in the home on the farm.

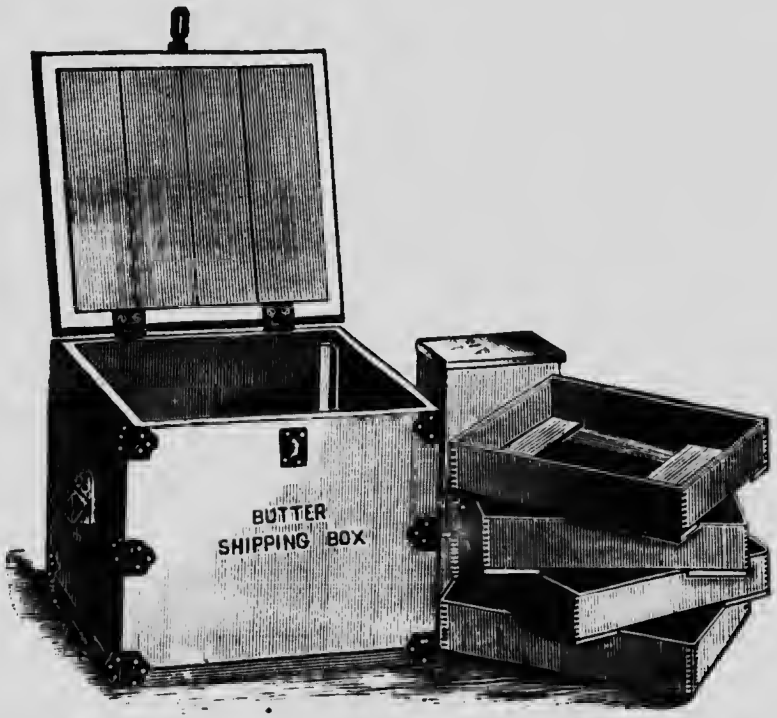


Fig. 41.—Shipping Box for Butter.

THE STORY OF THE CABBAGE BUTTERFLY.

PROFESSOR W. LOCHHEAD.

HE White Cabbage Butterflies can be seen almost any fine day in summer flitting about the cabbages in the garden, and among the wayside flowers. Although harmless, they are not liked by farmers and gardeners, because they are the parents of the common green "worms" which do much harm to cabbages by eating holes in their leaves.

It seems strange that a green, crawling cabbage worm should grow into a dainty, white-winged butterfly; and it is the object of this story to tell, in a simple way, the strange life of this insect. It must be remembered, however, that the life stories of all insects are not alike. Some insects spend their whole life above ground; some partly below ground and partly above; some almost altogether in water; some partly in the water and partly in the air; some eat their food while others suck up their food as a liquid; some spend part of their life as a crawling caterpillar, while others have no such stage. So varied are the habits of insects that a noted writer once said:—"Insects walk, run, and jump with the quadrupeds, fly with the birds, glide with the serpents, and swim with the fish."

Fig. 42 The boy and the insect.

It would be interesting work to find examples of many of the insects to which this writer referred, and to study their habits; but this story must deal with the White Cabbage Butterfly.

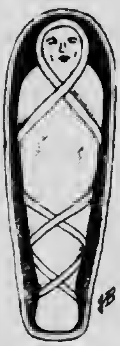


Fig. 43 Egyptian Mummy in its case.

The ancient Egyptians had a strange custom of embalming their dead, and wrapping them in linen bandages. These mummies, as they are called, were placed in curiously wrought cases, and stored carefully away in secret tombs or pits, in the belief that after a time life would return to them.

Now we have creatures which nature changes into *living mummies* for five or six months in the year; and living mummies ought to be more interesting than dead ones. These may be seen at any time during the winter if a little search be made for them under fence-rails, under the eaves of outbuildings, and in other sheltered places. I mean the pupae, or resting forms, of insects. But the particular mummies to which I shall refer are the chrysalids (Fig. 44) of the White

Cabbage Butterfly, which are usually abundant in late autumn on fences about cabbage gardens and turnip fields If one of these chrysalids be examined, it will be seen how carefully the tongue, feelers, and legs are folded over the breast and tightly packed together within its "mummy" case.

But of all the chrysalids which are alive in the fall, only a few are living in the spring. For many years observers have noted this fact, and my custom has been to prove it for myself every spring My walk this March afternoon was back along the farm lane, where I have always found chrysalids in early spring. I knew exactly where to look for them, for I had watched the full-grown caterpillars, or "worms," last autumn leave the cabbage, turnip, and rape plants upon which they had been feeding, crawl up the posts of the wire fence to the underside of the capping board, and change to mummy-like chrysalids, each securely fastened to the board by a silken pad at its hind end, and by a slender silken band about its middle. I found some of the chrysalids where I had seen them last fall; but a few of these had been killed by the grubs of little four-winged flies that had stealthily placed eggs within the chrysalids before winter set in. The greater number had been snatched away during the winter by birds who had found out their hiding places.

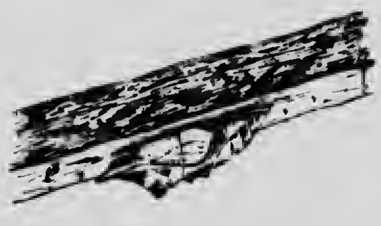


Fig. 44—A Cabbage Butterfly Mummy or Chrysalis slung up to a rail.

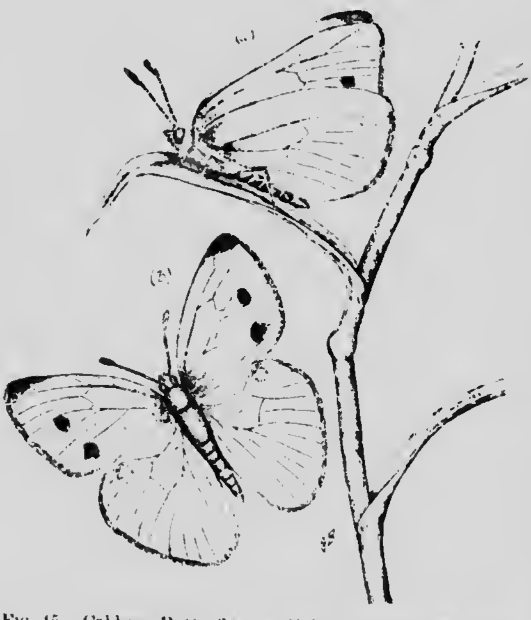


Fig. 45.—Cabbage Butterfly. (a) Male, at rest, wings erect; (b) female.

If one of these chrysalids is brought into a room in early spring, it will not be long before another wonderful change takes place. It will first show slight signs of movement, then its skin will crack open along the back, and soon a white butterfly will come out. At first its body will be soft and weak, and its wings small and shriveled; but in a few hours the body will become firm, and the wings will be filled out and expanded, ready for flight. As soon as the March snows have melted, many of the white butterflies may be seen flying about, lured by the bright sunshine into leaving their comfortable winter-quarters for the warm breezes of early spring. But if cold weather returns again many a poor butterfly is frozen to death. Those that have been made only stiff with cold, the sun's hot rays bring back to life again.

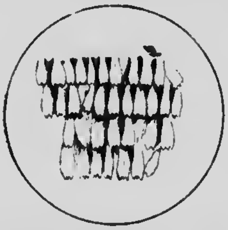


FIG. 46.—Scales on the wing of the Cabbage Butterfly. They overlap like shingles on a roof.

The nature student will observe that all the white Cabbage Butterflies are not marked exactly alike. Some have two black spots just below the middle of each fore-wing, while others have only one. The former are the females, and the latter the males (Fig. 45.) They all have six legs, and four wings covered with very small scales, which brush off readily. Under a microscope these scales can be seen to have the shape and arrangement shown in Fig. 46.

Fig. 47.—An Army-worm Moth at rest, showing the simple feelers, how the wings are folded.

But there are scale-winged insects which are not butterflies; for example, the large army of moths, big and little, which are readily attracted to lights during the late summer months. We can, however, easily tell butterflies from moths in these ways: The wings of butterflies at rest are held erect, while those of moths are folded closely over the back or by the sides; the feelers, or antennæ, of the butterflies are always knobbed at the tip, while those of moths are either simple or feathery; and butterflies fly about during the day, while moths as a rule fly at night or in the dusk. (Fig. 47.)

Like most butterflies, the white Cabbage Butterflies are fond of sipping the honey of flowers; but, unlike many, they show no decided liking for any special color or plant. Some observers are of the opinion that they perhaps visit yellowish-white flowers most frequently, but of this fact we are not absolutely certain. It is always interesting to creep up to a butterfly which is sipping nectar from a flower, and watch it uncoil its long sucking tube and insert it into the corolla. The honey is sucked up through the tube by means of little muscles acting

Fig. 48.—Head of Cabbage Butterfly, showing the sucking tubes coiled in (a) and partly uncoiled in (b).

Fig. 49—The eggs of the Cabbage Butterfly.

on a bulb at its base, just as water is drawn up from a cup into the mouth through a straw. (Fig. 48).

The female Cabbage Butterflies begin laying their pale-yellow eggs about the middle of April on the leaves of Shepherd's Purse, Mustard, and other like plants that have already come up. These eggs are beautiful objects, flask-shaped and ribbed crosswise as well as up and down. We must, however, examine them under a microscope, if we wish to see their extremely delicate beauty. Usually several eggs are laid on the under surface of the leaves in an erect position, but seldom are they in clusters. (Fig. 49).

In about a week tiny green "worms," or caterpillars, hatch from the eggs and begin to nibble at the leaves provided for them by the instinct of the mother butterfly. They eat greedily, and "gorge themselves till they seem near bursting." As a result, their growth is rapid; but as the outer skin cannot stretch enough to allow for the increase in size, the caterpillar must at certain times form a new skin under the old one and throw off the latter. This *moulting*, as it is called, occurs four times in the life of the caterpillar, before it changes into a chrysalis.

How different these caterpillars look from the white butterflies! They have horny biting jaws which work sideways, and eight pairs of legs—not all alike, however, for the last five pairs are more like stubs than legs. Their feelers can scarcely be seen, and wings are altogether wanting. Their bodies are long, and are plainly made up of thirteen segments, or rings.

Fig. 50. Two full grown cabbage worms resting after a good meal.

Reference has already been made to the change from the caterpillar to the chrysalis. The first summer chrysalis stage lasts about twelve days, and a second brood of butterflies appears about the end of June. Eggs are again laid, from which a second brood of caterpillars makes its appearance and feeds on the leaves of cabbages and other allied plants during part of July and August. These change into the second summer chrysalids, from which in twelve days the third brood of butterflies comes out in September. Eggs are again laid, and from these hatch the caterpillars which are usually so abundant in late autumn. These change into the chrysalids which pass the winter under fence-rails and other places.

Quite often in autumn many cabbage-worms appear bloated and sickly. They are sluggish and have no desire to eat. If some of the worms be put into a box and taken home, where they can be easily watched, the cause of the sickness will soon be made out. Small white maggots bore their way out through the skin and settle upon the poor caterpillar, as in Fig. 51; and if these maggots are watched, it will be found that they soon begin to spin silken cocoons about their bodies. The caterpillar has sometimes enough life left to crawl away from its tormentors an inch or two; but usually it dies beside them, and in a day or two no trace of its body can be found. If these cocoons be placed in a box for a few days, small four-winged flies will come out through lid-like openings at the end. These flies are *parasites*. By means of a needle on the hinder end of their body, they pierce the skin of the cabbage worm and lay their eggs within its body; in a short time the eggs hatch small maggots, which grow and feed within the body of their host until they become full grown, when they come out as already described.

