amount of heat is formed, and through these changes there is produced that energy which enables the plant to continue the general functions of growth.

The carbon dioxide of the air, though present in such minute quantity, is quite sufficient for the require ments of vegetation. As it is exhausted by the growth of plants, it is as constantly being returned by the respiration of animals, by the decay of both animal and plant remains and by the consumption of fuel in houses and factories, so that the amount is fairly constant, although somewhat greater near large towns and manufacturing centers than in the open country.

The gas passes into the plant through the pervious epidermis and also through the stomata when present, and is thus brought directly into the living cells of the plant. Here it comes in contact with water brought up from the soil, and these two compounds are then broken up into their constituent elements oxygen, hydrogen and carbon, which again unite in different proportions giving rise to solid products such as starch, and ultimately to sugars, oils, &c., together with free oxygen which is then returned to the atmosphere. These changes may be represented in a general way by the following chemical equation.

$6\,(C\,O_2) + 5\,(H_2\,O) = C_6\,H_{10}\,O_5 + 12\,O$ from which we learn that six molecules of carbon dioxide (CO_2) in connection with five molecules of water (H_2O) will give rise to one molecule of starch ($C_6\,H_{10}\,O_5$) and twelve atoms of free oxygen. Or if we state this in measures of weight, we find that for every 162 pounds of starch formed there will be required ninety pounds of w ter and two hundred and sixty-four pounds of carbon dioxyde, while one hundred and ninety-two pounds of oxygen will be returned to the air.

The starch thus formed at once goes to the building up of new structure, or if the growth of the plant is slow, as towards the end of the season, the excess of nutriment formed, is stored up to meet the requirements of growth at some future time, and thus we gain an insight into those processes upon which depend the entire value of farm crops for purposes of human alimentation. One fact is made prominent in the changes noted, and that is, that the fixation of carbon from the air results in a direct increase of the dry weight of the plant, while from what has already been seen concerning respiration, it becomes obvious that its effect is the direct opposite.

It is now essential that we note the conditions under which these important changes take place. Carbon dioxide can be take taken up from the air only by those plants which are green or contain chlorophyll. Therefore, we may reasonably conclude that such colorless plants as the mushroom must depend upon some other source for their carbonaceous food, and this source we discover to be in decomposing animal or vegetable matter.

A second essential condition is that plants be under the influence of sun light. When a green plant is trans ferred to a dark room the fixation of carbon wholly ceases, and the same is true of all plants at night. The growth of plants during the night is thus dependent upon the food accumulated during the day time, while the growth of bleached celery or of potatoes sprouting in a dark cellar, is likewise dependent upon the food already stored up in the tissues, and the growth must in all its essential aspects, be like that of the mushroom.

It may of interest to note in passing that this function in plants has, in past ages, exercised a most important influence upon the atmosphere of the earth and consequently upon the development of the higher forms of animal life. During the carboniferous age, the atmosphere of the earth was heavily charged with carbon dioxide and air breathing animals were unknown. At that time vegetation was extremely luxuriant and as it drew the carbon dioxide from the air, the latter became gradually purified until it eventually acquired the composition we now know. But the carbon accumulating in vegetable remains through long periods of time, eventually passed into the condition of coal as we now find it.

From the statement already made respecting nitrogen and ammonia, it might be inferred that leaves of plants are wholly incapable of taking up nitrogenous matter. While this is true in general, we must point out a limited exception to this law.

Certain plants such as the flytrap and the pitcher plant have for a long time been known, as was shown very clearly several years since by Darwin, to possess the power of digesting insects and even meat, and in consequence are known under the general name of insectivorous plants. It has for a long time been a matter of speculation how this digestion is accomplished, but recent investigation show that when an insect is brought in contact with the leaf of such a plant, it throws out a certain secretion which favors the rapid development of bacteria. These latter then seize upon the insect or the meat and convert it into soluble albuminoids which can then be taken up by the plant. The inference that these organic substances then serve as food is a justifiable one, but it is altogether improbable that the plant is in any way dependent upon food so obtained. While this process is of great interest from a scientific point of view, it has no value with respect to agricultural operations, since none of the plants having this power bear any relation to human alimentation

We may then recapitulate the leading points raised :

1. The food elements of the air are carbon and oxygen.
2. The air is the only source of carbon to the plant.
3. These gases are taken into the plant as free oxygen and as carbon dioxide.
4 The oxygen is essential to respiration.
5. The carbon dioxide is essential to the formation of new structure, and its fixation results directly in an increase of dry weight through the formation of starch and allied compounds with the liberation of free oxygen.
6. Carbon can be fixed only under the influence of chlorophyll and sunlight.
7. These gases enter the plant by diffusion through the epidermal membranes and also through the stomata. The leaves of plants are incapable of taking up the free nitrogen and ammonia of the air.
9. In a few cases, the leaves of plants may take up soluble nitrogenous matter

FIFTEEN MINUTES

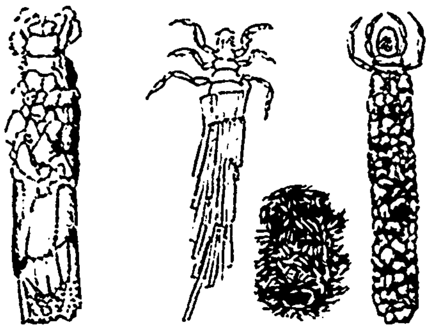
BY A TROUT BROOK.

