LIGHTNING STRIKE OF CACAO AND LEUCAENA IN NEW BRITAIN

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ABSTRACT.

A description is given of a condition, attributed to damage by lightning strike, involving 31 *cacao and about* 200 *interplanted* Leucaena leucocephala *trees at two sites on a plantation in New Britain. Symptoms consisted of sudden partial or full defoliation and death of bark, followed by discolouration of wood inwards and downwards, resulting in death of branches and some trees. Recovery occurred in all but six cacao and several* Leucaena *trees left after sampling of partially damaged specimens.*

INTRODUCTION.

Occasionally reports have been received from planters in Papua and New Guinea of lightning strikes of cacao. In some cases the date of the strike was not precisely known, as symptoms were usually not noticed until weeks later. In other cases strikes were not reported until months after the reputed event, so that it was impossible to work out the sequence of symptoms on the damaged cacao.

One planter in New Britain, however, notified the Department as soon as he noted suspected lightning strike damage. As the authors are not aware of any published description of lightning strike on cacao or any associated shade tree, the following description is given of the symptoms of the reputed strike in New Britain.

It is hoped that cacao specialists in other countries will record the symptoms shown by cacao and shade trees after lightning strikes so that information will be accumulated on the time lapse before onset of symptoms, the extent of damage to individual trees, the time to recovery, if any, and the size of the areas affected in different situations.

INITIAL OBSERVATIONS.

On 7th May, 1965, a report was received by the junior author at the Lowlands Agricultural Experiment Station, New Britain (in New Guinea) of a condition in cacao (*Theobroma cacao* L.) and *Leucaena leucocephala* (Lam.) de Wit. (the interplanted shade tree) at a nearby plantation. The owners and some of the staff were of the opinion that the condition was of recent occurrence, the trees having previously been in excellent health. They presumed that it was the result of a lightning strike on the property during a storm said to have occurred on 13th April.

The plantation was visited on 7th May by the junior author, who reported that one large and one small area were affected, the details of which were as follows :—

Site 1.—Trees situated on a ridge. Twenty-five cacao trees affected as indicated in *Figure* 1 and approximately 200 *Leucaena* in the rows of cacao. The extent of damage varied from one dead branch per tree to the complete death of the tree.

No scorching was noticed on the cacao (which was 9 to 18 months old and up to 4 ft. (1.2 metres) high) nor on the *Leucaena* (up to 15 ft. (4.6 metres) high).

Site 2.—Six cacao trees with tips of branches dead. Six *Leucaena* surrounding the cacao with dead tops and trunk to within 4 ft. (1.2 metres) of the ground ; upper leaves shed but seed attached. (Cacao three and one-half years old).

The positions of the affected trees at Site 1 are shown in *Figure* 1. Only those *Leucaena* with completely dead tops are marked in the diagram ; *Leucaena* with partially dead tops, that is, with one or more branches dead, are not shown. These extended along the rows of cacao outside the area of *Leucaena* with dead tops.

Specimens of the affected cacao and *Leucaena* forwarded to Port Moresby were examined by

