The Agricultural College

EXTENSION BULLETIN

VOLUME II JANUARY, 1907 NUMBER 5

THE FORMATION OF THE SOIL

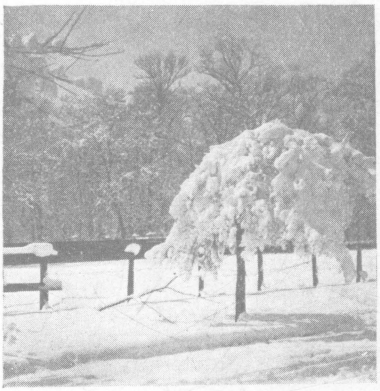
BY PROFESSOR ALFRED VIVIAN

Announced by all the trumpets of the sky,
Arrives the snow, and, driving o'er the fields,
Seems nowhere to alight; the whited air
Hides hills and woods, the river and the heaven,
And veils the farm house at the garden's end.
The sled and traveler stopped, the courier's feet
Delayed, all friends shut out, the housemates sit
Around the radiant fireplace, inclosed
In a tumultuous privacy of storm.

—*Emerson.*

PUBLISHED MONTHLY BY THE OHIO STATE UNIVERSITY
COLUMBUS

Entered as Second-Class Matter, November 17, 1905, at the Post Office at Columbus, Ohio, under Act of Congress, July 16, 1894.

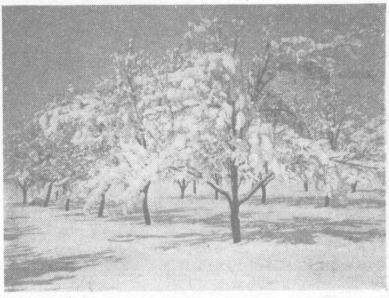


The Snow

"From the clouds the flakes of snow
Wander to the world below,
Falling lightly,
Softly, whitely,
To the ground,
Heaping drifts without a sound.

"Now the wind begins to blow,
Lighter, swifter, comes the snow,
Falling thickly,
Rushing quickly,
Soon there'll be
Castles built for you and me."

—*Selected.*



Talking in Their Sleep

"You think I am dead,"
The apple tree said,
"Because I have never a leaf to show—
Because I stoop
And my branches droop,
And the dull gray mosses over me grow,
But I'm still alive in trunk and shoot;
The buds of next May
I fold away,—
But I pity the withered grass at my foot"

"You think I am dead,"
The quick grass said,
"Because I have parted with stem and blade,
But under the ground
I am safe and sound
With the snow's thick blanket over me laid.
I'm all alive and ready to shoot,
Should the spring of the year
Come dancing here,—
But I pity the flowers without branch or root."

"You think I am dead,"
A soft voice said,
"Because not a branch or root I own,
I never have died
But close I hide,
In a plumy seed that the wind has sown.
Patient I wait through the long winter hours;
You will see me again,—
I shall laugh at you then,
Out of the eyes of a hundred flowers."—*Selected.*

THE FORMATION OF THE SOIL

By Professor Alfred Vivian

One could scarcely imagine any subject for discussion more commonplace than that of the soil. Nor could one think of anything which would be less likely to prove interesting to the careless observer. We are accustomed to think of the soil as merely "dirt," a thing to be shunned as far as possible, and kept hidden from sight. Perhaps you will not think the soil worthy of interest and study, but did you ever stop to think that without the soil we could not be living in this world to-day. The food which you eat could not have been produced if there was no soil, for the plants which make the food for animals, in their turn derive all their nourishment from the soil. So, you see the soil is after all very important to mankind.

"Underneath all soils are found solid rocks."

We are so familiar with the soil as it now exists that most of us do not stop to think that it was ever anything different, but it has really taken a long time for Nature to form what we call the soil, and in doing so she has employed the wonderful agencies about which something will be said in this article. Some one has defined the soil as "that portion of the earth at or near the surface, which consists largely of fine particles." And again it has been described as that part of the earth into which the plants send their roots and from which they take much of their food. Well, if the soil is the portion of the earth at the surface, what is below the soil? Most of you know that if you dig down deep into the soil you will come to solid rock. Sometimes rock is reached a few inches below the surface, and again you must dig many feet before you come to it,

but sooner or later you are sure to find a bed of stone. We learn therefrom this first interesting fact that underneath all soils are found solid rocks.

