Condensed for the Pearl.

RUDIMENTS OF GARDENING.

By Professor Rennie.

Mouths of Plants.—Unlike the mouths of animals, which are placed on the upper part of the body, the mouths of plants are placed at the lower part, in the root. At the very tip or point of every root fibre there is a little mouth, or rather a spongy sucker; by these root tips (which are called *spongelets*) the water and other fluids are sucked up, in the same way, perhaps, as ink is sucked up by blotting paper. The opening of the spongelets which are the sucking mouths of plants, are so very small that they will admit no liquid thicker than water, and no solid substance however fine. It will be obvious from this that all manure must be made as thin as water before it can be sucked up the spongelets; and hence even the drainings of manure heaps, which are very rich in nourishment, are too rich for plants; that is, too thick to pass the small openings till they be largely mixed with water, without which they will choke the growing crops instead of feeding them. When the leaves become yellow from this cause they are usually said to be *burnt* by the heat of the manure. In the same way the finest soot or the finest powdered lime, bones, or shells, cannot, till dissolved in water, get through the spongelets into any plant. It is on this account, that, in transplanting, the tips of the root fibres are pressed and obstructed by the earth of their new situation, and are therefore unable to feed till they can place themselves in similar freedom in the earth as they had before transplanting. When they are bent or obstructed in this way, their growth is also prevented, and new fibres spring from other parts of the root, out of the materials which would otherwise have enlarged the old fibres.

Plants thus acquire a greater number of mouths, the oftener they are transplanted, a circumstance usually acted on by nurserymen, who shift their young trees and other plants for the purpose of multiplying their root fibres, and consequently of strengthening the plants, by giving them a greater facility of feeding from having more mouths to feed with. This is also important in cultivating cabbages and greens.

Animals, such as the leech and the flea, which feed by sucking, have only one mouth, and when this is cut off the animal must die; but it is not always so with plants, which have many mouths, and to which Providence has given the faculty of forming new mouths, that is, new root tips when the old ones are destroyed.

Every removal, however, must tend to obstruct or injure the root tips, and of course check the growth by preventing them from feeding. But by lifting plants with balls of earth so as not to disturb the root fibres, or by taking great care not to injure these, and at the same time spreading them carefully out by hand in their new situation, Sir Henry Stewart, of Allanton, has introduced the novel and successful practice, founded on science, of transplanting even the largest trees.

Food of Plants. The indispensable ingredient in all plant food is water to dissolve the other ingredients, and enable them to pass into the root tips in the same way as the fluid in an animals mouth is indispensable to mix with solid food. A second ingredient in plant food is air—the common air; which, when mixed with water, as it always more or less is, gives it that agreeable taste which boiling renders vapid by driving off the air. It is on this account that the watering of a garden in dry weather by throwing over it buckets of water from a pump, is of far less use than if the pump water was thrown through the fine nose of a watering pot, so that each drop might mix with and carry down a portion of air. Rain, again, which falls from a considerable height, must carry down a great deal of air, and hence rain is found to fertilise more than any sort of watering by hand.

When the water supplied to plants has its motion stopt by any means, such as by a stiff clay soil or a dead level, it becomes unwholsome food for plants, chiefly from not having an opportunity to mix with air, which it can only do by moving or circulating freely. Besides common air, the water or moisture in garden soils is always more or less mixed with a substance termed by chemists, *humin*, which is the chief nutritive ingredient in dung, rotted leaves, peat turf and dark coloured loam. Humin when pure will not mix with water and plants, cannot of course, feed upon it till it be mixed and thinned down. This is effected by combining humin with lime, potass, or ammonia, when it readily dissolves in water. The mineral parts of the soil, which is composed of clay, lime and flint earth, in the form of sand and gravel of various finenesses, together with, sometimes, magnesia, iron, and a few other metals, contributes little or nothing to the food of plants. These portions of the soil appear to be chiefly useful in dividing the nutritive parts arising from decayed plants in natural soils, and from various manures in artificial culture. Such is the sort of food which all plants feed upon; and that they require a large quantity of this food, appears from the experiments of Dr. Hales, who found that a hop plant sucked up four ounces of water in twelve hours in a shady place, and eight ounces in a place more open; while a plant of mint whose roots were set in a tube containing water, made this water fall an inch and a half during the day, but only a quarter of an inch during the night. It would appear therefore, that plants feed most heartily in the day time and in open places, being most probably influenced to this by light. Artificial watering may be supposed on this account to be most beneficial early in the morning, just as the plants are commencing their breakfast.

