A NEW VIEW OF THE CAUSATION OF DIPLODIA DISEASE.

By

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One of the commonest diseases of tea in the low-country is that known as Diplodia. Affected bushes, though apparently quite healthy before they are pruned, fail to recover after this operation. In some cases, the bushes die without putting out any new shoots; in others, a few belated, rather weak shoots are formed, but these die back. Bushes which survive this critical period recover, and the disease does not occur till next pruning time.

The fungus, *Botryodiplodia Theobromae*, is usually to be found on the roots of such dead bushes. Because of its constant association with the diseased condition, mycologists have considered this fungus to be the cause of the disease, which consequently has become known as the Diplodia root disease of tea.

Botryodiplodia Theobromae, however, is a very common fungus in Ceylon. It may be found on a great variety of vegetable tissues which have been killed by other agencies. Its presence on dead tea roots, therefore, is no criterion that the fungus killed the roots unaided. In view of its ubiquity, its presence should suggest that the roots died of other causes, and that the fungus established itself on the dead tissues. At most, it would indicate that some adverse condition so reduces the vitality of the bush that the fungus is enabled to enter the living tissues and destroy them. The same argument holds in the case of other ubiquitous saprophytic fungi commonly found on dead tea bushes.

Three points concerning this form of Diplodia disease are worthy of notice:—

(1) The disease occurs only after pruning

(2) It occurs most frequently at mid and low elevations, where the plucking rounds are most frequent and the pruning cycle is shortest.

(3) Diseased bushes are scattered haphazard through the fields, and are not confined to definite areas from which the disease spreads, as is usually the case with diseases caused by parasitic root fungi.

These facts suggest that the disease results from physiological causes, rather than from the attacks of parasitic fungi. If a parasitic organism is in any way involved, its attack is limited to the period immediately following pruning. In that case, it is evident that the

operation of pruning in some way renders the bush susceptible to attack, and consequently, is a primary factor in the causation of the disease. The mere cutting of the branches alone cannot be the cause of the disease, nor can the operation so lower the vitality of the bush that the parasite is allowed entrance, else the disease would be prevalent at high elevations also, as neither pruning nor the fungus is confined to low elevations.

It would appear probable that climatic conditions play an important part in the causation of this disease, and that the condition of the bush at pruning time determines whether the bush will survive this operation.

A tea bush, when pruned, is normally denuded of leaves. The leaf is the factory in which the raw materials, obtained from the soil and the air, are manufactured into true foods, such as are found in seeds. Thus, when a tea bush is pruned, the manufacture of a food supply is stopped until such time as new leaves are formed to carry on this important work. Food, however, is required for the growth and development of new shoots and leaves. If a bush is to recover from pruning, the bush must have within it a sufficient reserve of elaborated food available for the development of its buds and the growth of new shoots and leaves. Until the new leaves are sufficiently developed to manufacture enough food for the bush's requirements, the bush must subsist on its reserves.

An abundant 'food supply' in the soil cannot make good any deficiency in the reserve of elaborated foods within the bush, when the bush is denuded of leaves. The food supply in the soil is raw material, and is of no immediate use to the plant until elaborated into organic foods. Moreover, the uptake of these supplies is dependent, to a large extent, upon the presence of leaves. The presence of an ample supply of reserve elaborated foods within the bush, when pruned, is therefore of the greatest importance. Without it the bush cannot recover.

The main reservoir for the storage of the reserve food supply is within the roots of the tea bush. Very little stored food is to be found in the stems. The chief constituent of these reserves is starch, which, being of primary importance and easily demonstrated, is the only one which need be considered here.

When tincture of iodine is applied to the surface of a root, cut transversely, the cut surface turns blue, almost black, if the root contains abundant starch. If no starch is present, the surface is stained yellow by the iodine. By means of this simple test, it is possible to determine whether a root possesses a store of starch or not.

Tests carried out on bushes, which have died of the so-called Diplodia disease after pruning, have shown that, in every case yet examined, the roots of the diseased bush are destitute of starch.

PLATE VIII.

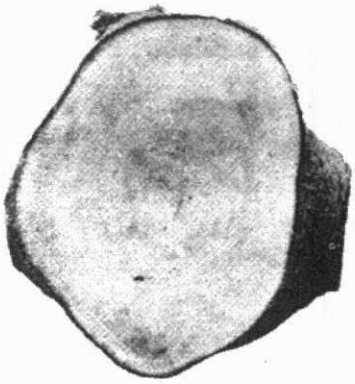

Fig. 1.

Fig. 2.