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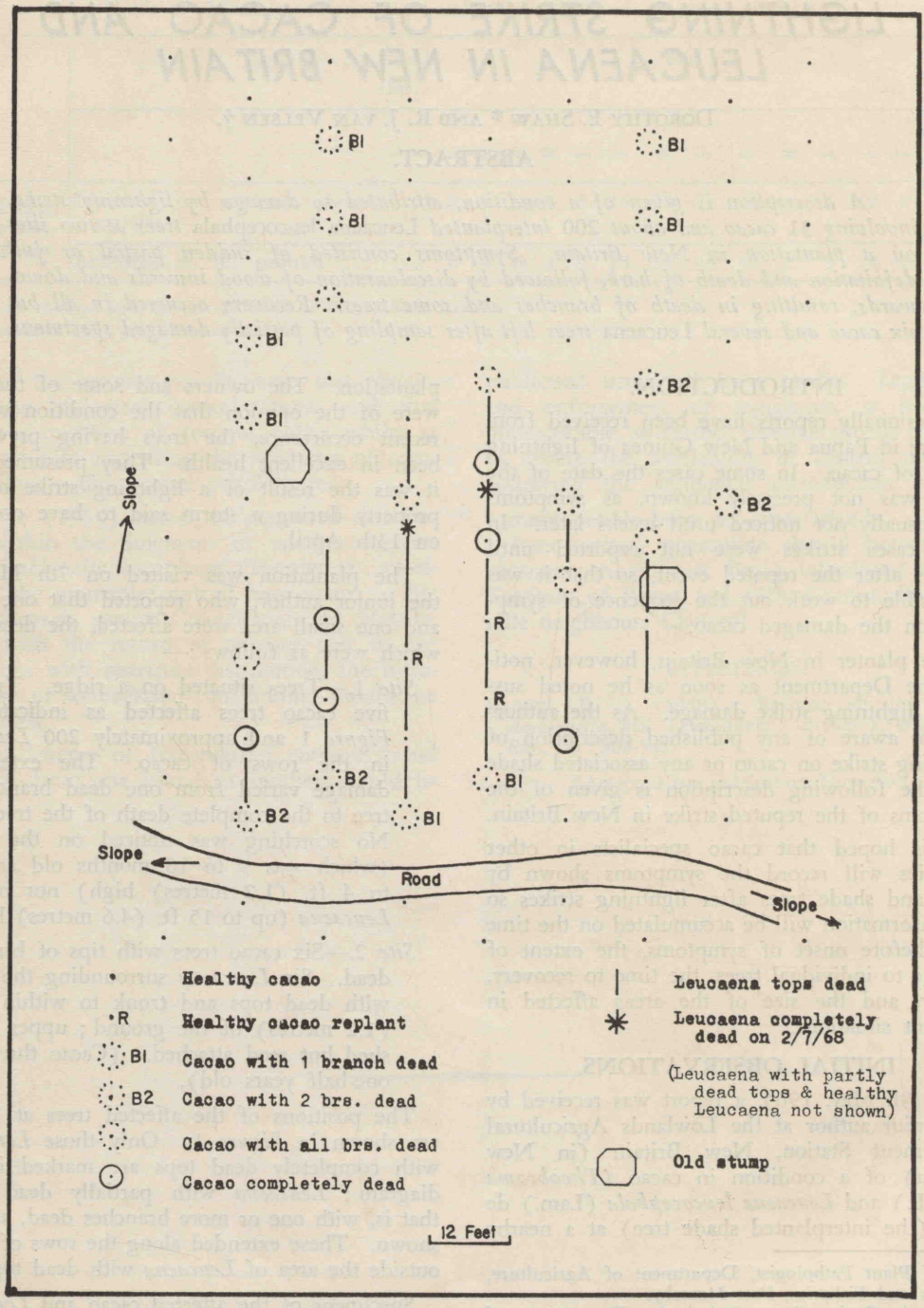

Figure 1.—Positions of affected cacao and *Leucaena.*

the senior author. The main symptoms on cacao were death of the branches preceded by death of the bark, with consequent lifting of the bark and blackening of the outside of the underlying wood, with deterioration preceding downwards. The main symptoms on *Leucaena* were death of the bark and discolouration of the underlying tissue inwards and downwards. Leaves of both cacao and *Leucaena* not already shed when dispatched had fallen during transit.

CONDITION OF THE TREES ON 25TH MAY, 1965.

Cacao.

On 25th May the senior author visited the plantation but no dead or dying leaves were present on the affected cacao at that time.

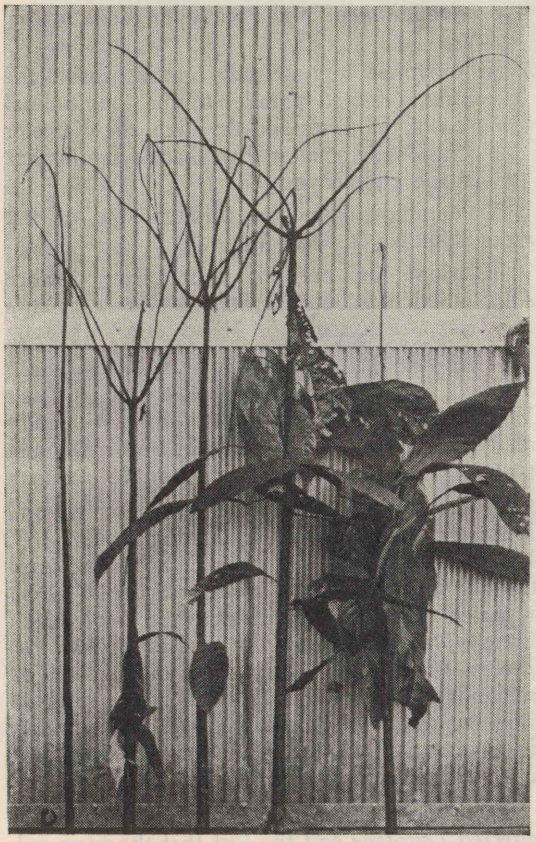

Plate I.—Young trees with dead tips but healthy bases, except tree marked "D" which was completely dead.

