DISEASES OF THE TEA BUSH—III

ROOT DISEASES AND TREE STUMPS

C. H. GADD

The usual point of origin of a root disease of tea is a dead tree stump. The main evidence for this statement is the frequency with which diseased tea bushes occur in close proximity to such stumps. The stumps may be those of jungle trees left when the land was cleared, or of shade trees felled because they had grown too big, or for any other reason. Where the root disease of the tea is of long standing and a bare patch has been formed, the original source of infection has usually long disappeared and no visible connection between the disease and stump remains, but records of such patches would show that, in the majority of cases, the disease originated at a stump.

In a clearing where jungle was felled and burnt before planting with tea, stumps are so numerous that the mere proximity of a diseased tea bush to one of them is of little importance. The presence of the same fungus on the stump's and tea bush's roots however provides the connecting link. A reasonable explanation of this association is that the jungle tree at the time it was felled was already diseased, that the fire failed to destroy the fungus on its roots, and that later the tea roots became infected. Much of the disease which occurs in a new clearing is thus a relic from the jungle.

In old tea lands where the original jungle stumps have long disappeared the position is different. The stumps are those of shade trees felled because they are too numerous or too large. There can be no question that at the time of felling the trees were healthy and free from root disease, yet in the course of a few years tea bushes

adjacent to some of them begin to die of root disease. On removal these bushes are found to have their roots in close contact with those of the felled tree, and the same parasitic fungus is found on both. There is usually evidence that the parasitic fungus has grown from the stump to the tea.

The fungi which cause disease cannot arise spontaneously; they must originate from like parents. Fungus spores (the equivalent of seeds) are, however, very minute and are carried long distances in air currents, but ultimately they come to earth. What happens then depends very largely on the place where they come to rest. Given suitable climatic conditions, the spores germinate and, if a suitable food supply is immediately available, growth continues. The fungi which cause root disease of tea are all capable of causing decay of wood and so are able to extract their food requirements from that medium. They cannot flourish in soil in the absence of such food material. Consequently, spores of such fungi which fall on the soil die, whereas those which find lodgment on a wood surface such as a tree stump continue development. The hyphae over-run the surface of the stump and reach its roots, where conditions are still more favourable for growth. The fungus spreads along the roots and reaches the tea roots which happen to be in contact with them. It will be recognised that in a jungle clearing too, infection may reach the stumps as spores, and thence pass to the tea.

Sometimes the tea bush itself provides the wood surface on which the fungus spore germinates; and disease occurs without any intermediary tree stump. In such cases the spore usually finds lodgment on a large unprotected pruning cut. Petch [1] has recorded cases of Brown Root disease which have originated in this way in old tea where no stumps have existed for many years. Charcoal Rot (*Ustulina zonata*) originates in this way even more frequently than does Brown Root disease. Direct, above ground infections can usually be easily recognised by the main root being more severely attacked than the laterals, whereas when infection occurs from below ground in the normal way, some of the laterals are more severely rotted than is the taproot at the collar.

Stumps alone, in the absence of appropriate fungus spores, will not lead to disease. Consequently it is not always possible to forecast the amount of disease which will occur as a result of felling shade trees if the stumps are left in. In some fields, trees are felled yet no disease follows; in others a large percentage of the stumps become infected and the losses amongst the tea are heavy. The fungi which cause root disease of tea occur in the jungle, and it is mainly from this source that the air becomes contaminated with their spores. Proximity to jungle may therefore increase the liability of infection of felled tree stumps, but it must also be recognised that neglected areas, particularly those which contain diseased bushes, may supply the requisite spores for infection.

So far, root disease has been referred to as an entity, as though there were but one causative fungus and not several, having distinctive characters and habits. In Ceylon, the pathogenic fungi which normally occur in association with tree stumps are *Fomes noxius* (Brown Root disease) and *Ustulina zonata* (Charcoal Rot), whereas *Poria hypolateritia* (Red Root disease) and *Rosellinia arcuata* (Black Root disease) rarely orginate on stumps in old tea.

It has already been inferred that the frequency with which a specific disease originates on stumps depends to some extent upon the number of the causative fungus carried in the air passing over that area. It would appear probable, therefore, that *Poria* and *Rosellinia* produce fewer spores than do *Ustulina* or *Fomes*. This conclusion, however, cannot be supported by direct observation on spore production. *Poria* certainly appears to produce fewer spores, but *Rosellinia* produces them in abundance, so much so that certain authorities have advised that before uprooting a bush attacked by *Rosellinia*, straw or dry rubbish should be heaped around the stem and set on fire in order to destroy them. It appears probable therefore that some factor other than spore abundance operates in determining the frequency with which pathogenic fungi become established on tree stumps.

The spores of pathogenic fungi which find lodgment on tree stumps constitute but a small fraction of all fungal spores which are deposited there. The spores of some species find their surroundings

unsuitable for further development, but those of many others find the environment congenial. A struggle for existence is thus established and the first arrivals normally have the better chance of survival. The odds against late-comers are enhanced partly owing to the chemical changes in the substratum resulting from the activities of the early established fungi, and partly by the inhibitory effects of some fungi on others.