Changes of Plant Food. As plants have no stomach like animals for the reception and digestion of food, the necessary changes similar to disgestion take place, first, in the soil without, before the food enters the root tips or mouths; and secondly within the plants, more particularly when the food has reached the leaves. For the production of the changes which take place in the soil, which consist of the fermentation occasioned by the decay of leaves etc. and the circulation through the ground of the plant food thus formed, *heat* is indispensable; and hence they do not take place in our winters, or in the cold weather of spring and autumn. This, however, is of little moment, as the plants are then torpid, like bats, bees, etc. and take very little food.—It will follow from this, that when a soil is known to contain rotting weeds and other plants, or has had rotted manure spread over its surface, this cannot be too well dug in, and raked in, in order to mix the richer parts with the less rich clay and sand; on the same principle that at dinner we mix in eating the richer beef or mutton, with the less rich potatoes, cabbage, and bread. Both ourselves and the garden plants must have a large portion of water to thin or dilute the food, otherwise health will suffer.

Other changes refer to the *sap of plants*. The sap is the water containing air, humin, and other nutritive materials, which is sucked up by the root-tips and passes into the plant. The bulk of the sap is water, which becomes thicker as it rises, probably, from mixing with what has undergone further change in the leaves. It is not yet known whether the sap rises through vessels similar to the blood-vessels of animals, or whether it rises through the tissue of the plant, as ink spreads through blotting paper, or water through lump sugar.

The sap, in whatever manner it does rise through a plant, at length arrives at the leaves in a somewhat thickened state, and is spread out under the very thin skin of the upper side of the leaf, most probably for the purpose of being exposed to the action of the air, in a similar way as the animal blood is spread out for the same purpose, in the minute blood vessels of the lungs.

On the leaves are very numerous minute openings, or pores, often much smaller than pin holes, which appear both to admit air and to facilitate the escape of moisture, similar, probably, to the nostrils of animals, or rather to the breathing pores in the sides of *insects*.

The pores of the leaf lead to small air cells, which, when larger than usual, form the white or yellow spots on plants with variegated leaves. Through these pores, the sap gives off two-thirds of its superfluous water, in a similar way as animal blood gives off its superfluous water by the breath and perspiration. The third of the sap that remains will of course be much thickened by the loss of two-thirds of its water. This thickened part is called the *pulp of plants*, to distinguish it from the crude watery sap. The pulp is of similar use to plants in promoting their growth, as the blood is of use in animals. It is chiefly composed of the *carbon* or charcoal derived from the humin of the sap, and is of a dark blue colour; but the transparent tissue of the leaf in which it is enclosed being more or less yellow, the combination of the two colours forms green, as blue paint mixed with yellow forms green. When the pulp is deficient, the leaves therefore become yellow. Several inferences may be drawn from these facts. The change, for example, of sap into pulp cannot take place in the dark, sun-light being indispensable to open the pores; and hence plants growing under thick trees, or under any thing that obstructs the sun's light, cannot sufficiently effect this important change, and the pulp being in consequence only prepared in small quantity, the plants become slender, yellowish, and sickly, for want of due nourishment. It is ignorantly said that the trees *draw* them.

When the change of sap into pulp is in any way hindered or prevented, as by shade or by moisture, the leaves of the plants become yellow, as when plants in pots have more water given them in saucers or otherwise than the sun-light can cause to pass off; or when, for want of pot room, they become root-bound, and the root tips have not space to feed.