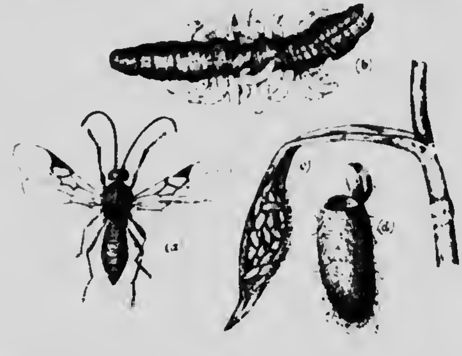


Fig. 51. (a) The 4-winged fly which lays her eggs within cabbage-worms; (b) the maggots coming out of cabbage-worm to spin their cocoons; (c) a mass of cocoons; (d) cocoon enlarged showing how the fly comes out by raising a lid.

Frequently, too, some of the chrysalids, which we find in early spring, are dead and straw-colored. When one is broken open, many little, grayish maggots may be seen to fill up the entire space within; and, if the dead chrysalids are kept in a closed box for a short time, many little bronze-colored flies make their appearance. These flies also are parasites. Their eggs are always laid within the chrysalis case late in the fall, and the maggots which hatch from the eggs feed on the body of the chrysalid. In a short time they are full-grown, and fill up the space occupied by the body.

Fig. 52. The [illegible] and the Boy.

One other thing about this insect may be noted. Its breathing system is made up of tubes which branch through the body and supply air to the colorless blood The openings of the tubes, or breathing pores, can be readily seen with the naked eye along each side of the body in the same line as the yellowish dots (Fig. 50.)

A good practical way of killing cabbage-worms, when they are spoiling the cabbages, is to dust a mixture of one pound of insect powder and five pounds of flour through a cheesecloth bag upon the infested plants. The fine powder of the mixture fills the breathing pores, so that the air cannot get into the interior of the body, and the worm is suffocated

How strange and eventful is the life of this butterfly! *Strange*, because, beginning life as a beautiful egg, which is easily broken, it soon becomes a sixteen-legged worm-like creature, which, after growing and moulting, reaches a certain size; then it changes into a passive body resembling an Egyptian mummy; which after remaining in this state for a definite time, bursts its case, and comes out a dainty, white, four-winged insect, flitting hither and thither among the flowers and sipping their sweets. *Eventful*, because it is ever exposed to danger from the attacks of parasitic insects, birds, and other animals, including man himself, and from the changing conditions of heat and cold, rain, and snow.

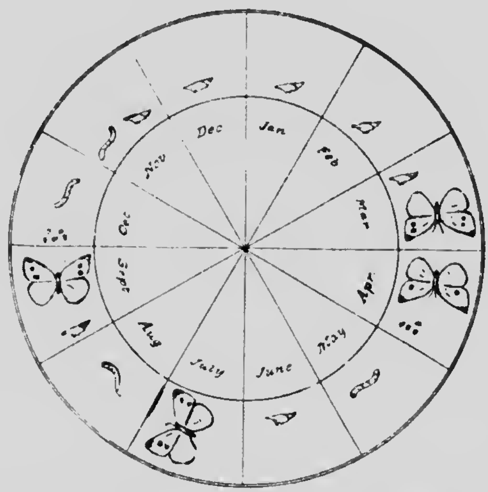


Fig. 53. The story of a cabbage-butterfly for a year. There are three broods or generations.

THE STORY OF THE BEES.

H. R. Rowsome.

Almost every one has, on some drowsy midsummer day, stood before a hive of bees, as close as he dare, and watched with absorbing interest the small portion of their daily toil he was able to see going on around the hive entrance, and has wondered what operations were carried on within that busy community.

If the hive is of a comparatively modern form—one with movable combs set within wooden frames it is an easy and safe matter to open the hive, take out the combs, and watch its inmates by the hour. Bees do not know one person from another, except as one learns their whims in order to deal with them peaceably; they are annoyed by persons standing in *front* of a hive and interfering with their flight to the hive. It is not well to wear wooly or black clothes when among bees, because the hereditary antipathy of bees to the bear is aroused if they catch their hooked feet in wooly clothes or hairy wrists; bears, on their part, keep up their traditions by destroying many telegraph poles in searching for bees' nests, on account of the humming of the wires.

Place a veil of leno over your head, get a bee-keeper's smoker, and puff a few whiffs of smoke in at the entrance to the hive. This drives the sentinels, who are looking for robber bees, into the hive; gently lift up the cover and blow half a dozen puffs over the tops of the frames. The smoke causes the bees to go down into the hive; each one dips head first into a cell and fills herself with honey and is then as good natured as a man after a full dinner. Now with a screw-driver pry a frame loose and lift it out. On a warm day all the combs may be taken out and leaned against the hive. One should be careful not to make rapid movements as if inviting a fight, and should avoid crushing the bees or jarring the hive.

One will first notice that it is at the top of the combs that the honey is placed. This is for the sake of convenience in feeding the brood below just as in a stable, the hay is stored in the loft. Honey, as such, does not exist in flowers but is really *made* by the bees. The bee has a very long under lip of reddish color, which can very readily be seen when in use; and with this she laps up the nectar that is contained in flowers. This nectar passes into a sort of crop and there undergoes a chemical change, which gives it certain medicinal qualities that make it curative of colds. This is honey. The bee gathers a load of twice its own weight. One can easily notice how a loaded bee drops heavily upon the alighting board, almost with a thud, or, missing it, falls into the grass before the hive and pants and struggles for half an hour to reach the hive. Each bee fills one cell at a time The honey, as it is carried into the hive, is nine-tenths water, most of which has to be removed or the honey will sour. The bees accomplish this, especially at night when they cannot work in the field, by standing in rows before the entrance of the hive; and there, in rank after rank all along the bottom board and up on the combs, their heads all pointed towards the interior, with abdomens thrust upwards and feet firmly planted, they go through the motion of flying without stirring from the spot. This forces a strong current of air through the hive, which absorbs the moisture in the honey and carries it outside of the hive. The work is very exhausting, and they work in short relays or shift In this way, if a colony has gathered a hundred pounds of honey in a season, it has also expelled from the hive one or two barrels of water. By this means too, the hive is ventilated and kept cool in very warm weather; but if the entrance is so very small that but little air can be forced in, the bees become discouraged and turn to loafing. The bee is not always an example of industry.

When nectar cannot be obtained bees will suck juice out of fruit. Raspberry juice will show through the bee's abdomen and give it a bright red appearance. Sometimes they gather a very rank liquid from the surface of leaves and grass. It looks like dew, and is called honey-dew. It falls upon the ground, being sprayed into the air by a louse or aphis, —the cow of the ant.

Looking at the comb again, you will notice that just below the honey there are many cells filled with a red or yellow substance. This is pollen, often called bee-bread, because it tastes not unlike bread. We used to believe that the bright yellow balls on the hind legs of the bee were wax. This is not the case; it is pollen, or the dust of the anthers of flowers. It is collected by hairs on the pollen brushes of the legs; then kneaded into a ball and placed in the pollen basket, a spoon-like hollow with stiff hairs on one side, like stakes on a wood-rack. One can watch this operation very closely by placing, early in spring when there is no pollen, a dish of oat meal thirty yards or so from the hive, with a little honey in it to attract bees there Bees sting only in the immediate neighborhood of their hive. Sometimes when the pollen is very plentiful, as in cucumber blossoms, they roll their bodies in it and pick it off with their feet.

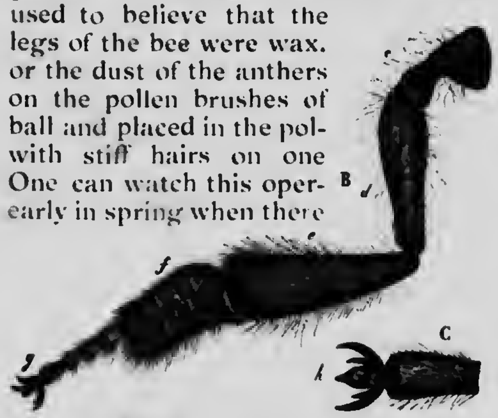


FIG. 51.—B, Hind leg of worker; e, tibia hollowed on outer side as pollen-basket; f, tarsus with pollen-brushes; g, foot, with claws, side view; C, foot, front view, more enlarged. (From nature.)

Each bee visits only one kind of flower on each excursion and thus the flowers visited are cross-fertilized without being hybridized. Another product that is carried in this way is bee-glue. It is used to stop up cracks in the hive to keep out draughts It is that sticky substance on poplar and horse chestnut buds. Below the pollen is the greater part of the comb which is nearly black and contains the brood or young bees in all stages of growth.

The most important personage in the hive is the queen or mother-bee, — so-called because she is the mother of all the bees in the colony. She is shy and hard to find, but easily recognized, being nearly twice the size of a worker. Early in spring when food commences to be brought in — for the queen is provident and will not lay when the larder is empty — she begins to deposit eggs, one at the base of each cell, and slightly glues it there. If she happens to place two or more eggs in a cell, the workers, that is the bees that sting, remove all but one to other cells. Drone, or male, eggs are placed in the larger cells and workers or female eggs in the smaller cells. She lays eggs of either sex at will; and the workers can distinguish the sex of an egg by some unknown instinct. At the end of three or four days, the eggs hatch into small, white maggots. The nursing bees prepare a food of honey, pollen, and water, partially digest it after the manner of patented foods for infants, and pour it into the cells for the grubs. In from four to six days, the maggot grows almost large enough to fill the cell. The nurses then seal over the apartment with a porous lid of wax and the grub enters the pupa state. From the middle part of the under lip two silky threads issue, which cling together and form a single thread; continually extending and retracting its body, it spins a silky white cocoon, something like that of the silk-worm. The inmate of the cell is now transformed into the shape of a bee, but is pure white, and for that reason is called a nymph. In twenty-one days or so after the egg is laid, the young bee chews away the cap of the cell. If you examine a comb of sealed brood, you will generally see two or three of them with their heads half way out of the cells, taking a first view of the world. When they emerge they are weak, flaccid, half grown creatures, covered with silver grey hairs that give them such a new appearance as to excite in the beholder the liveliest sympathy. The nurse bees then clean out the cell and fasten down its silken lining which serves to strengthen the comb, and is so thin that a hundred of them scarcely diminish the size of the cell. The first day the young bee does little but crawl about and sip honey; then in its turn it becomes a nurse and feeds the maggots. When about ten days old, along with scores of other young bees, it plays during the warm part of the day, just before the entrance to the hive. It is a pretty sight to see them dancing in the warm sunshine and learning the use of their wings; in half an hour they go into the hive again and all is quiet. Besides being nurses they are tidy little housekeepers, removing every impurity and all dead bees. At two weeks, the young bee builds comb and goes for its first load of pollen, of which it is as proud as a boy is of his first pair of trousers. After this it undertakes to gather nectar. After from two to four

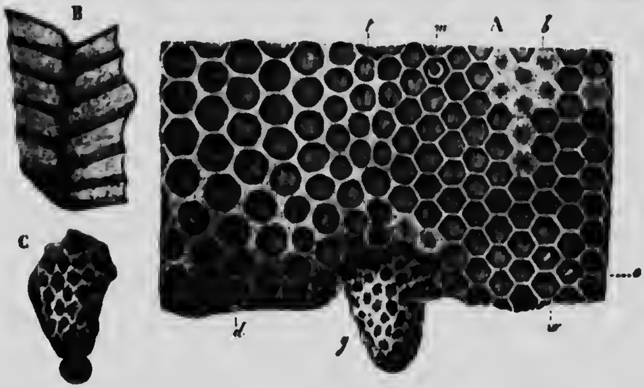


FIG. 55.—A, Comb, front view; *d*, drone-cells; *w*, worker-cells; *t*, transitional cells used for storing honey and bee-bread; *g*, queen's cell; *b*, brood capped over; *e*, eggs; *m*, larva or maggot. B, Section of sheet of comb, showing inclination of cell. C, Queen-cell, with cap cut off by workers. [From nature.]

weeks of this labor, it dies from the wear and tear of life. This generally happens out in the field, when, under a full load of honey, it is too feeble to reach home; or its career may be cut short by the toad that lives under the hive, or by the kingbird, or its feet may be stuck fast in the gummy pollen of the milkweed. But in winter and spring they live eight or nine months.

