in the soil, and thus become fitted to be again absorbed with beneficial results

The well known benefits of a rotation of crops have been attempted to be explained by supposing that the excrements disengaged from the roots of a plant, must be hurtful to others of the same kind if planted in the same soil, while on the other hand they might be nutritive to plants of other kinds. Thus if the roots of a pea be placed in water, they communicate to it in time a brown colour, in consequence of gummy secretions being thrown off from the plant; and if, after the water has thus been filled with excrements, another plant of the same kind be placed in it, it will not flourish; but if instead of a second pea, we place in it a plant of wheat, this will grow luxuriantly and take from the water a part of the matter previously deposited in it In the same manner, the soil in which any species of vegetable has long been cultivated may become surcharged with its excrements, and the substitution of some other crop, which can free the soil from these, may be rendered necessary. It is evident that the *inorganic* matters rejected by plants cannot have much influence in this way, since these previously existed in the soil; and we shall afterwards see that the quantity of these mineral matters *taken from the ground* and not returned to it, is one very powerful cause of the rapid deterioration of plants when long cultivated on the same soil. The *organic* excretions derived from that food which is obtained from the elements, afforded by air and water, are alone capable of rendering the soil poisonous to the plants from which they proceeded. We must not however forget that these secretions may, like other organic matter, be decomposed; so that after a sufficient interval, their injurious effect must entirely cease; hence it is found that fallowing, which gives time for the excrements in the soil to decompose, is a partial substitute, though a very wasteful one, for a rotation of crops.

THE ASCENDING SAP.—THE STEM.

The water absorbed by the roots is carried upwards into the stem, becoming, in its progress, more or less mixed with the fluids existing in the plant. In consequence of this intermixture, and probably also of changes effected by the agency of the cells and recesses through which it passes, the sap of trees, even in the lower part of the trunk, differs much from the water which the roots are sucking from the soil. Thus in spring, the sap of the maple is rich in sugar, a substance which could evidently have never been obtained from the water in the ground. The presence of this sugar is due to several causes—1st, the water and carbonic acid drawn up from the soil contain the elements of sugar, and may possibly be converted into it by the action of the wood, or of the young buds; to what extent such transformations can be effected by the wood, is not however very certain. 2nd, many trees store up in autumn, a quantity of starch, and possibly other substances, in the cells of their stems and roots; and that the starch thus prepared may be rendered useful in advancing the growth of the young leaves, the first process necessary is its conversion into sugar, a change as will afterwards be seen, very easily effected. 3rd in spring before the leaves are developed, growth is going on very slowly, and the sap not being used in the formation of wood and leaves, is allowed to accumulate in the wood, and when the tree is stimulated by the light and heat of the sun, may be obtained by tapping it. But as soon as the leaves are formed, the sap is rapidly withdrawn to furnish materials for their growth, and for the formation of wood; and for this reason it cannot then be obtained in the same quantity or of the same quality as in early spring.

THE LEAVES.

A leaf, as it appears to the unaided eye, consists of a framework of tough fibres, proceeding from its stalk, and branching over it in every direction; on these are stretched two skins or membranes forming its upper and under sides, and the space between these is filled with soft and pulpy matter. When examined with the microscope other structures appear. The surfaces of the leaf, especially the lower one, are found to be perforated with numerous minute openings, communicating with small cavities in its interior; the green matter is found to consist of cells filled with a soft green substance; and the fibres are found to be formed of vessels similar to those of the wood. Into the leaves thus constructed, the sap is conveyed from the stem, by means of the stock and fibres; from these it passes into the cells of the green matter, where it is exposed to the action of the external air, and of the light and heat passing the outer membranes. Under the influence of these powerful causes of Chemical change, the leaf becomes the seat of important processes.

1. A large portion of the water of the sap escapes from the leaves by evaporation and perspiration. Water contained in a vessel in which the roots of a growing plant are placed, is gradually drawn up and given out by the leaves, until at length, if not renewed, it becomes altogether exhausted; and then the plant droops and withers, because the leaves are rapidly exhaling its fluids, while the roots are receiving no new supplies. The emission of water proceeds with the greatest rapidity when the plant is exposed to the direct rays of the sun, and in darkness it becomes very slow or ceases altogether. Thus the sunflower *which in a sunny day can give off 30 ounces of water, emits only* 3 in a dry night, and none in a dewy one. In consequence of this rapid escape of water, the substances which it held in solution are left in a more concentrated state, and ready to be deposited wherever they are required The large quantity of water which thus passes through their system, also enables plants to obtain from the soil abundance of many substances which are contained in it in very small quantity, or are with difficulty soluble in water.

The powers of the leaves, with reference to water, are not limited to exhalation; they also in some cases can absorb it from the atmosphere, or from the rain and dew which falls upon them. It is thus that drooping plants may be revived by watering their leaves, and that thus the air plants of China and Buenos Ayres flourish when suspended from the walls and balconies of houses, without any connection with the ground.

2. The leaves absorb and decompose Carbonic acid, a gaseous substance which as before stated, exists in small quantity in the *atmosphere, and is the principal source of the Carbon in plants.* If a vegetable be confined in a glass vessel containing air, with the usual proportion of Carbonic acid, or having a little more artificially added, and then placed in the sun, after some time it will be found that a part of the Carbonic acid has disappeared, and that a quantity of Oxygen, corresponding to that which it contained occupies its place. This change is effected by the leaves, which therefore have the power of absorbing Carbonic acid and retaining the Carbon, at the same time expelling its Oxygen.

But while this process proceeds with rapidity in sunshine, it goes on much more slowly in the shade, and in darkness gives place to one of a contrary nature. The leaves, which by day receive and decompose Carbonic acid, by night emit Carbonic acid and absorb Oxygen. In plants growing in ordinary circumstances, the former process is carried on to a much greater extent than the latter, which appears in some respects to serve for resting and renewing the exhausted powers of the leaves.