Natural Grafting of Branches and Roots

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a small shrub with rather small leaves which, in my opinion, is not *S. arborescens*, T. And., but, if anything, is nearer *S. Wallichii*, Hook., f. & Thoms. Of the other numbers of Wilson's and Henry's specimens quoted, *Henry* 10469, 11200, 11069, also but not quoted 10546, 11426, 13328 belong to a large shrub with larger leaves and black fruit which probably really is *S. arborescens*, T. And. In Rehder and Wilson's description, *S. melanocarpa* is described as "0·3-1 m. altus," but in brackets they have added "planta yunnanensis interdum ad 5 m. secundum Cl. Henry." The statement in brackets refers to the *Henry* numbers above quoted, which I believe to belong to *S. arborescens*. It seems clear to me, now, that the Sikkim plant is *not* the type *melanocarpa*, but should continue to bear Anderson's name. So that, in my opinion, Rehder and Wilson's *S. melanocarpa* includes two species, a thin small-leaved low shrub which is real *S. melanocarpa* and which seems not to occur in the Himalaya, and the large big-leaved shrub of Yunnan which is probably the E. Himalayan *S. arborescens*.

XXXI.—NATURAL GRAFTING OF BRANCHES AND ROOTS.

W. DALLIMORE.

(With Plates.)

Natural grafting of branches and roots is of common occurrence amongst certain species of trees and shrubs, and the results are sometimes very curious, not only by reason of the complicated character of the unions between branches or roots of individual trees, but also by the joining together of large branches and even trunks of different trees of the same species.

Naturally-grafted branches are fairly common on beech, oak, holly, lime, willow, yew, and Scots pine, whilst they may also be noted on many other trees. The commonest form of natural grafting is that which results from the crossing of two branches. When young and light such branches are easily moved by wind, and the friction thus caused injures the bark, first by polishing the surface, afterwards by fracture. Later on the wood may also be injured, for, as the branches grow older and heavier, the easy, gliding action of one branch upon the other gradually gives place to a slower but more injurious grinding movement which may cause considerable injury and deformity, the affected surfaces losing their roundness and one or both branches becoming worn to a mere shell. During the whole of the time, however, nature is trying to repair the injury and patches of callus are formed on both branches at those points where friction is least active. As the branches become heavier and movement ceases the patches of callus grow together and eventually a strong union is effected between the two branches. A series of specimens in the Forestry Museum at Kew show quite well how such a union is brought about.

Another fairly common method of natural grafting of branches

is brought about by a side branch from a principal branch or from the leading shoot of a tree growing against another branch or a rival leader. In such a case there may not be sufficient friction to seriously injure the bark, but there may be considerable pressure and the small branch may cause a certain amount of constriction to the larger one in the same way that tightly tied string or wire does, except that the pressure is on one side only. The bark above and below, therefore, grows faster than the constricted part, with the result that the small branch is gradually overgrown in the same way that a string or wire may be completely buried in the wood, or a stone pressed tightly against the bark of a young tree may be overgrown. But in other cases there may be enough friction to injure the bark and expose the cambium. Then a union is brought about by fusion of callus formed at the point of injury. In either case it is easy to see in the early stages what has happened, but later on the end of the small branch may die and fall away, the point of union being completely overgrown by the main branch. As a result there is a small branch, to all appearances alive and healthy, perhaps from a few inches to several feet long, uniting two branches or two trunks in such a way that it is difficult to decide from which branch the connection originated. A few years ago, when visiting Scotland, I was shown two large Scots pines standing a few feet apart which were united by such a branch at a point 12-15 feet from the ground, the connecting branch being almost horizontal and appearing to grow from about the centre of each trunk. Two beech trees are joined in the same way on the Ashridge Estate, Berkhamstead, and a photograph has been recently received from British Columbia showing two trees connected by a branch at a considerable distance from the ground.

A curious instance of natural grafting of beech may be seen in the Forestry Museum at Kew. A small side branch after growing for about 8 inches, crossed the parent branch and became united. The end of the small branch died and no trace of grafting can now be seen on the bark. At its greatest distance from the parent branch it is $1\frac{1}{4}$ inches, thus forming a handle by which the specimen can be conveniently carried. Modifications of this style of natural grafting may often be noticed and a branchlet may grow several feet away from the parent branch and then gradually return and join again at a point higher up the branch.

Natural grafting is also effected by a branch growing through the acute angle formed by two fairly erect branches. In such a position there is little movement and the small branch is soon overgrown by the large ones.