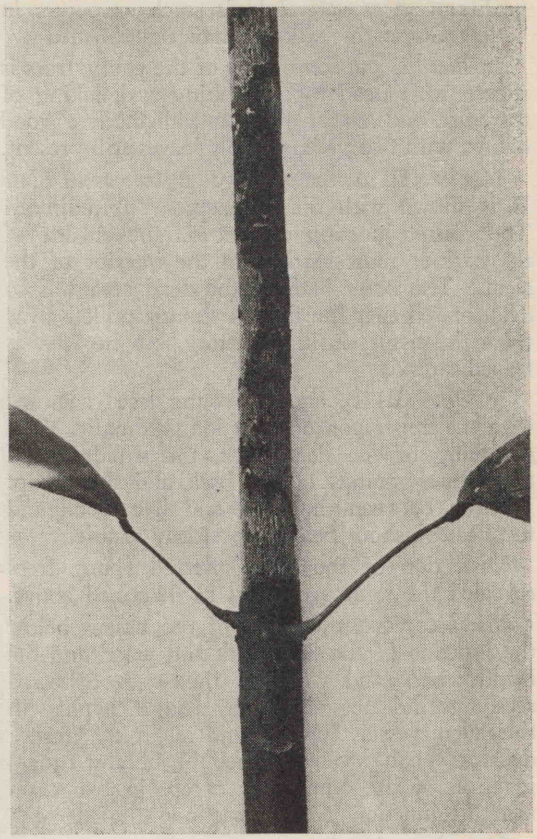

Plate II.—Trunk of young tree showing dead top with shrinking and flaking of bark and abrupt junction with healthy wood, with two green healthy leaves still present.

Most of the dead wood had been cut off the affected cacao trees at Site 2 before the visit. One of the trees with the trunk and several branches still standing was found to have secondary fungi growing on the bark of the trunk. When split, the wood was discoloured nearly to ground level. The tree would have died soon afterwards as the cambium could not have functioned very much longer.

Further specimens of young affected cacao at Site 1 were examined on the plantation and later in the laboratory. *Plate* I shows five young trees from this area; four had dead tips but healthy bases and one (marked 'D') was completely dead. Defoliation of the dead parts of each seedling had occurred but there was no

proliferation of lateral buds, such as occurs in " New Guinea dieback " (Shaw unpublished).

In *Plate* II portion of one of the young trees is shown with dead top, shrinking and flaking of the bark, and abrupt junction with the live wood below, with two green healthy leaves still present.

In *Plate* III A, the same young tree as in *Plate* II is shown with the stem split longitudinally. The abrupt junction evident on the outside of the bark is most marked in the interior of the stem. The outer bark of the dead area was so deteriorated that the fibrous strands pulled away from the tissue during splitting, can be seen as frayed strands.

In *Plate* III B, another young tree is shown with the upper portion split longitudinally. The shrinking of the dead bark, the shredding of the fibrous strands of the bark and the abrupt junction between the dead and live wood and the healthy shoot below are clearly visible.

Dissection of the other affected young trees revealed the same symptoms as described above.

Microscopic examination of the tissues below the junction of the dead bark and wood and the healthy bark and wood of the seven dissected seedlings did not reveal any fungal hyphae in the xylem vessels (as is found in " New Guinea dieback " (Shaw unpublished)) or any fungal invasion of the other cells except in two cases near the junction in many sections studied.

Secondary fungi were present on the dead tissue, as is common in New Guinea. No fungus which could be recognized as a primary pathogen was isolated from the tissues below the junction.

The death of the bark before the discolouration of the internal wood and the later discolouration of the internal wood inwards from the bark (as evident in the specimens examined in Port Moresby), the quick death of the branches, the absence of stimulated axillary buds and the absence of hyphae in the xylem all distinguish the condition reported here from " New Guinea dieback ".

Leucaena leucocephala.

Dead branches were still evident on the trees when examined. However, regrowth from many of the *Leucaena* branches below the dead portions of the trunks had already occurred when the trees were examined on 25th May.

The most noticeable feature of the specimens was again the deterioration of the bark which in most cases preceded discolouration of the wood. In some cases the junction between the dead bark and wood and the healthy undiscoloured wood below was abrupt (*Plate* IV A).

In a few cases the junction was not distinct—a diffuse edge occurred, the affected wood having a ' blue ' tinge as in blue staining of timber (*Plate* IV B).

