

through the earth, and this—though infrequent—is one of them. Some fruit trees give the gardener trouble with the shoots they throw up continually. These arise from buds on roots, whereas “suckers,” as they are called, arise from underground stems. Roots exposed to the air will also send up branches, as any old hedgerow shows plainly.

Life and Work in the Soil.—The root system should be compared with a river system, every minute tributary adding volume to the main stream. Or each rootlet may be likened to a groping feeler or finger with a protecting thimble on its tip. This is the *root-cap*, which protects the tender growing point behind it. As the rootlet grows it works like a corkscrew through the earth, searching persistently for food, and twisting according to the shape and hardness of the obstacles with which it meets.

It is well known how rootlets follow the curve of a flower-pot. The *root-hairs*, which may be seen fringing the rootlet above the tip, absorb moisture containing minerals through their thin walls. Note, too, that the hairs also give off a weak acid, which attacks those substances in the soil which cannot otherwise be dissolved and absorbed.

The strength which these numberless rootlets exert can be imagined. Growth is almost irresistible, and curious are the results sometimes produced by it. In towns we often see pavements raised and broken by the growing roots beneath. Another strange result may also be seen. The roots, as they grow, come against a hard layer of rock, through which they can find no opening. But growth continues, and the result is that the tree is lifted out of the ground by its own roots; then you may see the upper roots above ground. Of course, they are sometimes exposed by the washing away of surface soil, but not always. There are many trees in our parks whose roots are twisted and looped into the air, on one side or the other of the trunk, through the cause we have described.

Plants seem to select the minerals they require when they become used to the soil in which they are planted. The modern farmer provides for his crops such minerals as they require which the soil lacks.

The Kind of Roots.—It is quite easy to put all our roots into one or other of two systems—the *fibrous* and the *tap root*. Those who have studied Nature must have noticed that all plants grow in one or other of two ways—either with parallel-veined leaves growing independently from each other, or with a main stem from which leaves branch out in all directions, whose veins follow the same plan.

Take a root of grass as an example of the fibrous system. Notice the thread-like roots, growing in much the same way as the blades of grass above. All the grasses and their allies have root systems of this type. No main root can be seen. Most of our large plants follow

the tap-root plan. There is one main root, which grows straight downwards in the soil, and from this other roots and rootlets spring at intervals. We see it plainly in such tap-roots as beet, carrots and turnips, but in these edible roots the main one is so swollen that we usually ignore the others.

Sometimes it is difficult to follow the main root in a tree simply because the side roots have spread out and developed so much that the root system has become a tangled mass of roots, holding the tree in the soil. When the tree has to withstand great gales from one direction we find its roots piercing the ground for some distance on the windward side, as if the roots were doing their very utmost to aid the tree in keeping its balance and prevent it being torn up from the earth. This is one of the many ways in which living things respond to the forces that act upon them.

What makes the root grow downwards? It is a natural question, and bound to arise whenever roots are studied. Many clever people have given their time to the study of the query, and they have told us that the root goes down in answer to the call of gravity, further proving that it is only the tip of the main root that answers the call.

Another influence must be the moisture in the soil. Roots always grow in the direction of the moister soil. We do not know why, but we do know that it is so. Then again, light exercises an influence. We rarely see the roots of plants growing above the soil. It is true that the woody roots of trees are often laid bare by the wearing away of the soil, but the ends of those roots are hidden deep down in the earth. Roots seem to dislike the light, and turn away from it. It may be that they are seeking moisture, and do not find enough in the air above. In tropical swamps, where the air is saturated with moisture, such plants as mangroves frequently send up roots above the ground.

These air roots partly take up the duty of the stems, having special stomata which are entirely absent in underground roots. Other roots which have peculiar habits are those of parasitic plants, like mistletoe and broomrape. They intercept the food which the roots of other plants have absorbed; they also grow in any direction without obeying the general rule that roots must tend downwards owing to the force of gravity. But, then, they are rather “suckers” than true roots.

Origin of Edible Roots.—Not one of the roots on which we place so much store has been given us by Nature in its present condition. The carrot is, perhaps, as good an instance as we can find. Wild carrots are common enough, their pretty leaves ornamenting the field edges. They die down each season; that is they are annuals. By careful selection of seed and time of planting the carrot was persuaded to become a biennial with