Now, if you were to examine a sample of soil with a strong magnifying glass or a microscope, you would find that it is largely made up of very fine particles of rock. Mixed with these particles is a much smaller quantity of black material which is called organic matter, or sometimes humus. A little closer examination will show that the organic matter is simply the remains of plants which have formerly grown upon the land, and which have partially decayed or rotted in the soil. Take a small quantity of a black soil, heat it in the lid of a baking powder can, and see if the odor that comes off is not very much like that you notice on heating bits of leaves in the same way.

We find then that the soil is composed of small particles of rock mixed with the remains of former plants, and that by far the larger part consists of these rock particles. This suggests the thought that the soil has been formed from the solid rocks such as are found beneath it, and this, indeed, is what the men who have studied the subject have found to be true.

Geology teaches us that at one time all the surface of the earth was solid rock. At that time there was nothing like what we now know as the soil. These rocks contained all the constituents necessary to make a soil, and all the substances which the plants use as food with the exception of the element nitrogen. This plant food, however, was not in forms in which the plants could use it. Suppose you had a sack of wheat. You know that there is plenty of food there to nourish you for some time but it is not in a very good form to eat so long as it is in the whole wheat kernel. One of the first things you would do would be to grind it to a flour. And that is one of the first things that Nature does in preparing the food for plants; she grinds the rocks to flour. In other words the first process in the formation of a soil is the pulverization of the rocks.

Nature uses several methods to bring about the grinding or pulverization of the rocks. The first of these is change of temperature, or heat and cold. If you examine a piece of granite you will find that instead of being a simple rock it is composed of different minerals cemented together. Now these minerals are differently affected by heat and cold. You know that most substances expand when heated. The amount of expansion varies for the different minerals in the granite and as a result the effect of change in temperature is to separate the minerals, thus breaking the rock into smaller pieces.

If you look carefully at any piece of stone you may pick up you will find numerous cracks and openings in it. These cracks become filled with water and in the cold weather the water freezes. You know when water turns into ice it expands with great force and consequently when the water in the cracks freezes it tends to break the stones into pieces. If you have ever known water to freeze in a bottle or jug you know what force it exerts and from this you can see how easy it would be for the ice to break bits of stone off the surface of larger rocks.

More important than either of these factors, however, is the action of running water. You would hardly think that such a soft substance as water would do much grinding, but water running over stones grinds off

"Deep valleys are worn into the surface of the earth, and the fine material is carried away to form a soil at some other place."

the surface slowly but surely. If the stream is swift enough to carry along particles of sand or stone the grinding takes place more rapidly. A rapid mountain stream, for instance, tumbles the boulders along, causing them to rub against each other until they are ground to powder, and

"Running water grinds off the surface of the stones slowly but surely."

at the same time the bed of the stream itself is worn away. In this way deep valleys are sometimes worn into the surface of the earth and the fine material is carried away to form a soil at some other place.

Another agency which helps to grind the rocks is moving ice in the form of glaciers. At one time all of the northern part of our country was covered by a thick sheet of ice. This immense glacier pushed its way slowly down from Canada. As it moved south it carried with it large quantities of rocks, grinding them against each other until they were reduced to particles of various degrees of fineness. Later when the climate became warmer the ice melted and this rock material remained behind to become a part of our soils. So you see there are a number of ways in which the rocks are ground to smaller and smaller fragments until they become as fine as the particles in what is called soil.

But a soil produced by mere grinding of the rock alone is not suitable for the growth of farm crops. If you grind your wheat into flour you must still further prepare it before it is fit for food. In the same way the food in the rocks must be prepared for the plants. We say that the food must be made "available" to the plant, or in other words it must be made soluble so the plants can absorb it through the roots. Water is important in bringing about this change also. Pure water will not dissolve much of the rock, but the water which falls on the soil contains carbonic acid gas taken from the atmosphere, and water containing this gas will dissolve much larger quantities of the rock minerals. The oxygen of the air also helps to make the plant food available. You will see, then, that at the same time the rock is being ground its nature is being changed so that it is more readily dissolved.