Microscopic examination of some of the ' blue stain ' areas of the *Leucaena* revealed—

(i) brown septate hyphae running through the parenchyma cells of the rays at right angles to the main axis of the stem ;

(ii) hyphae rambling sparsely throughout the xylem vessels, i.e., lacking the definite orientation of those in the parenchyma ; and

(iii) hyphae very sparsely running inside the fibres, oriented parallel to the longitudinal axis of the fibres and the stem, the diameter occasionally smaller than that of the hyphae in the parenchyma.

A longitudinal section through one of the areas is shown in *Plate* V.

Isolations in nutrient agar after surface sterilization consistently yielded *Botryodiplodia theobromae* Pat. from the ' blue stain ' areas.

Some of the affected *Leucaena* had been attacked by scolytid beetles as shown in *Plate* VI A and B. Blackening of the tissues immediately surrounding the scolytid damage, and especially longitudinally from it, is most marked.

Specimens of the scolytids were collected, and later sent by the Senior Entomologist (Dr. J. J. H. Szent-Ivany) to Professor E. Schedl of Austria for identification. Professor Schedl (1968) reported that the specimens were Scolytidae : *Eccoptopterus spinosus* Oliv. and *Xyleborus perforans* Woll. In previous correspondence on scolytids Professor Schedl had stated that *E. spinosus* might be primary as well as secondary in its attacks but that *X. perforans* is mostly found as a secondary pest.

From the position of the scolytid attack on the affected *Leucaena* and the fact that the surrounding unaffected *Leucaena* was free from the insects, it is likely that in the present case both species were secondary.