The drone or male eggs are laid in cells a third larger than the worker cells and, when capped over, are much longer. The drones are bulky and have the proportions and habits of the alderman of tradition. They fly about in the middle of the day to sharpen their appetites, and when in the hive, do little but gobble and sip honey. They can neither sting nor collect food. However, when food does not come in rapidly, they are bundled out of the hive; often a wing is torn off and they are given a hint to go. This happens every fall and, at that time, the drones will be found all by themselves on the outside combs, hiding from their termagant sisters, after the manner of men in house-cleaning time. When expelled, they are often found in some warm place like a hot-house.

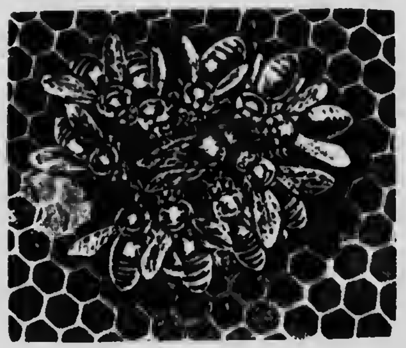


Fig. 56. The queen and her retinue.

The queen, curiously enough, is hatched from a worker egg, and is often developed from a worker maggot. When bees wish to rear a new queen, they choose three adjacent worker cells, cut out the partition walls, and throw them into one The cell is turned downward and looks very much like a peanut. Two of the worker maggots are destroyed and the third is supplied with about half a thimblefull of very strong food, called royal jelly. The worker grub, two or three days old, is to be changed into a queen. Sometimes when worker eggs or maggots cannot be found, bees will, without giving up hope, try to rear one from a drone grub, which, however, dies from the strong food. Two days feeding on this food, alters her color, curves her sting, doubles her size, deprives her of wax pockets, lengthens her life to three or four years, and reverses all her instincts. When she leaves the cell in which she has lain head downwards, she takes a sip from an uncapped cell; and then runs around and stretches her legs. She hunts for other queen cells of which there are about a dozen. If the workers permit her, she tears a hole in the side of the cell and stings the inmates because queens will not tolerate a rival. If another queen is found they fight, the workers standing around, and not interfering. Queens very often are afraid to leave their cells; and in that case they pipe—making a plaintive cry, a sort of "peep, peep," that may be heard several yards from the hive.

If nectar and pollen are coming in in large quantities, the queen will sometimes lay two or three thousand eggs a day, producing during her lifetime between a million and a million and a half. The hive, of course, becomes overstocked by the amazing fertility of the queen;

and steps are taken towards sending out a colony. Queen cells are begun and a week before the first queen comes out, by a sort of preconcerted mutual agreement, the inmates of the hive divide into two parties, one remaining in the hive and the other, which consists of the old queen and about three quarters of the colony, starts out to seek fortune elsewhere. Besides the old queen, the swarm is composed of many young bees, some of whom fall upon the ground too feeble to fly, drones, and a number of veterans whose tattered wings and hairless bodies show that they have seen something of life. The departing queen soon settles on the branch of a tree or other convenient spot and the whole swarm collects in one solid mass around her. While the swarm hangs there, scouts are sent out to look for a suitable home, and a hollow tree in the woods is generally chosen. In Asia Minor, a treeless country, swarms were sometimes found in the stomachs of dead beasts, as in the case of the lion killed by Samson ; and from this arose the superstition* that decaying flesh could of itself produce a colony of bees. The scouts return and report, for one bee may often be seen talking with another by crossing its horns, or antennae, with its own. The cluster of bees breaks up and follow the scouts. Even in these days some try to make a swarm cluster by tanning or beating tin cans. This is a survival of a heathen ceremony. The worship of the goddess Cybele, who taught mankind agriculture, was enthusiastic. Her priests ran about with dreadful cries and howling, beating on timbrels, clashing cymbals, sounding pipes, and cutting their flesh with knives. There is another tradition. If there has been a death in the family, the bees will take offence and die during winter, if they are not informed of the event.

Bees had a government and a civilization when we were savages. The division of labor was understood ; laws of hygiene were practiced ; and provision for the rainy day was made, when our ancestors obtained their daily bread by turning over stones in the pools of the sea shore, looking for crabs and clams.

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* Compare the legends of Aristaeus the first bee-keeper.

THE STORY OF THE BIRDS.

PROFESSOR M. W. DOHERTY.

Fig. 57. Swallows migrating.

THE snow has gone, the grass is growing green again, the buds are swelling in the trees, the leaves begin to open Spring has come; and, in a few days, we may expect to see our feathered friends again. They have been paying a visit to the people of the South, and, having travelled in foreign places and seen strange sights, they will greet us on their return with a merry tale set to sweetest music.

Many kinds of birds spend the summer with us, and in autumn go southward to spend the winter months. Others come to us from the northern districts and remain here over winter, returning in the spring to the place whence they came. There are other birds that spend the winter season south of us and the summer season to the north of us, so that in their migratory flight, they simply pass through our district on the way to and from their breeding places. These are "passing migrants" A few remain with us summer and winter. Who has not heard the peculiar "quank, quank" of the White-breasted Nuthatch coming from the almost lifeless snow-clad woods. In spring and summer these same birds may be seen running up and down and around the trunk and limbs of the trees. As climbers, the Nuthatches excel. They can run rapidly

Fig. 58. The Cuckoo migrating.

down the trunk of a tree headforemost. Woodpeckers even do not attempt this feat In the southern part of the Province, the Crow remains all winter; and so, along with the Nuthatch, must be classed as a "resident."

The migratory flight of birds is a most interesting study, and has engaged the attention of bird-lovers for centuries. A great deal, however, is not yet understood regarding the "lines of flight." For instance, "The Eastern and Western Movement of the Blue-bird" in our Province remains unexplained.

What causes these migratory flights? You immediately answer: "The change in temperature." This answer is partially correct, but you are leaving out of consideration a very important factor, viz., *food* *supply.* This, coupled with inherited memory, probably more than anything else, controls the migration of birds. Do all birds migrate in the same

Fig. 59. The flight of the ducks.

manner? No. We have all seen Swallows gather together in immense flocks before leaving us. There are others again, such as the Cuckoo, which quietly steal away in pairs, or in very small flocks. Some birds in their flight remain close to the earth, while others fly at such a height that they remain unseen to the naked eye. Some move mostly at night, others in the daytime. Some birds migrate to the south, leaving their young to follow them at a later date. In most cases the males precede the females by some days in their return to us in the spring.

Fig. 60. The Meadow Lark.

Before the snow is gone, we may hear the shrill piping notes of the Horned Lark coming from the plowed fields and meadows. The sound is not altogether unlike the pleasant note of the Meadow Lark. Early in March, the sharp-eyed, cunning old Crow bids good-bye to the southern parts of the Province and moves northward, with his head filled with new

Fig. 61. The return of the Crows.

schemes whereby he hopes to grow fat and to render the farmer helpless to prevent his devastations of the fruit trees and corn fields. Then follows the Robin, whistling and strutting around with renewed vigor and grace. Then follow in rapid succession, Blue-birds, Song-sparrows, Black-birds, Phœbes, and a host of others, until the air is filled with music. Every tree, shrub, and meadow has its full orchestra.

Fig. 62. Taking Notes.

Every boy and girl should keep a record of the dates when the first of every kind of bird is seen each season. It will add greatly to the pleasure of spring-time.

NESTING HABITS. Of all the evil traits which have been handed down to man, none is worse than the predisposition of the bad "small boy" to rob birds' nests. How much nicer it would make the home, if instead of driving the birds away in disgust, the boys would all fix up some nesting boxes in the old orchard, and upon the roof of the wood-shed. These need not be large nor expensive, and yet you will be astonished how soon the birds will use them as homes. Let every boy vie with his fellows to have the greatest number of birds summer around his home.

Here is a suggestion for you. Nail up some nesting boxes near your home, near by place some bits of string and hair that the birds may use in building nests. Then, if there is no water close by, set up on a post a tin dish that will catch the rain, and you can from time to time fill it with fresh water. This drinking place will attract the birds. Now keep track of the birds that come around, and, if you do not frighten them away, you will soon have some birds coming regularly to make their home with you. These new friends will be interesting, and you will be much happier in watching them coming and going through the summer than in frightening them away.

Fig. 63. Happy Homes.

Many of the birds are paired before they reach us in the spring, and soon they are busy making snug little homes in some secure and sheltered spot. The little workers labor industriously, all the while giving forth sweet melody. Birds differ widely in choice of places for their nests. The Horned Lark is satisfied with a shallow hollow in a meadow; while the Baltimore Oriole, trim of figure and bright of color, suspends its bag-like home from the end of some drooping bough, very frequently overhanging a stream (Fig. 64). The Bluebird prefers a hollow post or

Fig. 64. The Oriole's Nest.

fence-rail; the Bank Swallow, a home made in a sand bank; and the Blue Heron, or Crane, as it is erroneously called, selects the lofty top of a tamarack or black ash wherein to build his home of sticks.

Watch carefully during the summer, and make a list of the birds which build their nests: *1st*, on the ground; *2nd*, in shrubs or trees not more than 15 feet from the ground; *3rd*, in trees at a greater distance than 15 feet from the ground; *4th*, in other places, as sand banks, eaves of buildings, chimneys, etc.

Fig. 65. The Bluebird's Nest.

Man and Birds. From an economical, as well as an aesthetical, standpoint, man should always be found offering protection to birds. This statement is made with full knowledge of the fact that there are a few members of this class of animals which are of little service to us, and are not distinguished for their beauty. Nevertheless, the fact remains that, as a class, we should offer them every protection, cultivate their acquaintance, and encourage them to build nests and remain with us. It is very doubtful, indeed, if there is a single species of bird for the total destruction of which we would be better off. Those who dispute this point have never made a careful study of the feeding habits of birds. Many unthinking persons condemn Woodpeckers, which are seen flying to and fro in the orchard, because it is

Fig. 66. Woodpeckers at work.

assumed that they are working injury. A careful field study of their food habits, and an examination of the stomach contents, would reveal the fact that these birds are destroying thousands upon thousands of injurious insects, particularly those which burrow in the wood. The orchardist sees the Robins carrying off a few of his cherries, and immediately some thoughtless boy brings out the shotgun, with the result that dozens of these hard working friends are destroyed. In all probability, had it not been for these birds, there would have been no cherries; insects would have completely destroyed the foliage and fruit.