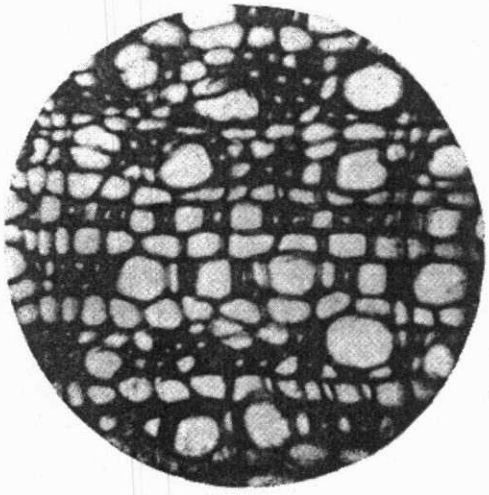

Fig. 3.

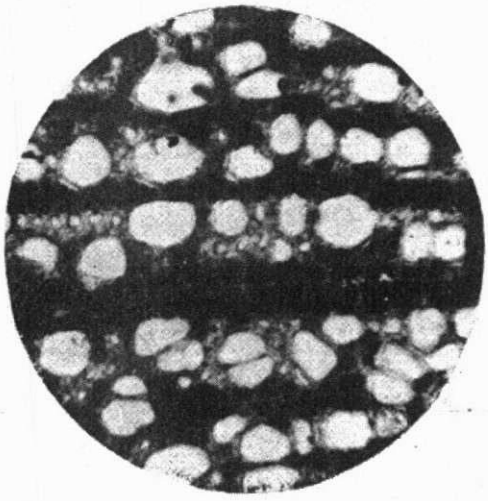

Fig. 4.

THE 'DIPLODIA' ROOT DISEASE OF TEA.

Healthy bushes, and bushes which have died of such diseases as are caused by Poria and Rosellinia, contain starch in sufficiently large quantities to be demonstrated by this test.

The absence of starch from bushes affected by the Diplodia disease is not the result of attacks by *Botryodiplodia Theobromae* or other fungi, as this condition is to be found in live roots, before they are attacked by fungi. It is more reasonable to suppose that death occurs when the reserve of food material is insufficient to support the life processes, or to furnish supplies for the development of new shoots and leaves after pruning. On the death of the roots, the tissues become invaded by Botryodiplodia and other saprophytic fungi, which at different times have been regarded as the cause of this disease.

On Plates VIII and IX are reproduced a number of photographs which illustrate the difference between healthy roots and those taken from bushes which have died after pruning (Diplodia disease). Figs. 1 and 2, Plate VIII, are of the cut surfaces of roots taken from Diplodia and healthy bushes respectively, and stained with iodine. The presence of starch in the healthy root is demonstrated by the dark colour of the treated surface. Figs. 3 and 4, Plate VIII, are micro-photographs of sections through smaller tea roots, stained with iodine. A comparison of these photographs shows that in a healthy root the starch is stored within particular cells, whereas the root cells of a Diplodia infected bush are destitute of starch. Figs. 1 and 2, Plate IX, are also comparable micro-photographs. These sections however, were not stained with iodine. The starch may be seen in Fig. 2 (healthy root) as definite granules which fill the storage cells. No starch grains are to be seen in the root from the Diplodia diseased bush (Fig. 1).

These observations afford a simple explanation of the cause of the death of tea bushes after pruning. A bush, which is destitute of starch at the time it is clean pruned, is incapable of making any further growth, though it may appear healthy and flush well before pruning. On the other hand, if there is but a very small reserve of food, the bush may begin to produce a few belated shoots which ultimately die back, if the supply is insufficient to bring them to a self-supporting stage. Bushes of this type are to be found in fields affected by the so-called Diplodia disease. Again, with a larger reserve of food, the bush will complete the development of its young shoots, the leaves of which, when capable of manufacturing enough elaborated food for immediate requirements, render the bush independent of its stored reserves. The whole of the symptoms observed in the field may thus be explained on the hypothesis that the cause of the disease is intimately connected with the state of the internal food reserves.

The importance of a reserve food supply has not generally been recognised. The great losses which occur annually after prun-

ing must be considered as a direct result of inadequate reserves. To prevent these losses it is necessary to treat the bushes culturally in such a way that they are enabled to store away such reserves as are essential for their recovery after normal pruning.

The application of manures at pruning time, as already explained, is of no immediate use to the bush; it cannot make good any deficiency of the reserve food, so long as the bush is without leaves. It is well known that affected bushes do not respond to manurial treatment. If manurial treatment is resorted to, the fertilisers must be applied some time, probably at least two months, before pruning is started. As a result of such manurial treatment, it is to be expected that the bush will flush well. The temptation to pluck hard, however, must be resisted; otherwise it is very unlikely that the store of reserve food will be materially increased.