These processes so far described combine to make the plant food in the rocks available, but it has been found that the mineral matter alone cannot support plant life. A soil to be fertile must contain nitrogen as well. All the nitrogen in the soil came originally from the atmosphere. The air is four-fifths nitrogen, but it is in a form in which most plants cannot use it. Before it can serve as a plant food it must be combined with oxygen to make nitrate nitrogen. A little of this is formed in the air during electrical discharges and is carried into the soil by the rain water. This amount, though very small, is probably sufficient to enable plant growth to begin.

Vegetation begins with the very simplest forms of plants, such as lichens and mosses, and is, of course, very scanty at first. These plants on dying become a part of the soil, all of the plant nutrients used by them being thus returned. Food that has once been used by plants is very readily made available to succeeding crops through the process of decay. The soil is now able to produce a larger crop, as it contains the plant food in the previous growth in addition to that added through the agencies detailed above. In this way the growth gradually becomes more abundant. The plants upon decaying give rise to humus, and this increases the fertility of the land both by being a source of plant food and by increasing the water-retaining power. Humus is a very important factor in fertility. During the decompositions of the plants, acid substances are formed which act upon the rocks in such a way as to make more of the plant food available. One of the products of decay or fermentation is carbonic acid gas, and this is dissolved in the soil water, and this gas-containing water is an important help in disintegrating the rocks.

LICHENS ON GRANITE ROCKS.

MOSS ON GRANITE ROCKS.

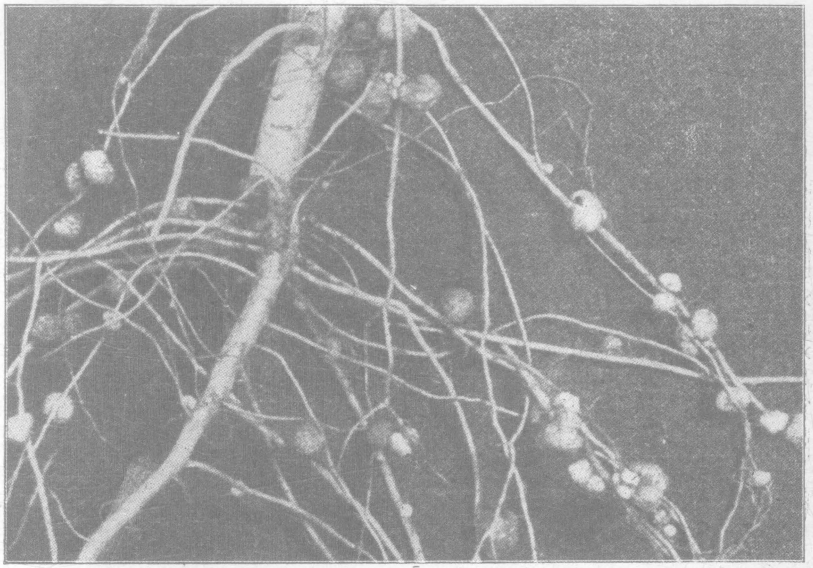
"Vegetation begins with the very simplest forms of plants, such as lichens and mosses.

As the nutritive materials increase from these various causes the lower and simpler forms of plant life are gradually replaced by those which are more highly organized. With the advent of plants, like our common crops, which bear roots other factors in the formation of soils are introduced. The roots secrete an acid substance that has a solvent effect on the mineral matter of the soil, and assist mechanically in breaking down the rocks. All are familiar with the tremendous force exerted by plants in breaking apart rocks and stones if once their tender rootlets obtain a foothold in a crevice. The roots penetrate the soil sometimes to great depths, and, as they decay after the death of the plant, they leave little channels in the soil which serve to carry down water laden with carbonic acid, as well as to introduce the oxygen of the air, that, in its

Nature's method of increasing the humus and soil fertility. Notice the rotten log and the leaves decaying, thus returning plant food to the soil.

turn, is a factor in bringing about chemical changes in the soil, which assist in making plant food available.