Definite information regarding the food habits of birds can be obtained only as a result of careful study and field observations, together with the examination of a large number of stomachs. A study along these lines frequently results in a complete change in our attitude towards the species under investigation. For instance, in the case of the Downy Woodpecker, an examination of a large number of stomachs revealed the fact that 13 per cent. of the food consumed, consisted of wood-boring beetles, 16 per cent. of bugs that live on the fruit and foliage, and a large proportion of the remainder is made up of scale insects, ants, and other such insects.

We might thus speak of all our common birds, and show that most of them are entirely beneficial; and, as to the rest, their depredations are very small when compared with the beneficial service which they render to the gardner and orchardist. Farmers each year spend much time and money in keeping up the fight with aggressive and persistent weeds. Seldom do they realize that their efforts would be of little avail, were it not for the many varieties of birds which each year destroy millions upon millions of weed-seeds.

Birds have enormous appetites, and, as digestion is rapid, a large quantity of food is consumed each year. They eat during three hundred and sixty-five days of the year, so that, even though they do treat themselves to an occasional feed of luscious fruit, during two weeks of the year, we may rest assured that during the other fifty weeks they are with us they have rendered us services valuable far beyond the injury.

If the birds were destroyed, it is very doubtful whether after ten years a farmer or gardener could possibly bring any crop to maturity.

THE STORY OF AN APPLE.

PROFESSOR H. L. HUTT.

FIG. 67.—McIntosh Apples.

One evening after tea, I had just settled down in my easy chair for a glance at the newspaper, when my trio of little folk pounced on me for a story. "A fairy story," said Jean "No, one about wild animals," said Fred. "I like to hear about what you did when you were a little boy," said Gordon. Here was too much of a variety to be given all at once; so I said, "Look at those beautiful red apples on the table." "Wouldn't you like to hear their story?" Fred was doubtful whether much of a story could be told just about apples; but I informed him that every apple has a history, and some have a very interesting one. 'What variety of apple is that?" I asked. "A McIntosh," they all shouted in chorus, for they had been learning the names of apples, and were always pleased to be able to identify a variety correctly. "How do you suppose it got that name?" I next enquired; but as this was too much for them, I said, "Well, that is where we will begin our story.

"Once upon a time (for all good stories begin that way), about thirty years ago, on a farm near Dundela, a little village in Dundas County, in the St. Lawrence Valley, lived a man by the name of Allan McIntosh. He was one of the early settlers in that section, and had cleared off most of the forest which once covered his fields, only a few acres of it having been left for bush. The bush was the favorite resort of the cows when the weather became warm and the flies were too troublesome in the adjoining pasture field.

"One evening, late in September, when Mr. McIntosh's little boys, Allen and Harvey, were hunting through the bush for the cows, they espied just on the edge of a clearing, a little tree bearing near its top a number of bright red apples. If they had discovered it sooner, they might have found many more on the lower branches. What do you suppose had become of them?" "The cows must have got them," suggested Fred. "Yes, the cows had found them first; but the boys were soon up the tree making sure that the cows would get no more of them.

"The apples were at that time hardly mellow enough for eating, but that did not prevent the boys from sampling them; and they declared that they were the finest wild apples they had ever tasted. Those not eaten at once were taken home and kept in the cellar till the family gathering at Christmas, when all present pronounced them finer than any of the named varieties grown in the little orchard near the house.

"Here then was a little tree growing wild without any care given it, yet it produced handsome apples of fine quality. How do you suppose it came to be growing there?" "Somebody must have planted it," declared Gordon. "No," I said "it was not planted, but grew there from the seed, and was, therefore, what is called a chance seedling." "The Brownies must have planted it," remarked Jean. "Well, probably they did," I said, "but I think the Brownies in this case were the men who helped to chop down the trees in the woods; for it is most likely that they had taken with them some Snow apples to eat when they felt hungry. They threw away the cores and when these rotted the seeds were left on the ground, and from one of these seeds this little tree may have grown."

"What makes you think they were Snow apples," inquired Jean. "Well," I said, "if you will fetch a few Snow apples from the cellar, to compare with those in the dish, you will probably find the reason yourself." In less time than it takes to tell, they were making comparisons, and they agreed that there was not much difference in appearance, except that the McIntoshes were, on the whole, a little larger and redder than the Snows. "What makes those black spots on the skin," asked Gordon, "they are on both kinds." "Those," I replied, "are caused by a fungous disease with which the Snow apple and its relatives are often troubled. Now cut an apple of each kind and compare the flesh." "Why, they are both nearly as white as snow, aren't they?" asked Jean. "That is still further proof," I said, "that they belong to the same family. Now taste them." After much tasting of one and the other, it was decided that they were both so good that it was hard to say which was the better; but when asked to shut their eyes and guess the name of the one they were given to taste, they found no difficulty in telling which was the McIntosh, because it had a "spicy flavor."

"Now," I said, "I think that you have sufficient proof that these two apples are related. In fact, there is little doubt that the McIntosh, and a number of other varieties I might mention, are seedlings from the Snow, or, as it is more properly called, the *Fameuse*. None of these varieties, however, take their names from their parent. The McIntosh, as you may have already guessed, received its name from the man on whose farm the first tree of that kind was found."

"But how does it come there are so many trees of that kind now?" asked Fred. "We have them, and Grandpa has them, and lots of people have them." "Well," I said, "that is one of the interesting points in the story of nearly all cultivated fruit trees.

"All of the McIntosh trees now growing in all parts of the country have descended from that one little tree in Dundas County, not by planting seed from it, for that most likely would have produced other varieties, but by grafting and budding other trees with cuttings and buds taken from it.

"One of the remarkable things about nearly all our cultivated fruit trees is, that trees grown from their seed show endless variations. If, for instance, you should plant 100 McIntosh apple seeds, probably no two of the trees from them would bear apples just alike, and most likely none of them would bear as good fruit as the McIntosh, although it is just possible that even better fruit might be produced. Some day you may find this an interesting thing to investigate."

Fig. 68. A glimpse in the nursery.

"But what do you mean by budding and grafting?" inquired Fred. "These," I replied, "are methods adopted by nurserymen who make a business of growing trees, whereby they can grow any number of trees that will bear the same kind of fruit, without varying, as they naturally would if the trees were grown from seed. These methods of propagating trees depend upon the fact that every perfect bud on a tree is capable, under favorable conditions, of producing another branch; or indeed, a whole tree of the same kind as that on which it grew.

"The McIntosh in our garden is a budded tree, which was obtained from Mr. Smith's nursery, where he grows thousands of other trees just like it. In growing these trees, Mr. Smith had in long rows in the nursery, thousands of little seedling apple trees (that is, little trees grown from apple seeds), which, if allowed to grow naturally would, he knew, bear a great variety of mostly inferior fruit, but he had heard of the excellence of the McIntosh apple, and intended to make them all bear McIntosh apples; so he wrote to Mr. McIntosh and got him to send all the young shoots he could spare from his McIntosh tree. From these shoots, which were obtained in July, Mr. Smith's men budded the little seedling trees in the nursery rows. The bark on each little tree was cut open near the ground, and one McIntosh bud was put in and bound firmly in place.

Fig. 69. Budding the seedlings.

By the end of the season, the bud showed by its plumpness that it had been adopted and nourished by its foster parent, and to all appearances it was much the same as any of the other buds, except for the scar around it showing where it had been inserted.

"Early next spring, however, each seedling tree was cut off just above the McIntosh bud, which was thus suddenly given the responsibilty of making a new top for the tree, and that is just what each little McIntosh bud did. In three years, each had made a little tree, big enough to be sold for transplanting; and that year they were all taken up and sent to the purchasers throughout the country."


No. 70. The adopted bud with scar around it.

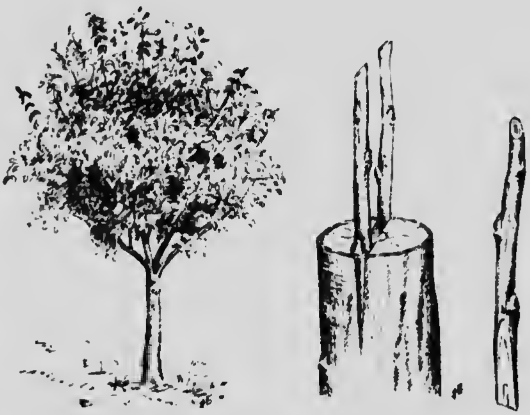
"In Grandpa's orchard you may have noticed that the tree which bears the McIntosh apples bears also a few yellow apples." "Yes, Talman Sweets", said Gordon. "Well, that tree once bore all Talmans; but one spring Grandpa cut off most of its branches and grafted into the stubs left a few scions, or bits of twigs, from a McIntosh tree. These scions united with the growing part of the Talman tree, and produced large branches which bear the McIntosh apples, while the branches which were not grafted still bear Talman Sweet apples."

"By grafting into a large bearing tree in this way, Grandpa's tree was bearing McIntosh apples in three or four years; whereas our tree, being a young one, was nearly twice that old before it had apples on it."

"From the story of this particular apple, you will have learned how new varieties of fruits sometimes originate. Varieties found in this way


No. 71. Taken from the nursery and bundled for shipping.


No. 72. Old enough to begin bearing.


No. 73. How the grafting was one.

are said to be of chance origin. All varieties, however, do not originate by chance. Some are the result of careful and patient work on the part of men who not only gather and plant the seed, but contrive to have the new kind combine the good qualities of the two other varieties. If you will remind me of it next spring, when the trees are in bloom, I will show you how this may be done."

"From what has been said about budding and grafting you will also have learned how a new variety, once obtained, may be multiplied and scattered all over the country. If you would like to try what you can do at such work, you may begin next spring by planting a row of apple seeds in the garden; and when the little trees are big enough, I'll show you how to bud them, or how they may be made to bear fruit in two or three years by grafting them int.. a bearing tree. How many of you would like to try it?" "I, I, I," they all shouted; so we began operations at once by eating all the apples in the dish, to get the seeds for next spring's planting.

Fig. 74. Mr. McIntosh of Dundela and the original McIntosh tree.

THE STORY OF SUGAR.

Professor W. P. Gamble.

From early childhood, the boys and girls of Canada are familiar with the substance called sugar. We all know that it is used in large quantities for the purpose of giving a pleasant taste to many of the delicious dishes prepared for our use; but how many of my young friends have taken the trouble to inquire into the origin and manufacture of this useful substance?

Fig. 75. The Maple in summer.

There are many kinds of sugar; but the one we shall speak of more particularly is the cane-sugar, so called because it was first manufactured from the sugar cane. Pure cane-sugar, as it appears on our market, consists of a mass of white crystals. If this sugar be heated to 320° Fahrenheit, it will melt to a colorless liquid, which rapidly assumes an amber hue, such as you have noticed when boiling it for the purpose of making taffy. If heated to a still higher degree, it turns brown, becomes less sweet, and gradually takes on a bitter taste.

Old-fashioned brown sugar owed its color and flavor, in part at least, to this treatment; for, as sugar was formerly made, in the process of evaporation over the open fire some of the sugar was browned or half burned. Cane-sugar was formerly sold more extensively than at present in the form of coarse brown sugar. To-day, with the improved methods of manufacture, we see very little cane-sugar placed on our markets in this form. You might think that cane-sugar, from its name, is found only in

Fig. 76. The Maple leaf and key.