A transverse section of timber may show two or even three or more hearts. This may be due to the union of a secondary leader with the true leader, or several leaders may become involved but it does not appear to hold good in every case. In some instances the appearance of the timber suggests that the union of two or more shoots has been complete from infancy. In elm trees two or more hearts may often be found in a section of the timber especially if the section is taken from a point

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higher than the middle of the trunk. Several hearts are often found in a transverse section of yew wood. In yew, however, the condition is usually due to erect stems formed at the base of the main trunk being overgrown by the trunk, but now and then natural grafting is in evidence.

Whenever a large tree is felled, evidence of root grafting is found, for, as the roots of trees growing close together become intermixed with those of the same species, and sometimes of allied species, they easily unite. Pressure is probably responsible in most cases for root grafting, and very curious results are sometimes seen, although, obviously, grafted roots attract less notice than grafted branches. Roots growing amongst close gravel or in clay and chalk often present a very curious appearance not only by intergrafting, but by deformity caused by the rough edges of stones and by their growing round and enclosing stones.

Whether trees actually benefit to any great extent from this natural intergrafting of roots or branches is doubtful, for there can be no discrimination of stocks and scions which makes propagation by grafting of such importance to the horticulturist, but that some local benefit may result is seen occasionally, more particularly by a branch of a weak or unhealthy tree which has become united to a healthy tree, being more vigorous than the other branches.

An interesting series of photographs, three of which are published with this article, has recently been received at Kew from PRIVATE C. C. PEMBERTON, of Victoria, British Columbia, now with the Canadian Army. They represent a series of studies in the natural grafting of roots and branches as seen in the forests of British Columbia, together with other interesting conditions of tree growth. The branch grafts are varied in character, but similar ones are of fairly frequent occurrence. Amongst the root grafts, however, a particularly interesting condition is represented. This is the healing under certain circumstances of the cut surfaces of Douglas fir and *Abies grandis* stumps when cut over at a height of 1-2 feet above the ground. Mr. Pemberton makes no pretence to silvicultural or botanical knowledge, his observations having been conducted solely by reason of his love of nature. The healing of branchless stumps appealed to him as being something apart from the ordinary behaviour of trees, and he set to work to find a reason. By baring the tree roots over a considerable area of ground he was able to satisfy himself that every stump that had healed or was well advanced towards that state was attached by root grafting to a standing tree with healthy foliage, and further, that by cutting down the living tree the stumps were killed within a short time. He noticed further that the roots of decaying or dead stumps were rarely attached to the roots of a living tree.

The phenomenon has been previously noticed and is referred to by Sorauer, *Handbuch der Pflanzenkrankheiten*, Berlin, 3rd ed., 1909, vol. i. p. 774. The views there expressed coincide largely with the observations made by Mr. Pemberton, for the theory is favoured that the healed stumps obtain nourishment

by means of the concrescence of their roots with strong roots of neighbouring trees which still possess a trunk and crown. The author, however, does not consider that this is always so, for he instances cases of healed stumps standing too far away from living trees for the roots to have any connection. To some extent he favours the idea of reserve material stored in cut over stumps accounting for the commencement of new growth, but once a callus is started he thinks that further growth may be stimulated by chlorophyll present in the cortex of the callus, more particularly when the stump is in a light and open position.

So far as Mr. Pemberton's observations go, however, and he has paid a good deal of attention to the subject, he has been unable to find a single instance of the healing of a stump that is unattached to the roots of a tree bearing healthy branches. Should he be able at some future time to extend his studies it would be interesting to learn whether he finds any other indication save natural grafting that would account for the phenomenon.

Natural grafting in its various phases holds peculiar attractions for people interested in tree life, and the subject is well worthy of attention by people who have the necessary time at their disposal.

EXPLANATION OF PLATES.

1. Healed stumps of Douglas fir (*Pseudotsuga Douglasii*).
 2. Two trees of Douglas fir showing the connection of roots above ground.
 3. Naturally-grafted roots of *Abies grandis*.
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XXXII.—THE NATURE OF CHARRED WOOD.

L. A. BOODLE.

The blackening of organic matter by heat or by the action of sulphuric acid is generally described as carbonisation, and the use of this term implies the presence of free carbon in the blackened product. In wood-charcoal obtained by heating in the usual way, the percentage of carbon present varies with the temperature employed for charring. Thus it is stated that charcoal produced at 249° C. contains 65 per cent. of carbon, and that temperatures of 399° C. and 1499° C. give charcoals with 80 and 96 per cent. of carbon respectively. Ordinary charcoal is known to contain oxygen, hydrogen and a little nitrogen, besides carbon and the constituents of the ash. One might suppose, therefore, that the charcoal prepared at 249° contains free carbon, as well as a considerable proportion of some compound of carbon, hydrogen and oxygen, and that the blackness of the material depends on the presence of the free carbon.

Some experiments recently made with charred wood have a bearing on this subject, and, though they were quite simple and unaccompanied by any chemical analysis, they gave some suggestive results.