Sooner or later in the process of soil formation, plants of the pulse family (leguminous plants) such as clover, vetches, lupines, etc., are introduced. If you dig up some of these plants you will find little nodules or tubercles on their roots. These nodules are the homes of numerous bacteria, which enable the plants to derive part of their food from the nitrogen of the atmosphere. This peculiar property of leguminous plants is of great importance, for it is undoubtedly Nature's principal method of increasing the supply of nitrogen in the ground. The nitrogen compounds accumulated by these plants eventually become a part of the soil through their decay, thus adding to its fertility.

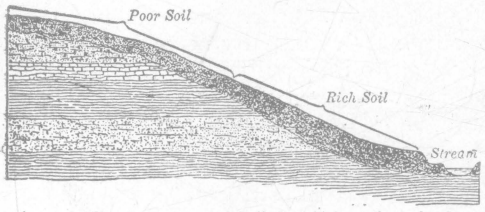


NODULES ON THE ROOTS OF COWPEAS.
Clover, alfalfa, and sweet clover have much smaller nodules.

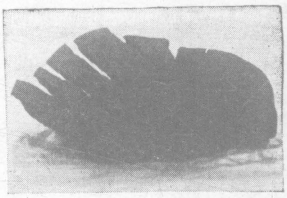
It will readily be understood that the various agencies concerned in the formation of the soil do not act separately nor necessarily in any such order as that in which they have been discussed. As a matter of fact all the processes described take place simultaneously. The lower plants do not wait for the rocks to be pulverized, for we see such organisms as the lichens growing on rocks from which one would think it impossible for them to obtain food. If the lichen is removed, grooves or furrows will be found on the surface of the stone, due to the action of the plant. Nor are all soils formed directly from the original rocks, for one of the effects of weathering, etc., is to separate such rocks as the granites into simpler substances, with the result, for example, that huge deposits of limestone are formed in one place, and in another whole hills of sandstone.

The soil is almost constantly moving, for some of the same agencies which form soils are continually carrying them away. Running water grinds the rocks, but at the same time transports the fine particles to

lower levels. It cuts deep valleys in the surface of the earth and carries away the debris, depositing it at various distances from its source. Notice a stream muddied by a recent rain; the mud will be deposited somewhere to help form a soil. The soil is always moving from a higher to a lower level, consequently, it is thinest at the top of a hill and deeper in the valley. Lakes and ponds are gradually filling up and in time become fertile fields. If the pond is largely filled by the remains of the plants which have grown on it a humus or peaty soil is formed.



Showing movement of soils from higher to lower levels.



The effect of freezing on rock.

Sedentary and Transported Soils.— Soils which have been formed from the rocks directly beneath them are known as "soils in place," or sedentary soils. These partake very nearly of the composition of the underlying rocks. Transported soils, on the other hand, may bear little resemblance in composition to the rock upon which they lie. Those deposited from water are called "alluvial soils," and are found in the river valleys and in the beds of former lakes, and are usually very high in fertility. Those transported by glaciers are known as "drift soils." A large part of the northern United States is covered by drift which was pushed down from the north by the glaciers that once covered that section, and was left behind as the ice melted away. Drift soils are distinguished from all others by the presence of rounded boulders of various sizes, and are usually fertile, although very variable in composition.

"Lakes and ponds are gradually filled up and in time become fertile fields."

"Drift soils are distinguished by the presence of rounded boulders."
Notice the line of true soil at the top of the bank.

The important lesson to be learned from a study of the origin of the soil is, that Nature undisturbed has many ways of adding to the supply of available plant food in the soil. The various forces which have been

An unfinished soil. Nature has not completely reduced the stones to powder.

under discussion have all tended to change more and more of the food into forms that can be assimilated by the plants so that the amount of vegetation which the soil can produce has been constantly increasing. Under natural conditions this growth is not removed from the ground, but is again made available, so that the land is constantly increasing in fertility. It will thus be seen that the fertility of the virgin soils is the result of accumulations due to a variety of forces acting doubtless through countless ages, a period during which practically nothing has been removed from the soil while much has been added to it.

Man, on the contrary, has reversed this process and while adding little to the soil has removed much from it. Through the constant harvesting of crops and by leaving the ground bare and exposed to the action of the elements, he is rapidly depleting Nature's store of food and the yield steadily becomes smaller.