Fig. 77. The Maple when it bleeds.

Fig. 78. Shows a branch of the Maple when growth again becomes active.

the juice of the cane, but not so. It is found also in Sorghum, a plant native to India, and now cultivated in the United States and in the south western counties of Ontario, near Lake Erie; in certain palms, such as the cocoanut, and the wild-date palm; in some kinds of grasses; in the green stalks of corn; in the Maple; and in quite large quantities in the sugar beet. Maple sugar, on account of its unique and agreeable flavor, is now eaten chiefly as a luxury. This sugar, when freed from the color and flavor derived from the Maple, is identical in composition with that derived from the sugar cane. Most boys and girls in Ontario, especially those who live in the country, are familiar with the Maple, and the process by which sugar is obtained from it; but why the sap runs from the Maple is not so well understood by the majority.

During the summer, the Maple is clothed with green leaves, which, through small openings on their underside, give off the excess of moisture taken up by the roots. Before the water is given off, the food which is held in solution is removed from it. This food goes to form a new growth of wood in the tree. In the autumn, the leaves of the Maple fall; and through the winter, the tree stands bare and does not grow. In spring, if the Maple is bruised or cut in any way, we notice that the tree "bleeds," or, in other words, "the sap runs." We have also noticed that the "bleeding" of the Maple occurs at different times of the year. The sap will run from the Maple before growth has begun, and just as it is beginning. In the two cases, the cause of the run of sap is quite different. We find a good example of both kinds of bleeding in the gathering of sap by the sugar maker. Sap is first gathered when the ground is still frozen, and the roots are therefore almost, or quite, unable to absorb any water; but, at the same time, the air is warmed through the middle of the day by the increased heat of the sun. At this season, the flowing of the sap from holes or cuts made in the trunk of the Maple is due to the expansion by heat of the air inside the smaller branches and twigs of the tree. This sets up at once a pressure upon the sap, and this pressure extends to all parts of the tree. The sap with which the Maple is filled, is thereby forced out as soon as an opening is made for its escape. Later in the season, as the frost disappears, the roots begin to absorb water. This absorption process sets up a pressure within the tree, by reason of which the water is forced out of the same opening. "Bleeding," or the flow of sap, from this last mentioned cause, continues until the leaves are sufficiently expanded to throw off the water absorbed by the roots. The other source from which we in Canada obtain cane-sugar, is the

Fig. 79. Keys of the Maple separate. During germination a radicle is sent out which endeavors to obtain a hold in the soil.

sugar beet; and, because of the particular attention which it is receiving just now in many parts of our Province, we shall study it with a view to finding out its life-story.

Beginning with the seed, we find that what is commonly called the seed is in reality a pod. With the aid of a sharp knife, let us open a number of these pods, by cutting them straight across the centre. We now notice that the pod is composed of a rough irregular shell. Inside the shell are chambers, separated from one another by woody partitions. In some of these pods, we find but one chamber; in others, there are as many as four or five of these cavities. Inside each chamber, we find the true seed of the beet. The seed, you will notice, is kidney-shaped. It

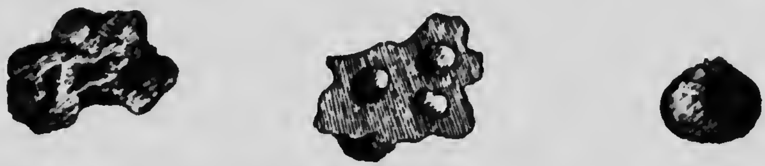


Fig. 80. The beet pod (on the left). The beet pod opened, showing the chambers within. The true seed of the beet (on the right).

is about the size of a turnip seed, and is enclosed within a dark brown wrapper. When this wrapper is removed, we discover the embryo, or infant plant, curved around a mealy substance. This mealy substance is the ***endosperm***, and is the food upon which the young plant feeds during the germinating, or infant, stage. The embryo is the essential and most important part of the seed It has root, stem, and leaves, although these organs are often as undeveloped in form as they are in size.

Boys and girls will do well to observe carefully the various stages in the act of germination. For this purpose, a dozen pods or more are sown in a soil kept duly warm and moist, and one or two pods are uncovered and dissected at successive intervals of, say, 12 hours, until the process is complete. In this way, it easy for us to trace all the visible changes which occur as the embr starts to grow.

We thus notice that the seed first al.. rbs a large amount of moisture. As a result, it swells and becomes oft. The embryo enlarges, and shortly the shell bursts, and a sprout makes its appearance. In the figure given below, you will notice three sprouts making their exit from a single pod. Notice also that these sprouts have the same general appearance. Each sprout is called a radicle. In time, the radicle becomes the true root.

Fig. 81. A beet pod showing three sprouting seeds (on the right). The radicle making its exit from the seed coat (on the left).

In the process of germination, the young plant grows at first wholly at the expense of the seed. It may, therefore, be compared to the suckling animal, which, when newly born, is unable to provide its own nourishment, and consequently depends upon the milk of its mother. The *cotyledons*, or young leaves of the plant, during germination absorb the endosperm, and remain within the seed coat some time after the radicle has made its exit. When the plantlet ceases to derive nourishment from the mother seed, the germinating process is finished.

The baby stage in the life-story of the young plant is passed. It must now depend on its own exertion to supply the necessaries of life. For this purpose, the radicle buries itself in the soil, and sends out slender rootlets to gather in the food found there.

Fig. 84. Sugar Beet at full growth.

Fig. 82. Plantlet with two leaves expanded.

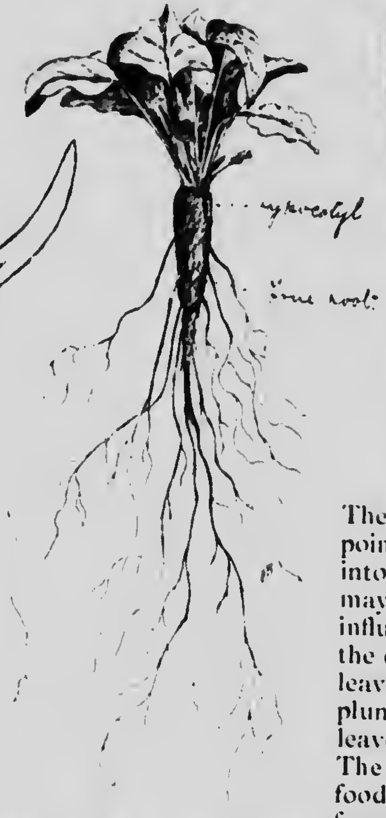


Fig. 83. Showing immense development of the root system of the beet.

The *plumule*, or growing point of the embryo, ascends into the air, in order that it may come under the direct influence of the sunlight. As the days pass, we notice new leaves unfolding from the plumule Why are these leaves sent forth by the plant? The leaves, like the root, are food gatherers. They absorb from the atmosphere substances which are necessary to the formation of plant food, and it is in the leaves that the manufacure or working over of those materials obtained from the soil and from the air takes place.

Let us now direct our attention to the root of the beet. Removing the earth carefully, we find that there is one well developed root pushing straight downward into the soil, and that smaller roots are sent out from it in two side rows. We notice also that for some distance below the surface of the soil the main root is smooth, and free from these smaller rootlets. How is it that so very little of the fleshy root of the beet appears above the surface of the soil? In reply to this question, we would ask you to observe the great length of these rootlets. "It has been frequently found that drains four and five feet below the surface of the soil have been blocked by them." As the rootlets develop, therefore, they exert a downward force upon the bulb, and this force tends to draw the bulb into the soil.

Conditions being favorable, the beet plant grows quickly. The main root thickens rapidly for a time; then we observe a less marked increase in size, and finally we can detect little, if any, development in this direction. During this development, small sacs, or cells, are formed within the root. These cells act as store-houses for the food material of the plant.

Let us again observe the leaves. The first thing that attracts our attention is the color of the leaf. Have you ever thought of the cause of this shade in the leaves of growing plants? It is due to the presence of a certain green substance known as *chlorophyll.* This big word has been made up from two Greek words that simply mean "leaf green." This chlorophyll plays a very important part in the life-story of sugar. The particular use of this green matter is to change the raw material into plant food. One of the chief materials of plant food is carbonic acid gas. This gas comes from the lungs of animals. All living creatures are continually breathing out carbonic acid from their lungs. This gas is poisonous to man, but is an essential food of plants. Without this food, the plant could store up no sugar, nor could it even live.

Fig. 85.—Shows the stem sent up from the crown of the beet. Second year of growth. The flower of the beet (in upper corner on right.) The ovary cut down through the centre (in lower corner in right.)

Carbonic acid gas passes into the leaves of the plant through small openings situated on the underside of the leaves. Large quantities of this gas are taken in by the leaves of the beet plant. This gas under the influence of chlorophyll is made to unite with water, and thus form a compound from which sugar is ultimately derived. After the sugar has been formed in the leaves, it is carried to the roots of the beet by the downward flow of the sap or juice. In the root of the beet, the sugar is deposited in cells, which very closely resemble those of the honey-comb in structure.

You will naturally ask: Does the beet go to all the trouble of manufacturing and storing up sugar for our special benefit? Not at all. As you all know, the sugar beet does not produce seed during the first year of its growth. If we take a beet root from the cellar and plant it we observe that it again begins to grow. From the crown of the beet, a strong leafy angular stem is sent up. This stem bears the flowers which are the forerunners of the fruit. The flowers, you will notice, are arranged at short intervals along the stem and its branches, and are usually in clusters of four or five. Below each cluster is a small bract.

The flower possesses a perianth, which is composed of five small green leaves. The lower part of the perianth is united with a fleshy substance called the receptacle. We also notice five stamens opposite the perianth. The ovary, or sac, encloses a small body called the ovule. The ovule eventually changes into a seed or fruit.

After fertilization, the receptacle and base of the perianth of each flower enlarge considerably. In this way, the perianth of each flower becomes more or less firmly attached to each other. The fleshy portions, with the ovaries, eventually become hard. These spurious fruits finally come into the market as "seeds."

During the period of growth and development of the fruit, what has become of the bulb or fleshy root? Upon examination, we find that only the walls of the former bulb remain (Notice Figs. 84 and 85). What is the cause of this change? The reply is: The store-house has become emptied of its contents. By what agency? The sap or juice has carried it up for the young seeds in the course of their development. We see therefore, that the sugar and other contents of the cells in the roots were stored up by the plant for the purpose of supplying the food necessary to fruit or seed, production. In obtaining sugar from the beet, we, therefore, simply intercept Nature's plans, and are thus able to appropriate that which was not originally intended for us. This sugar is stored up by the beet plant in the root that it may feed itself the next season when it is forming seed.

We shall now examine the process of the manufacture of sugar from the beet. The beets are at the close of the first season removed from the soil, and are taken to the factory. At the factory, they are put into large sheds with V-shaped bottoms, which are connected with the factory by means of channels. Through these channels a moderate flow of water carries the beets into the first washing machine. By means of a spiral arrangement, the beets are tumbled about, washed, and carried along until they drop into an elevator. This elevator carries the beets to the top of the building, where they are weighed and sliced in such a manner as to open up the cells of the beet as much as possible.

