Nutritional Exchange between Lianas and Trees.

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Plate XV.

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Natural unions between the branches of different individual trees of the same species are somewhat rare, and those between trees of different species are of still less frequent occurrence. Such cases as those of the mistletoes, the sandalwood, and such parasites which habitually form natural unions with plants belonging to other families, must of course be excluded. Adhesion and cohesion of branches have been reported on various occasions in the eastern States of Australia; but in a number of instances one tree has grown in the hollow trunk or branch of another, rooting in the detritus of the pipe and forming no organic union. Such cases are by no means infrequent.

In 1886 the late A. Norton [1] drew the attention of members of the Royal Society of Queensland to the curious behaviour of a stump of Moreton Bay Ash (*Eucalyptus tessellaris*) in the Gladstone district. This remarkable stump had no leaves or branches, and had continued living for from fifteen to eighteen years. Mr. Norton described its appearance as that of a stump which had been left standing when the upper portion of the tree had been snapped off by a strong wind. Its height was 9 ft. 3 in., and its circumference 4 ft. 6 in. No investigation was made of the cause of this remarkable prolongation of life in the absence of leaves, but Dr. (then Mr.) A. J. Turner suggested an inoculation of the roots of the stump with those of neighbouring trees. Dr. Joseph Bancroft, in the same discussion, referred to a spotted gum which, its natural attachment to the ground being severed, had maintained its life by intimate coalescence with the tissues of the branches of two neighbouring trees into which it had fallen. A. D. Hardy [2] records the case of two trees of *Eucalyptus rostrata* 8 ft. apart, joined by a cable root. One of these trees is considered to have been originally a sucker of the other. There is a possibility that this stump was joined to its parent tree in such a way, but from Canada comes interesting support to Dr. Turner’s suggestion. Dallimore [3] publishes some observations by C. C. Pemberton, of British Columbia, accompanied by photographs, which prove pretty conclusively that similar stumps of Douglas fir and *Abies grandis* have natural root grafts with other trees. Stumps which have healed over without producing leafy branches continue to live until their neighbouring tree is cut down, when they die.

Cohesion of roots is often seen when a tree is uprooted. Fusion of stems and branches is, however, more easily observed, and Maiden [4] in 1904 gathered some data on natural grafts, and again drew attention to them in his “Forest Flora of New South Wales,” in 1917, and [5]
in the "Critical Revision of the Genus Eucalyptus" [6] in 1921. In the case of a union between *Eucalyptus hemastoma* and *E. capitellata*, some of the red colouring matter of the former was found in the fibres of the pale timber of the latter, with which they were in juxtaposition. J. W. Audas [7] in 1911 reported the fusing of a yellow box (*E. melliodora*) with a grey box (*E. hemiphloia* var. *microcarpa*). Hardy (l.c.) figures cohesion of the branches of *E. rostrata*, and describes a composite growth where *E. obliqua* and *E. viminalis* are fused at the base.

Unions of this nature are for the most part between closely related species. Fusions between widely separated forms seem to be unknown, except for a few cases such as that cited by Masters, where a branch of *Sambucus* contracted a firm adhesion with that of *Sophora*. The observations recorded in this paper show, however, that adhesion between unrelated plants often does take place, and that a certain amount of transference of food material from one to the other results from the process.

It was noticed that in the rain forest of Tambourine there occasionally occurred small oval pieces of dead wood like large date-stones stuck to tree trunks. These were obviously no part of the tree to which they were adherent, though they were closely associated with it and could usually only be removed by pulling off a flake of bark as well. There was no union between xylem and xylem. The foreign chip was separated from the living wood by healthy and normal bark. The opinion formed was that these pieces of dead wood were the remains of lianas which had formerly been entwined round the trees and which had died, decayed, and left these oval woody buttons. The well preserved state of the residuals was almost as remarkable as their very definite shape, and there must have been some very good reason for it. A section showed that the bark on the inner side of the chips was still intact and that the cortical parenchyma was fused with that of the bark of the tree. That of the chip was, of course, dead, but its structure was quite well preserved. No tongue of invading tissue penetrated the bark of the tree, but the two sets of parenchyma were in such close contact that food material could readily be transferred by osmosis from one to the other. That such a transfer can be effected is proved by some of the cases already quoted.