This study of the formation of the soil then suggests two things that the farmer can do to prevent the exhaustion of the fertility. The first is to so treat the soil as to assist and hasten nature in the process of converting the plant food into available forms by means of good tillage. The second is to return to the soil by means of manure and fertilizers an amount of plant food equivalent to that removed by the crop.

FARM LOSSES

Thousands of dollars' worth of farm implements rust out every year because no care is given to putting them away properly or protecting them from exposure to the weather.

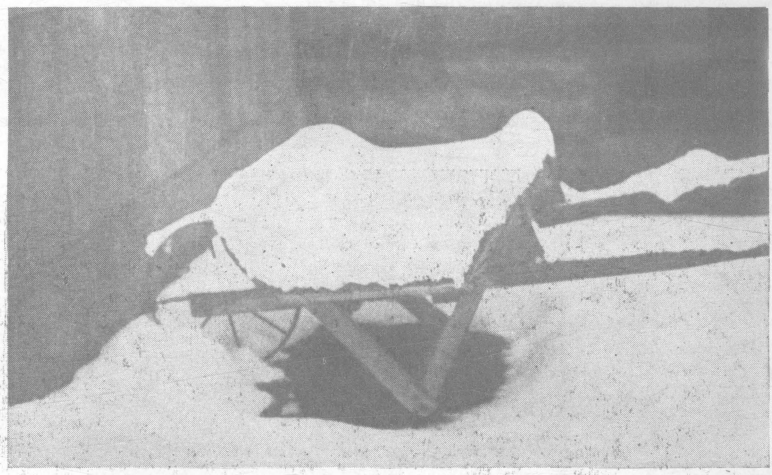
Under the sleet and the snow,
Waiting the junkman's day.

It has not been many years since the frames for harrows, grain harvesters, and a few other farm implements were made of wood. To-day nearly the entire implement or the parts that must be strongest are made of steel. When these implements were made of wood many could be seen

rotting to pieces, or after more years of exposure than use they were knocked to pieces to feed the kitchen-fire. But now that they are made of steel, after an exposure of ten or eleven months each year, they become a part of a great junk pile.

Where may one look to find such a show of negligence? As one goes along any country road there can be seen in the middle of winter a corn plow just where it was left at the end of the field at the close of a warm June day. If it is ever used again is it strange that the shovels will not scour?

Here is a roller with a tongue pointing upward over a fence, and there a harrow over which the grass has woven a soft cover, folded and abandoned, it stands for "Absence of owner and care" like an A of a nursery rhyme. The hay-rake or the hay-loader is in the open meadow or at the edge of the wood lot waiting for the haying time to come again. The farm wagon and wheelbarrow in the barn lot, share alike the alternations of rain and shine. On a picket fence a rusty bladed hoe and a



The old wheelbarrow taking its share of exposure.

dirty rake and against it a rust reddened spade remind one that once a garden was at least begun. The binder left where the last sheaf was dropped and the mower at the end of the last round speak loudly of the indifference of the land owner as to sufficient shed room or of the thoughtlessness of the owner of the implements.

Is it necessary for you to imagine a farm yard picture in which there is an assembly of implements under the shade of a walnut or an old apple tree or can you see such a scene day after day on the road to town or to school?

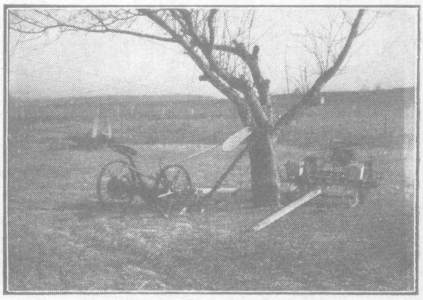
Oil will usually prevent rust. Shelter for the implements and oil for bearings and the exposed surfaces of metal such as the mould-board, shovels, etc., are things which must be provided.