We have already noticed that the cells of the beet in which the sugar is deposited are very similar to those of the honey-comb. Therefore, it is very important that the knives used in the slicing operation be sharp, so that the cells may not be ruptured, but clean-cut. As the slices come from under the cutter, they are put into large tanks. Warm water is forced through the contents of these tanks or jars. By the action of the water, the greater part of the sugar contained in the sliced beets is dissolved. You know how quickly sugar will dissolve in water. The water containing the sugar in solution is then withdrawn from the tanks and taken to a measuring tank. The part of the sugar beet left over, that from which the sugar has been extracted, is called "pulp." This pulp is of no further use in the manufacture of the sugar, and is therefore thrown aside or taken to feed stock.

After the liquid containing the sugar has been measured, it goes to the mixer, where it is mixed with lime, and then put into a large tank for carbonation. Carbonation is the process of converting the lime and other impurities in the mixture into an insoluble form, by means of carbonic acid gas forced through the bottom of the tank. The mixture is then poured into a filter-press. A filter-press is simply a large strainer, by means of which the insoluble matter is retained, as the clear sugar solution goes through. This process is repeated a second time, after which the solution is treated with sulphur fumes. The syrup is then boiled down to remove the water contained in it. This is done by passing the syrup through four large boilers. What is left after the boiling is called thick juice. This juice is again boiled in a peculiar kind of pan, called a vacuum pan, and now becomes raw sugar. The raw sugar is then run into centrifugals, which are machines used for the purpose of separating the white sugar from the molasses. At this stage, the sugar is, of course, damp. By means of a granulator, this wet mass, which has the appearance of snow, is dried. It is then run through sieves to separate it into fine and coarse grained sugar, and is ready for the market, clean, white, crystalline sugar, such as we use every day on the table. Some of the sugar that we use has been made from sugar cane grown in the West Indies or in South America, some has been made from sugar beets grown in France and Germany and Belgium. We cannot tell the difference between the two kinds—there is none. We shall soon be using sugar that has been grown in beets by the farmers of our own Province.

THE STORY OF AN EGG.

W. R. Graham, B.S.A.

Everyone is familiar with the size and shape of an egg; but very few of us stop to think how wonderfully it is made. We all know that the contents of the egg are enclosed in a shell. This shell appears to be hard and solid, but this is not the case. True, it has much strength; but we find upon examination, that it is full of little holes. These small holes allow the air next to the shell to get into the egg. Thus it will be seen that we should keep the egg in a clean place, away from dirty straw, such as we often see in the nest; also away from strong-smelling substances, such as onions; otherwise, these strong odors, passing through the shell, will affect the taste of the egg more or less.

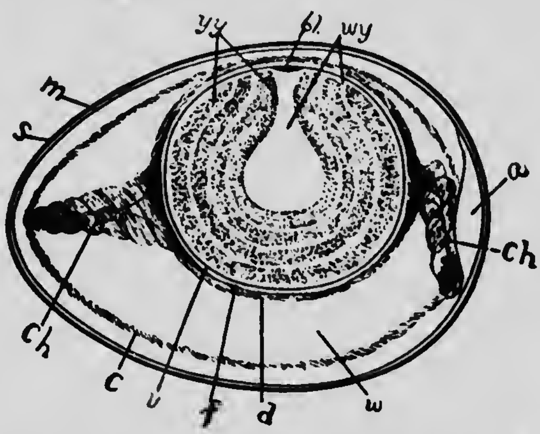


Fig. 86. Diagrammatic section of an unincubated fowl's egg; *bl* germ-spot; *wy*, white yolk, consisting of a central flask-shaped mass, and a number of layers concentrically arranged around it, the outer layer of white yolk lying immediately beneath the vitelline membrane, and connected with the central mass beneath the blastoderm; *yy*, yellow yolk; *v*, vitelline membrane; *f*, layer of more fluid albumen surrounding the yolk; *ch*, chalaze; *a*, air chamber between the two layers of the shell membrane; *m*, shell membranes, where they lie in contact over the greater portion of the egg; *s*, shell; *d*, denser albumen, which extends around the yolk, outside of the internal layer of more fluid albumen; *c*, boundary between the outer and middle portion of the albumen.

Next to the shell is a thin tissue. This tissue is made of two layers all over the egg, except at the large end, where they separate, forming a small open space, called the air-space. This air-space increases in size as the egg evaporates or dries. The longer the egg is allowed to remain in the air, the more air will pass through the shell; and each little particle of air carries away with it some of the moisture of the egg, and thus the contents dry up and the air-space increases in size. Sometimes eggs that have been left exposed to the air in a nice clean place for a year, are found to have very little content; and that which is left is dry and almost hard. These tissues may be pulled off the shell, especially in the case of a hard boiled egg.

Now we come to the white of the eggs, or what is called the albumen. This is said by doctors to be a very good food; but we are particularly interested in its appearance. So let us break an egg in a saucer. Notice that the white on the outside is thin and watery; in a little farther, we see a grey or whitish streak that extends all the way around the yolk, or yellow portion, but does not touch it. You will also notice that at each end of the yolk and extending from this whitish portion is a knotted portion, like a little piece of white string. We wonder what these are for, and observe that they are simply an extended portion of this first white streak as mentioned. Inside the white streak is another watery portion. This comes in touch with the yolk. We shall now look at the yolk. Take your finger, or a blunt pencil, and try to turn it over, and you will notice that the covering of the yolk goes into all sorts of wrinkles and folds. So we find that the yolk is separated from the white by a thin layer of tissues or skin.

If you have been careful in breaking the egg, you will notice a little round spot at the top of the yolk This spot is about the size of a pea, and is called the germ spot ; and it is from this that the chicken grows when heat and other conditions are properly applied.

Fig. 87—An Incubator.

To study further the structure of an egg, we will have one boiled hard ; and, after removing the shell and lining tissues, we will tear loose a small piece of the white at the large end of the egg. Now by continuing to pull the torn portion from the left towards the right, you will notice that this white has a spiral arrangement. This is generally considered as giving strength to the egg.

Fig. 88.

We will next examine the yolk. Take the yolk out, cut through the centre, using a very sharp knife, and you will notice a small, flask-shaped portion of the yolk, which is soft and light in color, and that the neck of the flask extends to the outer edge of the yolk. Upon this the germ rests. The hardened portion of the yolk, you will notice, is arranged in regular rings around this flask. This flask-shaped portion is lighter than the rest of the yolk, and is therefore always uppermost. No matter how you turn the egg, this spot will be on the upper surface.

Let us ponder for a few minutes over the many things we have found in the egg content. The germ, resting upon a nice soft cushion in the yolk, the yolk covered with a thin skin, adjoining this is a very thin portion of the white, and outside this a thicker portion. Now these two portions hold the volk in position. If a sudden jar occurs, the yolk, or chiefly the germ, is protected by the skin of the yolk. The thin white portion acts as a pad or cushion, and the thick white portion holds it steady. Those extended cords of the thick layer of the white act as the axis of the yolk holding it in position ; and, as you turn the egg around quickly, you twist the cords similar to twisting a string, with the result that, as soon as the egg is steady, these cords unwind, and help to right the germ spot, on the upper surface again.

No doubt by this time you are wondering, if this germ-spot and the portion of the yolk under it are so light, why the yolk does not come right up against the tissues lining the shell. But nature has guarded against this by the thick layer of albumen, which always tends to hold the yolk in position. Sometimes when the egg is left for weeks in the one position, the thick layer is overpowered, and the yolk touches the wall of the shell. If the yolk remains against the wall any length of time, it appears to become fastened to it, after which you cannot successfully hatch a chicken from the egg. Being fastened in one position, the germ cannot move properly in order to develop, the result being that the germ dies. You may say a hen sitting on eggs never moves them, but in this you are mistaken. The next hen you set, put a large pencil mark on each of the eggs; and place the eggs under a hen with the pencil marks uppermost. Next day lift the hen, and you will see that she has altered the position of the eggs.

We have to imitate the hen in running an incubator, in that we turn the eggs twice a day. But some one asks, what is an incubator? Well, it is simply a well-built box, heated by a lamp, and the heat evenly distributed over all parts of the interior, so as to give the eggs the same temperature. This box is not exactly airtight ; for you know that if this little germ inside of the egg is going to develop into a chicken at the end of 21 days, it must have air. This air, you will remember, passes through those little holes in the shell, the good air going in, and the foul air coming off in much the same manner as you breathe. Now, you will see we have this incubator ventilated in order to supply the little germ with pure air. There is another point we nearly overlooked, that is the temperature.

If you will place a thermometer under a hen, you will notice that it reads 103 degrees ; so we try to run the incubator at that temperature.

If any of you would like to see that the germ spot always stays next to the surface, you can readily do so by taking a lamp after dark, and going to a hen that has been sitting four or five days. Wrap a black cloth around the lamp chimney, but first make a hole in the cloth, much the same shape as an egg, and have the hole exactly opposite the blaze of the lamp. Put the lamp on a little box, the hole facing you. Now very carefully remove an egg from under the hen, taking great care not to turn it over. Place your finger at the ends of the egg, and hold the egg in front of the light coming from the hole in the cloth that is around the chimney. If the egg is fertile, you will see a dark spot, and from this a number of little veins running in different directions. This is the germ, and it has started to grow. Now turn the egg slowly around, and you will observe that the germ moves as you turn the egg, always resting near the surface. It is best to take a white egg to see this, as white eggs are clearer than brown ones, and the germ is more readily seen through them. Should the egg appear clear, or no dark portion be seen, it is infertile, and will not hatch.

Fig. 89.—The latest thing out.

THE STORY OF WOOL.

PROFESSOR G. E. DAY.

The next time you visit a fall fair, be sure you do not come away without going to see the sheep. If you are fortunate enough to visit one of our larger fairs, such as at Toronto, London, or Ottawa, you will find the sheep pens a very interesting place. Here you will see many different kinds of sheep; some large, some medium size, and same small; some with white faces, some with brown or gray faces, and some with black faces; some with their faces so covered with wool that they can scarcely see out through it, and some with no wool at all on their faces; some with horns, and many with no horns,—in fact, the longer you look at these beautiful creatures, the more you will find to interest you There is one thing about sheep that makes them look very different from all our other farm animals, and that is the warm coat which they wear. This coat is so thick and so warm that the sheep can stay outside in the coldest weather without minding the cold in the least, while a horse, or a cow, or a pig will shiver and look very uncomfortable indeed. Now, the horse, cow, and pig have coats, too; but their coats are made of hair, while the sheep's coat is made of wool, and wool makes a much warmer coat than hair.

Fig. 90.—Lock of wool, showing coarse crimp.

Fig. 91.—Lock of wool, showing medium crimp.

Did you ever think of what is the difference between wool and hair? If you part a sheep's wool with your hands, you will find that it is made up of a great number of very fine wool hairs, or fibres, which grow out from the skin of the sheep so close together, and so long, that they form a coat which the wind cannot blow through. After handling the wool, you will find that your hands are quite greasy. This grease, or oil comes from the skin of the sheep and is called "yolk." It keeps the wool fibres soft and smooth, and keeps them from tangling or matting together. It also helps to keep out water, so that a sheep can stay out in quite a heavy shower of rain without getting its coat wet through. Then, again, if you look at these wool fibres closely, you will see that they are not perfectly straight, but that they have a wavy appearance. In some kinds of wool these waves, or bends, in the fibre are much closer together than in other kinds. Look at the two fibres shown in Figs. 90 and 91. In the first fibre there are very few waves while in the second the waves are close together. The finer the fibre is, the more waves it has, while wool with coarse fibre has very few waves.