By tying the leaves of lettuce near the top, the inmost leaves are kept from the light, and hence little or no pulp being formed there they are rendered white, crisp, and tender, as cabbages and savoys grow of their own accord without tying, though tying will hasten the process. This is called *blanching*, which means "whitening."

In all cases, the more plants are exposed to the light the more hardy they will be, provided they be not gorged with too watery food; and the less light they have the more feeble, sickly, pale, and yellow, they will be. Light from above, also, is greatly better than side light.

The advantages of wide planting in most cases will therefore be obvious; for if potatoes, cabbages, or other plants, are crowded together, they become (at least at their sides) nearly as much shaded from the light by each other, as if growing under trees.

The common *air* contained in the sap when it first arrives from below at the leaves, is composed of twenty measures of oxygen gas, and eighty measures of nitrogen gas. At the same time then that two thirds of the water of the sap passes off through the leaf-pores, a considerable portion of the oxygen gas is given off; a process that tends to restore to the atmosphere the oxygen consumed by the breathing of animals, or by the burning of fires. This effect however only happens during day-light. During nights, plants, instead of giving off oxygen gas, take it up from the air, while they give off carbonic acid gas; and hence plants in pots must render bad the air of rooms where they are kept, except during day-light, and particularly in the sunshine, when they improve the air in which they grow. From these facts the value of a free circulation of air to the healthy growth of plants must be great; and hence a garden cooped in by high walls, even though it have plenty of sunlight which is still more indispensable than free air, will never produce great crops.

Growth of Plants. When by the loss of its water and some of its oxygen gas, the pulp has been formed from the sap, it passes back from the leaf to the branch or stem; though by what channels is no better understood than by what channels it came from the root. As the blood of animals, prepared in the lungs by losing water and carbonic acid gas, goes to form or increase the bones and the flesh all over the body; so the pulp of plants, prepared in the leaves, goes to form new branches, leaves and roots, and to increase in size those already formed. The use of the leaves will now be understood, as being nearly as important to plants as lungs are to animals. When plants, therefore, are stript of their leaves by accident—such as by caterpillars or by the browsing of cattle—the plants either die or remain sickly, till new leaves (as will happen in vigorous plants) sprout again to prepare the necessary supplies of pulp. A neighbour's savoys this autumn (1833) were devoured by caterpillars down to the stumps; but I advised him not to pull them up, and they formed very fine little heads in two months.

It is therefore an error to pick off leaves, as is sometimes done with the intention of exposing fruit, such as grapes, to the sun to hasten their ripening; for a supply of pulp is still more important to their ripening than such exposure, and without leaves no pulp can be formed.

Rotation of Crops. Plants, like animals, do not appropriate all the food which they take; and having the means of separating what is useful, they reject what is useless and put it aside. Independent of the great quantity of water and gases which plants throw out by their leaves, they also throw off by their roots a sort of excrementitious slime, different in different plants, but poisonous or injurious to the same kind of plants which throw it out.

The fact has been long known to gardeners and farmers, that they could not get good crops of the same kinds from the same piece of ground, season after season, though the cause of this has only been investigated of late years, and has been proved from experiments by Brugmans, and more particularly by Macaire, not to arise, as was formerly alleged, from the plant food in the soil being exhausted, since all plants feed nearly alike, but from the excrementitious slime, which acts upon the same sort of plants that produce it, as a slow poison. Thus the slime from a crop of cabbages will greatly injure another crop of cabbages, though it will do little or no harm to potatoes or peas; while the slime from peas will injure peas, though it might not injure cabbages or turnips. When this is known, it will prevent two successive crops of the same kind from being tried, unless the ground be so trenched and dug as to bury the slime deeper than the roots can reach; or the ground be dug up and exposed to sun-light to evaporate the slime as is done in fallowing; or the surface be pared and burnt with the same view; or the slime be dissolved by laying the ground under water as in irrigation.