The Tambourine Mountain material was too scanty for a general conclusion as to the transference of food from liana to host. No definite proof could be claimed from the examination of two specimens. During August, however, a fortnight was spent in the rain forest on Dunk Island, North Queensland, and a special search commenced for further evidence on the subject. This was soon forthcoming. The woody buttons were found in great numbers, and were no rarity, and the earlier stages of their formation were found as well. These are well shown in the photograph (Plate XV., a., b., c.). A liana wrapped round a living stem dies and commences to decay. Gradually all disappears except a
small section a few inches long. This section, when rubbed with the fingers, crumbles away, leaving only the characteristic oval piece of wood firmly adhering to the living bark. In nearly every case this is all that is found; it is not often that the rotten piece of liana is seen. The transition stages are shown in the photograph at a, b, and c.

The size of the wooden button varies; the largest collected was 5\(\frac{1}{2}\) in. long, 2 in. wide, and 3\(\frac{1}{2}\) in. thick. Others ranged in size down to mere splinters. In each case examined, however, the adhesion between parenchyma and parenchyma was quite definite. It was, of course, impossible to identify the liana; there was not enough material in the fragment of undecayed wood for a decision, though it was more than likely that in some cases it was *Entada scandens*, the matchbox bean. The living tree could, however, be classified, and it was found that the range of species with these curious adherent objects was very large. One monocotyledon, *Archontophoenix Alexandra*, a palm, was included in the list, and almost any of the woody dicotyledonous members of the rain forest and monsoon forest seemed capable of forming such attachments. The case of the palm is of special interest, constituting as it does the first record of a graft between the stem of a monocotyledon and that of a dicotyledon. (Parasitic attachments such as those of *Cassytha* with monocotyledons are not counted). There was, of course, no vascular continuity, but the adhesion of the parenchyma of the two and the transference of material is undoubted.

The structure of the buttons is rather peculiar. Many of them closely resemble a date stone in shape, though differing in size and colour. The groove is on the side remote from the tree and represents the pith of the liana. In none of the specimens discovered did the button represent more than half of the cross section of the lianoid stem; in nearly all cases it was less. Its long axis always corresponded with the axis of the stem of which it was residual. Some of the buttons, especially those in which the rest of the wood had only recently decayed, were partly encrusted with the black wefted hyphae of a septate fungus, which was possibly one of the Polyporaceae, though no fructifications were found. In all cases this fungus was found creeping over the under-side of the button and spreading on to the bark of the living tree. At first sight this looked like an appressorium, but in section it was found that the button was not much penetrated except on its outer layers where the other wood had decayed away. The cementing hyphae were not the agents holding it to the bark of the tree. The conclusion that must be arrived at is that the fusion of the parenchyma of tree and liana, rendered possible by their mutual pressure, had resulted in the transfer of material by osmosis. In the aureole of transfusion the changed chemical constitution of the lianoid stem was sufficient to preserve the wood and bark from the attacks of the dry-rot fungus for some considerable time after the rest of the vine had decayed. It would naturally be expected that the osmotic diffusion would be more favoured in the direction of the longitudinal axis of the stem than in that of the

NUTRITIONAL EXCHANGE BETWEEN LIANAS AND TREES. 117
transverse, and that therefore the button would tend to be oval in outline. The exchange can hardly be great, but is sufficient to cause a difference in a few cubic centimetres of liana tissue nearest the point of adhesion.

In such a case of nutritional exchange, the tree stem should show similar change, and the young stem of a liana was found with a large piece of wood adhered to it (Plate XV., p); the case being similar to that of the residual pieces of liana on trees. Only one specimen was found, but it indicates that there is a flow from liana to tree as well as from tree to liana.

**Summary.**

Small bean-shaped pieces of dead wood found adhering to the trunks of rain-forest trees in North and South Queensland were found to be the remains of lianas which had died and rotted away. It was found that the cortex of the liana had fused with that of the tree, and that the wood and bark of the former had been preserved adjacent to the junction, whereas the rest had succumbed to the attack of a dry-rot fungus. It is concluded that the relative immunity of the woody button from attack was due to the presence of substances obtained by diffusion from the tree. The reverse was where a fragment of a dead tree trunk had been preserved near a junction with a living liana. A case of a graft between the stem of a dicotyledonous vine and that of a mono-cotyledon (*Archontophoenix Alexandrina*) was also found; as in the other cases there was no vascular connection, but such an occurrence seems to be the first on record.

**LITERATURE.**

Natural Grafts between Lianas and Trees.

PLATE XV.

(A) Rotten piece of liana attached to a living stem.
(B) A section of liana which has rotted away, leaving two of the bean-like pieces of wood attached to a living stem.
(C) A characteristic woody residual; the black substance is fungal mycelium.
(D) A thin stem of a liana with the remains of a small tree trunk fused to it. The rest of the tree has decayed, leaving a relatively round piece of wood in contact with the liana.

All half natural size.

Face page 118.

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