The antagonism which sometimes occurs between fungi is well illustrated by the work of Henry and others [2] with *Gibberella saubinetii*, a fungus which causes a foot root disease of wheat. These workers have shown that the mycoflora of the soil has a pronounced controlling effect on the development of *Gibberella saubinetii* and that the presence of certain saprophytic species of *Rhizophus*, *Penicillium* and *Fusarium* in the soil have a protective value for wheat against the attacks of this parasite. It is conceivable that similar antagonisms occur amongst the flora of tree stumps.

Whatever may be the real reason for it, the fact remains that the root diseases of tea caused by *Poria* and *Rosellinia* rarely originate on the stumps of felled trees in old tea in Ceylon. This fact is of economic importance in that if the control of the red or black root diseases (*Poria* or *Rosellinia*) is the object in view, the removal of all stumps from the attacked fields has relatively little importance. Stumps within the affected patches must of course be destroyed. If however *Fomes noxius* or *Ustulina zonata* are the cause of the disease, the removal of all stumps becomes an important operation in its control.

What has been said above concerning the struggle for existence which occurs on tree stumps and the antagonism late-comers may experience, is suggestive that, with the passage of time, stumps become less dangerous as centres for the emanation of root disease. Unfortunately few records have been kept of the age of stumps from which root disease has originated, and, consequently, statistical proof cannot be produced to confirm or refute such a conclusion. That the commoner root diseases occur within a few years of felling shade trees has been the writer's experience, and one of the most severe epidemics of Brown Root disease he has seen occurred within

two years of the felling of Grevillea trees. Old stumps are to be found in many fields yet root disease is rarely associated with them. If disease should occur at such sites it is likely to be due to such fungi as *Fomes lucidus*, *Fomes applanatus*, *Irpex subvinosus*, etc., well-known and common wood rotting fungi, which have on rare occasions been found to attack tea.

Petch, however, considers that "The danger of disease is not past until the stumps have decayed, a process which may not be completed for many years. One case has been recorded in which Brown Root disease spread to tea from stumps of Na (*Mesua ferrea*) fourteen years old".

The effect of time in diminishing the risk associated with stumps is of more than academic interest in that the question arises whether estates should remove old stumps from their fields. Economically, it is a matter of equating cost against the advantage obtained by the removal of risk of root disease. If the risk is small the cost of removing the stumps may be disproportionate and uneconomic. Estate superintendents could afford material assistance in evaluating this risk, if when removing diseased bushes from the immediate vicinity of a stump they informed this Institute of the disease and the age of the stump.

It is sometimes claimed that the use of a chemical for killing a tree before felling will remove the risk of root disease originating subsequently from the left stump. The basis of such claim, however, is obscure, but a chemical toxicity to fungi which prevents their entry into the stump is implied. Chemical tree killers are normally introduced into the upward water stream which carries it into the crown. That the poison becomes distributed through the root system is very improbable. Assuming, however, that the poison is distributed through the root system and is there sufficiently concentrated to prevent the growth of parasitic fungi in the wood, the poison would prevent the growth of saprophytic organisms also, and the stump would not decay. That would not be altogether advantageous. If later, the poison is washed out or undergoes some change which allows decay to proceed, the parasitic fungi would have the same

chance of becoming established on the stump as they would have had if no poison had been used. The use of chemical tree killers is therefore unlikely to eliminate the risk of disease.

In this connection the following experiment may be of interest. Sections of roots about half inch thick were taken from two Grevilleas, one of which had been killed by an arsenical tree killer, and the other by ring barking before felling. The sections were then placed on cultures of a wood rotting fungus in the laboratory. The roots from the chemically killed tree were attacked as readily as the others. Evidently this particular tree killer afforded no protection against the entry of fungi and therefore could have no value as a preventative of root disease.

The cost of removing all jungle stumps from a new clearing is considered to be prohibitive. The fungi which develop on such stumps are not necessarily such as will cause disease in the tea but there is a definite risk that a small percentage of the stumps will harbour a parasite which later will attack the tea. This risk has to be accepted, but the planter should be prepared to take appropriate measures when and where the root diseases arise The removal of the diseased tea plants alone is insufficient. The jungle stumps responsible must be extracted with as many of their lateral roots as is possible, and burnt.

In old tea the position is somewhat different. Here the chief source of danger lies in the stumps of shade trees which have been felled. Grevilleas and Albizzias are notorious offenders but it is advisable to eliminate risk by the removal of all stumps soon after felling. Needless to say, shade trees should not be left until they have grown to unmanageable size, otherwise the removal of the stumps after felling becomes impracticable.

If the stump is removed immediately after felling the living tree, it is sufficient to sever the large lateral roots and to cut the taproot well below ground. The object in view is to leave no exposed wood surface when the work is completed. Any attempt to remove all the laterals is likely to do more damage to the tea than would a root disease occurring from the left stump.

If, however, the stump is left for a year or more before extraction any parasitic fungus which may have invaded it will probably have reached the roots. Then the removal of the stump alone is likely to be of little value as the tea will become infected from the already parasitised roots of the stump. Where root disease has occurred in the tea the roots encountered when removing the dead bushes must of course be extracted.

If the risk of root disease is to be eliminated, all stumps must be removed at the time the trees are felled. The removal of stumps a few years old, except where Brown Root disease or Charcoal Rot is prevalent, is of doubtful value. Very old stumps may well be left *in situ*, as the risk involved is probably negligible.

REFERENCES

(1). Petch, T.—The Diseases of the Tea Bush (1923).
(2). Review of Applied Mycology, X, p. 447 and 719. XII, p. 18.