Heat, Cold and Shelter. Plants though not so warm as animals, are in general some degrees warmer than the soil they grow upon, and in winter a little warmer than the air. As the heat in animals appears to be produced by the chemical changes which takes place in breathing, so the heat of plants is probably produced by the change of sap into pulp. The external heat of the air is indispensable to the due flowing of the sap, and hence it flows very slowly in winter and in cold weather. The stoppage of the flow of sap at the beginning of winter, is erroneously ascribed to its descent to the roots of that season. As heat then is probably one of the chief causes of the flow of the sap, the artificial heat produced by hot-beds, and also by any sort of shelter, tends to forward the growth of plants.

Heat is very equally distributed among all things on the earth's surface, by a process somewhat similar to that of water always coming to a level; that is, heat will always pass from a hot substance to one near it which is colder;—from the warm ground, for instance, to the cold air, till the heat in the ground and the air becomes equal.

Now this off-streaming of heat, from a warm substance to a cold one, is as easily prevented as the passage of light by any thing non-transparent; as we have only to interpose something that heat will not easily pass through; such as canvass, flannels, or straw, on the same principle that we prevent the heat of our own bodies from streaming off into the air, by means of dress, which will be more or less warm, in proportion as it can prevent the escape of animal heat. Upon these principles are founded the different modes of sheltering plants, or, in other words, of preventing them from being robbed of heat by the cold air. Shelter will be most wanted in gardens during clear cloudless nights in spring and autumn; for when there are clouds, they prevent a great deal of heat from streaming off into the upper air; and hence no dew (which is always caused by the moisture or vapour in the air losing its heat) is even formed on a cloudy night; and the same holds for the same reason of hoar-frost.

Seed Sowing. Every seed has a shell more or less hard to protect it from external injury, and at its base what is called the seed-pore (popularly the eye), for the passage inwards of the nutrient pulp before it is ripe, and for the passage outwards of the young plant after sowing.

Within the shell is the kernel, consisting of the embryo plant, with its radicle or root, its gemlet or stem, and the neck between these, besides the seed lobe or lobes containing materials for nourishing it in the first stage of growth. In order to begin the growth of the embryo, four things are indispensable; heat, water, air, and darkness. The heat is required to soften the nutrient materials in the lobes, but without water it would be more likely to harden these. Pure water is more advantageous than water containing humin or other rich materials, what is contained in the lobes being sufficiently rich. Freely circulating air is indispensable for supplying oxygen gas and carrying off carbonic acid gas, a process the reverse of what takes place in leaves exposed to sun-light. For the same reason light is injurious by carrying off the oxygen gas requisite in this stage of growth.

In sowing any sort of seed, these four circumstances must be carefully attended to. For want of heat, accordingly, seeds will not come up during frost; for want of water they will not come up when sown in dry sand; for want of air they will not come up if too deep in the ground; and if not duly covered, they will not come up from having too much light.

Seeds, however, often germinate in the light, such as corn in wet seasons, before it is cut; but they do not in these cases produce strong plants, as the root requires to shoot away from the light as much as the stem into the light. Birch seed does best when not covered. These are exceptions not rules.

Most seeds are benefited by steeping them for an hour or two in pure water, which in the cold weather of spring, may be made milk warm. Pickles, train oil, urine, and other steeps, must in most cases be injurious and will never, as is ignorantly pretended, kill the eggs of insects, even if such be among the seed, of which I know not a single instance, not even in the eggs of the turnip fly, as lately asserted.

Too much water, however, will be certain to injure the seeds, by gorging them, and rendering them dropsical and liable to rot. Hence the well known benefit from sowing in dry weather, to insure only moderate moisture. The seed lobes, when in part exhausted of their nutrient matter, are changed into seed leaves, and go on to prepare pulp from the sap now taken up by the young root. The seed leaves are now therefore so important to the very existence of the plants, that when they are eaten off by insects as is done in seeding turnips, radishes, and cabbage by the turnip fly, or by slugs, the crop perishes.

THE HALIFAX PEARL,

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