The most obvious method of enabling the bush to build up a reserve is by resting it. The time necessary for the manufacture and storage of food in sufficient quantity for growth requirements after pruning, is at present unknown. The period for which badly affected fields should be rested, will have to be determined by experiment; no doubt, it will vary from district to district. For the present, it is suggested that one month's rest before pruning would have a beneficial effect on fields which normally show heavy losses after pruning.

A very light form of pruning should also be practised in affected fields. This should take the form of a light cut across, with the removal of some of the centre shoots if necessary. The object is to leave as much leaf as is possible on the bush, so that the manufacture of food supplies may be carried on without a break. This type of pruning cannot be continued indefinitely; after a number of such prunings, the bushes will have to be taken down or pruned normally. Under such a system, a heavy call on the food reserves is made at intervals of five or more years, instead of two years or less under the system at present in vogue, and the bushes should be in a better position to meet the demand.

The above suggestions regarding treatment are offered tentatively. The main object of this article is to draw attention to the importance of internal food reserves at pruning time. The deaths which occur at mid and low elevations, after pruning, and which are ascribed to the Diplodia root disease, are due primarily to a deficiency of such reserves.

It is very probable that several distinct diseases are known by the name Diplodia. Watt and Mann first recorded the occurrence of the Diplodia fungus in association with diseased tea in the Bishnath district of Assam. Young tea on grass land was dying out rapidly when 3 or 4 years old. "The leaves of the plant take a yellow

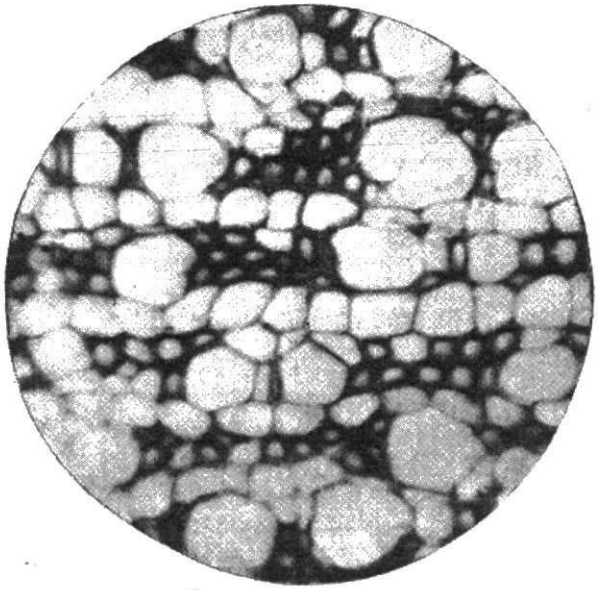

Fig. 1.

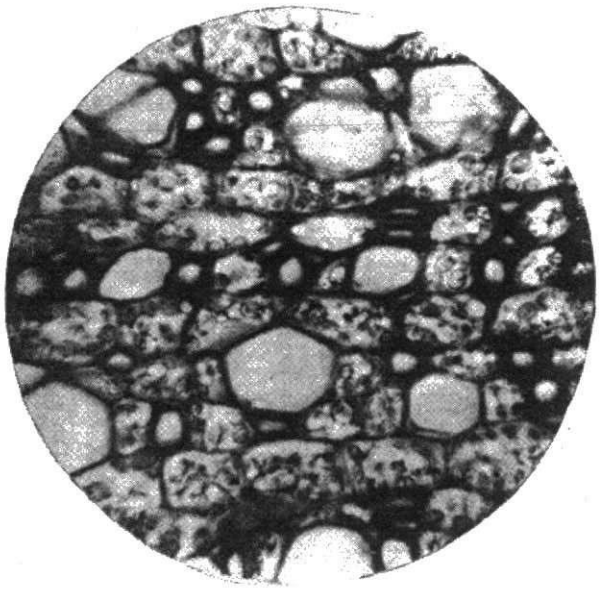

Fig. 2.

PLATE IX.

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appearance, in which the network of the veins is very prominently seen (an appearance easily recognised after a little practice) and then they begin gradually to fall off and branch by branch the bush dies."

Dr. Butler, after examination of diseased material, ascribed the cause to the fungus Diplodia. Since then, the same fungus has been found associated with other diseases of tea, one of which is characterised by the death of the bushes after pruning in Ceylon. It is to this form of Diplodia disease that the above observations apply. As this disease is prevalent in certain districts in Ceylon, where it is well-known by the name "Diplodia disease," this name has been retained for the purpose of this article; but it would appear advisable to give this disease a distinctive name to distinguish it from the other diseases having different characteristics and with which the fungus, *Botryodiplodia Theobromae*, is commonly associated.