These waves, or bends, are called the "crimp" of the wool. When the waves are very close together, the crimp is said to be fine, so that fine wool has fine crimp, and coarse wool has coarse crimp.

But there is another difference between wool and hair. If you get a single fibre of wool, and take hold of the end that grew next to the body of the sheep, and then draw the fibre between the finger and thumb of the other hand, you will find that it slips through very smoothly. But if you take hold of the other end of the fibre, and then draw it between the finger and thumb as before, you will find that it seems to catch, and does not slip between the fingers nearly so easily. Why is this? It is because every wool fibre has hundreds of very, very small scales on it, something like the scales on a fish, only so small that they cannot be seen without looking at the wool with a microscope, which makes the wool fibre appear many times larger than it really is. These tiny scales all point towards the outer end of the wool fibre, so that when you took hold of the outer end of the fibre and tried to draw it between the fingers of the other hand, the points of these little scales caught on your fingers and made it hard to pull. The picture, Fig. 92, shows how these scales grow on the wool fibre, but the fibre and scales are made to appear very much larger than their natural size. Hair also has scales upon it, but the points of the scales on the hair are rounded, and they lie so close to the hair that they do not catch hold of anything they rub against; while the scales on the wool fibre have sharp points and rough edges, so that they catch and cling to everything they touch. This difference in the kind of scales, is the most important difference between wool and hair.

Fig. 92.—Wool fibre, showing scales.

Now, when the weather grows warm in the spring, the sheep does not need its warm winter coat and so the farmer clips it all off, or shears the sheep, as we say. The wool is then sold, and is sent to the large factories where it is made into all sorts of clothing, blankets, yarn, and other goods.

Before it is made into cloth, the wool is twisted, or spun into yarn. If the wool fibres had no crimp, they would not stay tightly twisted together, and the yarn would be of very poor quality. Then the yarn is woven into cloth by machines, and the way the wool is handled in spinning and weaving causes the little scales, which we have described, to catch into one another, and the wool fibres become all tightly matted, or felted together, making a firm, strong piece of cloth. From what has been said, you will see the use of the crimp and the scales of the wool. The crimp makes it possible to twist the wool into yarn which will not easily untwist again, and the scales cause the wool fibres to stick together, or felt.

It would take too long to describe all the different things that can be made out of wool; so we shall mention only a few of the principal classes of goods. Wool that is very long, strong, and coarse in fibre is often called "braid" wool, because it is from such wool as this that braid is made. Then there is other wool, not quite so coarse as the braid wool, but still quite long and very strong in fibre; this is made into what are called "worsted" goods. Worsteds are used very commonly in making men's clothing. Some sheep produce wool that is quite long and yet very fine in fibre. Wool that is between two and three inches long and very fine in fibre usually sells for a higher price per pound than other kinds. It is used very largely for making ladies' dress goods, such as delaines, and is often called "delaine" wool. Wool that is short and fine in fibre is used for making such goods as broadcloth, fine underclothing, tweeds, and other goods of that kind. Some wool that is long and coarse has weak spots in its fibres; and any wool that has weak fibres cannot be used for delaines, worsteds, or braid, but is made into cheap tweeds, blankets, coarse underclothing, carpets, coarse stocking yarn, and such like. Thus, you see, there are many kinds of tweed, underclothing, blankets, and such goods, depending upon the quality of the wool that is used in making them.

Such goods as delaines and worsteds have a smooth surface. This is because the wool is put through machinery which stretches the wool hairs out straight, and they are then twisted together in such a way that all their ends are tucked in out of sight. This stretching is called "combing," and the wool fibres must be sound and strong in order that they may not break during the operation. But if you examine a piece of tweed or blanket, you will see the ends of the wool hairs standing out from the surface, making the material look rough. This is because the wool has not been combed, but has been put through a process called "carding," in which the wool is rolled up in such a way that when it is spun, the ends of the wool hairs stand out from the yarn and give a rough appearance to the cloth after it is woven. As a rule, wool that is less than two inches long is not combed, but is used for carding; and wool that is weak in fibre will not stand combing, and therefore must also be carded. There are many other interesting things which might be said about wool, but I shall simply ask that whenever you see a sheep, you will think of what you have learned about the wonderful coat it wears, and remember that we should always be kind to these gentle and timid animals because we owe to them much of the most beautiful and most comfortable clothing which we wear.

TOMBOY THE STORY OF A COLT.

J. Hugo Reed, V. S.

I am a four year old filly. My name is Tomboy. My mother is a half-breed, and her name is Duster. My sire's name is Jim Wassen; he is a thoroughbred. Therefore I am three-quarters bred. My mother is a large white mare, a great favorite of my master, who both rides and drives her. She is a grand saddle mare and hunter. She likes to gallop across country after the hounds with my master in the saddle. She jumps over fences, ditches, stone walls and anything that is not too high; she can

Fig. 93. Tomboy's Mother, "Duster,"—26 years old.

run fast and jump better than the other horses in the hunt. She is large and strong, and although my master weighs 200 pounds, she likes to carry him as he is kind to her, rides her well, and never pricks her sides with the spurs, nor hits her with the whip, nor hurts her mouth by bearing too heavily on the reins. He has always been kind to her and fed her well, and that is why she is strong and sound and as lively as when she was young, although she has done a greal deal of hard work in both harness and saddle.

The first thing I remember was one Sunday morning in May, 1898, when my master and Ernest, his stable man, came to the stall where my mother and I were. I was only about one hour old, but I was walking around the stall. They looked at me for a while, and then my master came into the stall and put his hand on me and spoke kindly. I was afraid at first and ran behind my mother, but he followed me, saying, "Poor little thing, do not be afraid, I will not hurt you;" so after a little time my fear left me, and I have never been afraid of him since, as he has always been kind to me, and provided me with a nice clean box stall with plenty of straw to lie on and good food to eat, and he never works me too hard. That morning, after looking me carefully over he said, "Well my little beauty, I am glad that you are a filly; you are tall enough but rather too slim, but time and good care will cause you to grow stouter; your knees are rather weak but they will grow strong after a while; I will call you Tomboy; and if you make as good a mare as your old mother you will do well." He then gave my mother a nice feed of warm bran and crushed oats and a drink of water. He told Ernest to clean the stall out and put in a liberal supply of clean straw. I liked to lie on the straw, and did so most of the time for a few days Whenever I got hungry I got up and took some milk and walked around a little. My mother did not lie down for three days after I was born; she appeared to be afraid to do so for fear of hurting me. My master and mistress came to see me often, and would always pet and handle me. I liked to see either of them come, and would always walk up to them to be petted. Ernest gave my mother her food and water, and kept the stall clean and well supplied with straw. He likes horses and was very kind to us, and we both liked him, and would do what he told us. When I was three days old, my master put a little halter on me and Ernest put one on my mother and led her out of the stall. I was not afraid, but did not know what to do. My master, however, was kind and did not get angry and jerk or hit me, but petted and coaxed me; he did not expect me to lead the same as a horse that had been trained to it; so I soon learned what he wanted me to do and went along with him. They took us to the yard between the stable and the house. I forgot to tell you that we live in town. There was some nice grass in the yard; and as soon as our halters were taken off and we were given our liberty, my mother commenced to eat it. The day was fine and warm, and it was nice to be out in the open air. I began to run around my mother and kick up my heels.

My master and Ernest stood and watched us and laughed at the fun I was having. Master said, "That is right, Tomboy, have a good time but do not hurt yourself, you are not very strong yet, and a little sun will do you good." When I became tired I lay down and stretched myself out in the sun. All this time my mother continued to eat grass, but would often look to see that I was all right; she was very proud of me. After a little while some bad boys came along and threw stones at me, one of them hit me on the head and hurt me. I jumped up and ran to my mother; the boys continued to throw stones and mother became greatly excited; she galloped around and whinnied, and my master heard the noise and ran out He was very angry at the boys, and told them that if they ever threw stones at me again he would horse-whip them. We were then taken back to the stable. We were taken out to the yard every fine day after that and left there for a few hours, and I soon became stronger. When I was two weeks old I had my photograph taken. You can see by it that I was tall and slight, and that my knees had not yet become quite straight. When I was about three weeks old we were taken out as usual. A third man was leading my brother, who was a year old. His name is Banbury. Instead of leading us to the yard as usual they took us in the opposite direction, down a long street, until we came to a gate. They led us through this gate into a field, took off our halters and set us at liberty. There was plenty of good grass in the field and a stream of nice cool, clear water running through it. Banbury and I had any amount of fun running and kicking up our heels; our mother would occasionally join us in our frolic, but usually she would just look on. I soon discovered that grass tasted nice, and I used to eat all I could. The weather was warm, and we stayed in the field day and night. There was plenty of grass and good water, and we had a good time with nothing to do but eat, drink, play, and sleep. After a while, the grass became rather dry and less plentiful, and the flies began to torment us during the day time. Our master soon noticed this, and every morning, about the time that the flies were beginning to trouble us, he would mount his wheel and ride down to the gate, which he would open. Then he would whistle; and as soon as we would hear him we would all gallop up to him, when he would put a halter on my mother and lead her out of the gate. We would follow, and he would then shut the gate, mount his wheel, and start towards home. Banbury and I would sometimes run ahead and sometimes lag behind; but we never got far away. We all were taken to the stable and put into our stalls, the windows of which were darkened to keep the flies out. Ernest then gave us some nice new hay and crushed oats, having nailed a little box up in one corner of the stall, just the proper height for me to eat out of. I was too small to reach my mother's feed box. When evening arrived, we were taken back to the field, as the flies did not bother us now, and it was better for us to be out than in the stable, and we liked it better. This was done every day until the weather became colder in the fall, and the nights were so cold that we would be uncomfortable in the field. The flies had mostly all disappeared by this time, so we were kept in the stable at night and turned out in the day time. After a time the weather became so cold that we were not taken

FIG. 91. Tomboy when two weeks old.

to the field at all, but were allowed to run out in the yard for a few hours every fine day. The time soon arrived when I had to be weaned. I was taken to a nice stall in a part of the stable distant from my mother. I did not like to be taken away from her. Neither did she like to be left alone. I was taken to her stall and left with her for a few minutes three times a day for three days; then twice daily for three days; then once daily for a few days; after which I was not allowed with her at all for a long time. By this time, I had grown quite stout and strong, and my knees had become straight, as my master said they would the first time he saw me. I was fed all that I could eat the first winter. Ernest gave me good hay and scalded chopped oats, with a carrot or two every day, and twice weekly he gave me a feed of bran. My stall was kept clean and well supplied with straw, and I was allowed to run out in the snow with Banbury every day that was not too cold or stormy. My master used to trim my feet every month. He said that the wear was not equal to the growth, and that if he did not keep them trimmed to the natural shape there was danger of them becoming ill formed and injuring me for life. He used to put a little bridle on me and leave it on for an hour or two every day. He said this was to give me a mouth. By that he meant to accustom me to the bit. I did not like it at first, but after a few days I did not mind it in the least. Then he put a set of little harness on me and left it on for a few hours daily. He soon put a check rein on the bridle. A portion of this rein was elastic. He fastened the rein to the check hook, but did not check me up tightly.