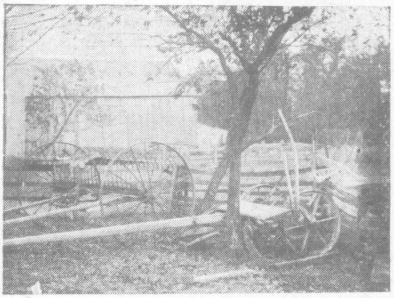
Stop just a moment and calculate how many days each year a self-binder is used. Make a calculation as to the time other expensive implements are used each year. Make a table of the cost of each one. Don't

you think it a pretty heavy investment for the time they are in actual use? Ask some one to find out how many years his most expensive implements have been in use.

There are some who pay a little cash down and make a small payment each year. In one year from the last installment the dealer makes a new trade, taking in the first machine at a price that wouldn't purchase half the raw material for the new one!

The latest improvement, the newest attachment, and the brightest paint and polish should not be permitted to argue too strongly in making new purchases.

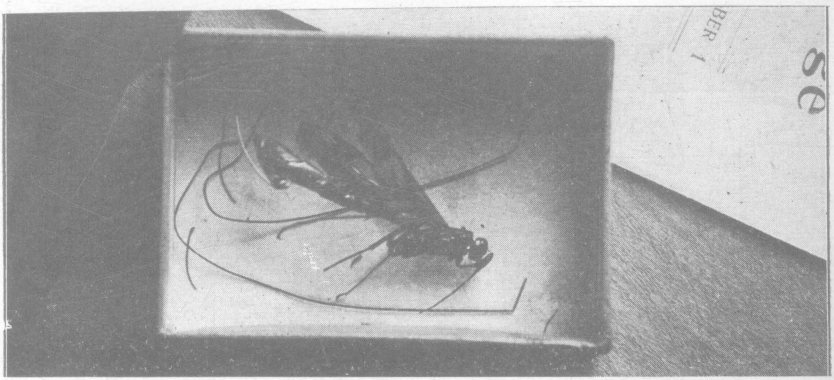




Where one may look to find a show of negligence.

From the Unknown to the Known

This department makes a standing offer to name plants and insects which are carefully packed and mailed or expressed to it. If the sender will pay the charges from his home to the College of Agriculture specimens will be returned at our expense if it is desired that they be returned.



An ichneumon as it was sent to the Agricultural College at Columbus, to be named for a teacher.

Many teachers and children have taken advantage of this offer. As a result some very interesting plants and insects have been received. There have been more of the common things that any of us are likely to pass day after day and look upon with little or no interest. A whole world of common objects lie about us. Should we not become acquainted with these first?

The offer that this department makes is only one way of assisting you to become acquainted with your nearest neighbors.

Agricultural Clubs for 1907

Teachers who are expecting to have their children do some planting and field work at home, to direct their attention during the growing season to subjects discussed at school, will be furnished *field seeds*, direction sheets, and record and report blanks, free, by the College of Agriculture. *Garden and flower seeds will no longer be furnished free* except to those who have made reports on garden vegetables and flowers for *1906*. Names of children should reach us not later than the *first of March*, 1907, in order that those having only eight-month schools can be reached in time. While it is desired that a brief report be sent to the College of Agriculture, it is intended that what work is done shall be a part of the school exercises, rather than a requirement of this department.

The vacation period presents an opportunity to make observations that cannot be made during the school term. Every boy or girl receiving the BULLETIN is required to send in his report on what has been grown from seed sent, or write a letter about his school, home or pets, or send a photograph of some animal belonging to him, to entitle him to the BULLETIN for the coming year.

Sleighing Song.

R. T. KNOX. S. G. SMITH.

1. Hark! the mer - ry bells are peal - ing, Joy - ous - ly we speed a - long;
2. Light - ly now our hearts are bound - ing, As we glide a - cross the snow;

O'er the snow the moons - beams steal - ing, As we sing our sleigh - ing song.
Hill and vale with joy . . . re - sound - ing, All is hap - pi - ness . . be - low.

CHORUS.

Tink - le, tink - le, tink - le, tink - le, hap - py, hap - py voic - es, Tink - le, tink - le,

tink - le, ming-ling with the sweet-toned bells; Tink - le, tink - le, tink - le, tink - le,

all the earth re - joic - es, Tink-le, tink - le, tink - le, har - mo - ny in nat-ure dwells.