R. E. H LOWE.

Come over the pasture bars and down by the brook, I have a small pet to show you. No, it is not the fish you know so well from tip to tail. But you are a beauty, Mr. Trout, and how easily you float! That is because of the silvery gas bag fastened beneath your spinal column. We also know about the luck stones floating in your bony ears, and that you are able to keep your mouth open so long without drowning because the water passes through the mouth and over that pile of blood-red brushes, or gills, inside, by means of which you breathe. So no wonder you gasp and die as soon as you are taken out of the water. But you need not eye so hungrily that poor little thing down on the bottom, just thrusting his head out of his front door If you try to gobble him up, you will have your labor for your pains, for, like a flash, his head will disappear, dart after him as quickly as you may.

This little creature at the bottom is well worth our attention. Can it be that the tiny mite built the wonderful stone mansion himself? He must have a glue-manufacturing establishment in his body, instead of an air bladder. See the litte house, a two-inch cylinder, a quarter of an inch in diameter, fashioned from gravel stones and sticks, just big enough to hold its occupant. He is quite modest, for, you see, he has put his brown stone front in the rear.

Now take the little builder up, house and all, and hold him in your hand. Try to pull him out of his case, and you will find that he has hooked himself in by his hind feet. If he feels lively, he will try to get away from you by biting hold of the skin of you hand with his strong jaws, and pulling himself



HOUSES OF THE CADDIS WORM.

and his house along so rapidly that he sometimes turns somersaults in the effort. And now comes the pathetic part of his history. After this lowly creature has spent the most of his life in the water, he suddenly closes up his front and back doors, shutting himself in for two weeks, during which he is perfectly quiet. At the expiration of that time he emerges, an entirely different creature, looking like a small moth. But his strong jaws have disappeared, and he is provided instead with a weak sucking tube. So he flutters around for a few days, and then dies. The female lives long enough to lay her eggs on a stem in the water, so that the young may hatch out in their native element. Before this transformation my pet's name is "Caddis-worm;" afterwards, "Caddis-fly." She has relations to be found on the bot tom of almost any small stream. Some of them live in log cabins, made of tiny sticks; others in houses of moss; and still others in green houses, made of leaves chewed up and fastened together, forming a case with a small opening through the centre for its builder. Some forms of these interesting houses are shown in the illustrations. Ex.

ALL ABOUT CUT-WORMS

DESCRIPTION OF THE PEST—HABITS—APPEARANCE OF THE MOTH AND THE WORM—REMEDIES, NATURAL AND ARTIFICIAL.

The term cut-worm is very loosely used, being often applied to the larvæ of the June bug, which cut grass roots; to the wire worms, the larvæ of the snapping beetles, and even to the borers that cut channels in woody plants. The term cut-worm is principally confined by entomologists to larvæ of the Owlet Moths (*Noctuidæ*), that have the habit of hiding just under the surface of the ground during the day and feeding upon the roots, stem or leaves of plants by night. When the larvæ climb high and feed upon the foliage of tall plants or trees, they are called climbing cut worms.

The cut-worms may be known by the following general characters : The moths known as Dart Moths or Owlet Moths are deltoid or triangular in

FIG. 1.

shape when the wings are closed, and usually fly at night, and often enter rooms, being attracted by the light. The worms when full grown measure from one to two inches in length, have sixteen legs, thick bodies which taper somewhat at the ends ; without hairs and greasy looking, brown gray or greenish with indistinct longitudinal or oblique markings ; head, long, shining red or brown, head and anal segments armed above with a horny plate, darker than the remainder of the body. On each segment are six or eight dark colored humps, each bearing a hair. When disturbed, the worms curl themselves into a ring. There are upwards of three hundred species, one of the most common and destructive is the greasy, or black cut-worm.

The larva, (Fig. 1) or worm, when full grown is about an inch and a half long, a dull red brown color, with five paler stripes running along the body, the under side of the body being pale greenish yellow.

The moth (Fig. 2) has dark forewings with a bluish tinge on the front border and with a dark brown lance-shaped mark running from the posterior portion of the kidney-shaped spot in the middle of the wing. Hind wings

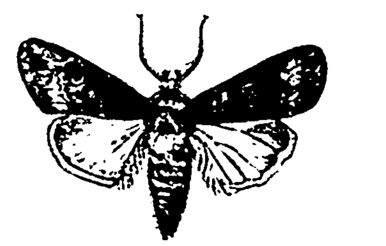


FIG. 2.

pearly white and semi-transparent. There are two broods, and the moths are on the wing from April to October.

The *natural* enemies of cut worms are various species of parasitic and predaceous insects, birds like the robin, starling, catbird and poultry, and animals like the skunk and mole.

Among *artificial* remedies we name preventive measures, a handful of salt on the surface of the plant hill, tobacco dust about the stem of plant, paper, burdock or walnut leaves wrapped around the stem of the plant, paper or tin tubes slit at one side slipped over the stem, or dusting dry