When I poked my nose out the elastic would stretch; but when I relieved tension it drew my nose back to the proper position. He said that this would gradually teach me to yield to the restraint of the bit, give me a good mouth, and thereby make me a more valuable horse, and more pleasant to ride or drive. I did well the first winter, and I learned a great many things that came very useful afterwards. When the grass became plentiful and the weather fine in the spring Banbury and I were taken out into the country and turned into a field on the farm of Mr B. This was about the end of May. Our master told Mr. B. to watch us closely, and if we should not do well to be sure to let him know. The grass was very nice, and there was a stream of clear, cold water running through the field. We enjoyed ourselves very much, and resumed the sports of the previous summer, as we were always great chums and never quarreled. In two or three days I began to feel unwell, my throat became sore, and I could not swallow easily. I felt cold all the time, although the weather was warm. I did not feel well enough to play with Banbury. I grew worse day by day. The soreness of my throat increased until I could not swallow anything without feeling great pain; my eyes became sore, tears ran down my cheeks, and I could not bear to look at the sun. My joints became sore. I had a painful cough and a discharge of mucous from the nostrils. Mr. B. saw us every day. One day he said to his son, "The filly has a cold, but I guess she will soon get over it." The son said, "But, father, you promised to let Mr. R. know if anything went wrong with the colts. You know he is very fond of them, and you should send him word about it." Mr. B. said, "I'll think of it some day when I am in town." I gradually became weaker, as I could neither eat nor drink. One day we saw our master coming down the lane, and we were both very glad. (Banbury was quite well, but was very anxious about my condition). We knew that he would do something to help me. As soon as he saw me he said, "Poor Tomboy, how you have failed. What is the matter?" Mr. B. was there, and after our master had examined me, he said to Mr. B., "Why did you not let me know that the filly was ill? You are in town mostly every day." He said that I had influenza, and that it would require very careful nursing to pull me through. He was very angry with Mr B. for not telling him. He took both Banbury and me home. I was very weak, and we had to go slowly. When we reached home he rubbed something on my throat and gave me some medicine, which did not taste nice but did me good. He and Ernest gave me a great deal of attention, and my throat soon got better, and I was able to eat. When I got strong enough he turned us out to pasture on Mr. W.'s farm, where we remained until the weather became cold, when we were taken back to town. The following winter we both did well. One day my master put a set of harness on me and drove me out on the street. I was so accustomed to harness and to do as I was told that he had very little trouble with me. He did this a few times, and then he hitched me to a light cutter. It was something new for me to have to draw a load, but I knew that it was all right, else my master would not ask me to do it. He walked behind at first, but I went all right, so he got into the cutter and I drew him too. He drove me a little every day for a couple of weeks, and I heard him tell Ernest one day that I was pretty handy now and would never give any trouble in harness. The next spring we were again turned out on good pasture and again taken to the stable in the fall. We were well cared for during the following winter. Banbury did some regular driving, and I was driven some to continue my education. The next spring Banbury was four years old and I was three. One day a man came to the stable and looked at all the horses. He asked if Banbury was for sale, and my master said, "Yes, I will sell him; he will make an excellent lady's saddle horse." The man said that he wanted him to send to South Africa with the mounted infantry. My master then said, "Well, you can not have him, as I will not sell him for that purpose;" so the man went away, and I was glad that he could not get Banbury to send to the wars. After a little while a lady came to the office one day and asked my master if he had a good saddle horse to sell. Banbury was taken out for her inspection. She liked his looks and asked if she might ride him. My mistress's saddle and bridle were put on him, and the lady mounted and rode away. When she came back she said she liked him, that his paces were good, and he had an excellent mouth and good manners. She bought him. I was sorry to see him leave the stable, but glad that he had been bought by a kind lady who wanted him for herself. My master saw him a few months later, and I heard him tell Ernest that he looked well, that he was homesick for a few weeks, but was now quite contented and happy in his new home, that his mistress was kind to him and very fond and proud of him. One day Mr. T., a friend of my master's, asked permission to ride me. He was told that I never had been ridden, that I was of a nervous, sensitive disposition and required very gentle, kind treatment, and that he would like to ride me first himself but was too heavy for me. Mr. T. said that he would like to try me, so a saddle and bridle were put on me, and I was taken out to a vacant lot. My master held me while Mr. T. mounted, and then led me for a while. I was afraid, as I never had weight on my back before, but while my master went with me I knew that it was all right and I went nicely. He said to Mr. T., "Now, I will let her go; be gentle with her and do not worry her mouth ; " so he let go. I became nervous then and made two or three plunges. Mr. T. sat me well, was easy with my mouth, and spoke kindly to me, so I settled down and walked along quietly. Mr. T. then said, "So my lady, you thought you could unseat me, but I will teach you that I am master here." He then drew heavily on the reins and hurt my mouth, and he hit me a smart cut with his whip, which caused me pain. This made me angry, as he had no right to punish me when I was acting nicely ; so I bucked and threw him off. He alighted heavily on the hard ground ; and I stood still until he got on his feet. My master came to me and caught the bridle ; he asked Mr. T. if he was badly hurt, and told him that he should not have punished me. Mr. T. said that he was not badly hurt and that he would mount again, which he did; and as he used me kindly I did not throw him again. The next day I heard my master tell Ernest that two of Mr. T.'s ribs had been broken by the fall. I felt sorry, but really it was his own fault. After this I was ridden daily by Ernest. He was kind to me, and I acted well. I soon became handy, and Ernest said that I was very easy to ride. One day my mistress asked if she might ride me, and my master said yes, that I was perfectly safe. So they put saddles and bridles on me and my mother, and my mistress and master rode us. After that she rode me often, and said that she liked me better than her own saddle horse. She sits me well and has very light hands. I like to have her ride me. She says that I walk, trot and canter well, and that my mouth is perfection. One day she asked me to jump a ditch, and I did it so well that she tried me over fences. I like jumping ; I think I inherit the liking and ability to jump from both my parents. When the hunting season commenced, my master rode a big bay half-breed that he calls Pharoah, and my mistress rode her big bay half-bred mare, Dorothy. There are so many barbed wire fences and so many swamps around here that they cannot hunt foxes as they do in some countries ; so the huntsman rides across the country with a ball soaked in oil of anise


Fig. 95. The colt gives a lesson.

trailing after him. He avoids swamps and barbed wire fences. Then the club comes out on horseback, and the huntsman brings the hounds out. The hounds scent the anise, and follow the course that the huntsman had gone. This is called hunting a drag. The hounds make a lot of noise, which is called giving tongue. I heard my master tell the huntsman one day to make a short run, as he wanted to try Tomboy across country, and that he would ride Duster; that the one was too young and the other too old for a long run, and to make it about four miles. So we were taken out one afternoon. My master rode my mother, and my mistress was up on me. As soon as the hounds came in sight I noticed that my mother became excited. She pawed the ground and champed the bit and wanted to be off. I did not understand it, as I saw nothing to be excited about. There were about twenty ladies and gentlemen in the saddle. After a while the hounds scented the drag, and one of them gave tongue. My master said, "Old Cecil has found it; steady Duster, steady."

Away the hounds went over the fence. My master had his hands full controlling his mount, but he managed to steady her and said to my mistress, "Now, I will give you a lead; steady her well at her jumps." He gave my mother her head and took the fence. I followed and off we went after the hounds. The other riders followed. My mother was very anxious to go fast, but her rider held her in, and said to my mistress, "Keep Tomboy back for a while; we will save our mounts at first, and see if the old mare and her daughter cannot beat them all out at the finish." I soon understood my mother's excitement, as I was becoming excited too, and anxious to run to the front. Our riders held us back without being severe or cross with us, and we jumped everything that came in the way. We enjoyed the sport as much as our riders. My mistress talked to me and praised the way I was carrying her, and said that she would let me have a brush with my mother at the finish. By this she meant that she would let me try to outrun her. I would rather have gone faster, but wanted to please my mistress, and I knew that she was the better judge. Some of the riders were ahead of us and some were behind as their horses refused to jump. We went along steadily and did not make any mistakes, but took our jumps well. After we had gone about three miles we noticed those in front of us stop short. The riders took their mounts back and then turned and whipped them; after which they ran to a certain place and balked. Two of the riders went forward over their horses heads and were lost to view, while the horses galloped over the field with empty saddles. My master said to my mistress, "They have come to a stream and the horses refuse to take water." He meant that they would not jump over the water. "It is a broad jump and our mounts will require speed to take it; steady Tomboy and follow me, but do not whip her." He gave my mother her head, and she went fast, with me close up. We passed through the other horses and both jumped the stream with ease. The hounds had lost the scent and were running around the field without making any noise. We came to a standstill and got a rest. Our master blew his horn, when every hound raised his head and looked towards us. He blew again, and they all came to us. In the meantime, some of the horses got across the stream, but some would not take it. Master told th hounds to hunt and Cecil again found, and gave tongue. The others soon joined her, and away they went, making a great noise. Both my mother and I were excited now and anxious to be off, but our riders controlled us until the hounds got well away, when our master said, "We are near the finish now so let us have a brush and try Tomboy's mettle." They gave us our heads and off we went side by side. I was anxious for my mistress to win; but my mother can run fast even though she is old. We left the other horses behind. There was an open gate leading into the road, and about a quarter of a mile off we saw the hounds had lost again, and we knew that this was the finish. We ran down the road very fast; and just at the last I got about half my length ahead of my mother and won.

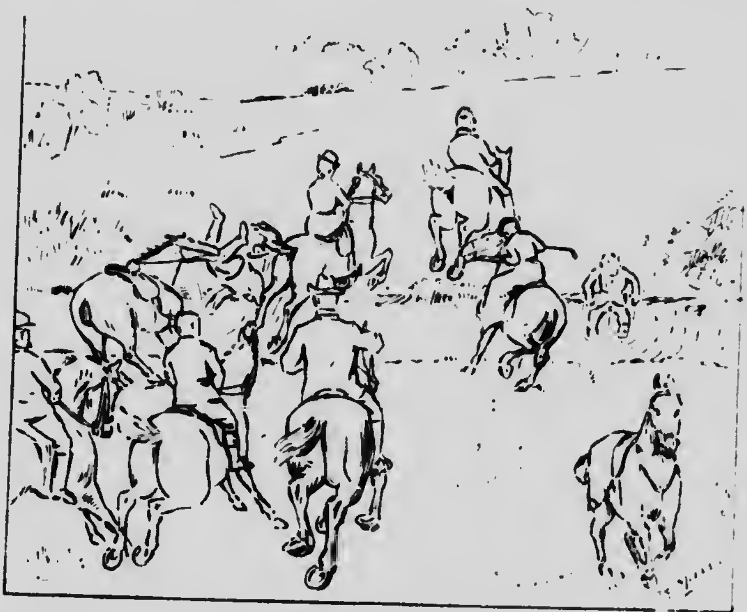


Fig 26. Tomboy and Duster lead the way.

I think she allowed me to do so, but she will not admit it. This was near home; so we were ridden home; and my mistress gave me great praise and said she would never allow me to be sold, but would keep me for her own saddle horse. I was glad that I had done so well, as I liked my mistress and had a good home, and a horse never knows what kind of a master he will get when he is sold. We were taken home and given a few mouthful's of water, put into our stalls, and given a nice warm mash each, rubbed until we were dry, and bandages put on our legs, and left on for about three hours. The next day we were given some walking exercise, and we both felt quite fresh. My mistress intends to ride and hunt me regularly; but my master says my mother is too old for such violent exercise, and he does not think he will hunt her again. He says he will keep her as long as she lives; that it would be mean to sell so good a servant in her old age, and that he could not bear to see her owned by any person who might not be kind to her.