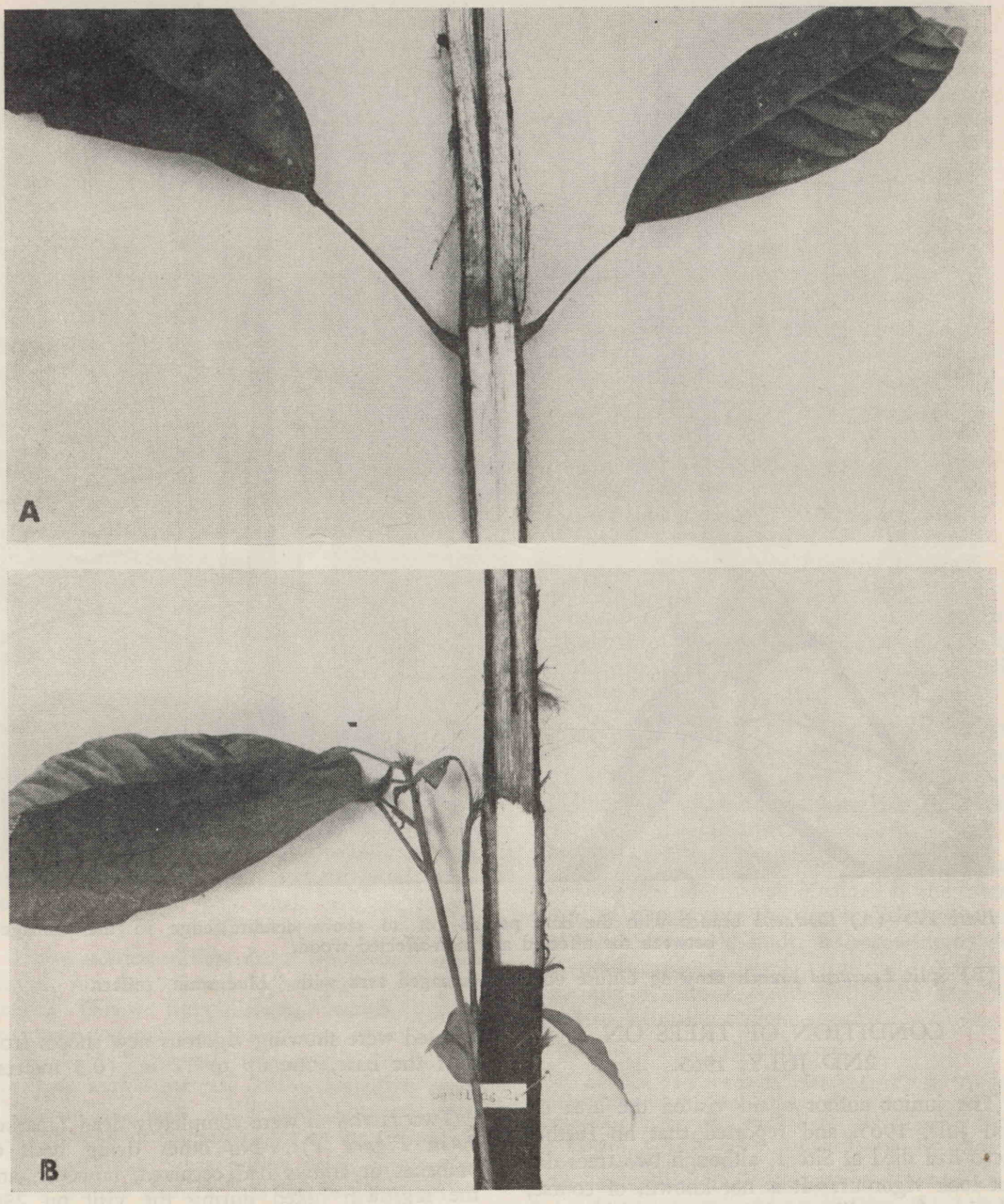

Plate III.—(A) Portion of trunk shown in *Plate* II split longitudinally showing abrupt junction between affected and healthy wood.

(B) Another seedling split longitudinally to show abrupt junction and shredding of deteriorated bark.

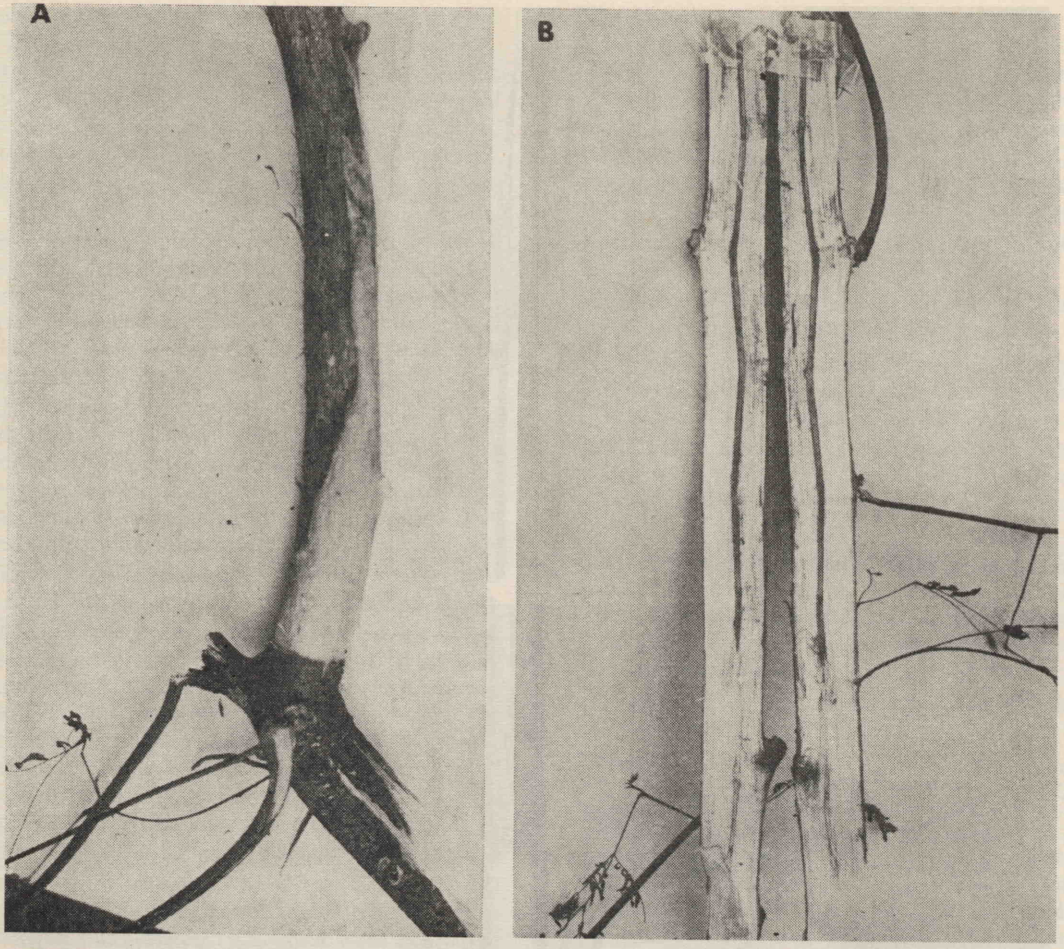

Plate IV.—(A) *Leucaena* branch with the bark peeled off to show definite edge to the damage between the affected and non-affected wood.

(B) Split *Leucaena* branch showing diffuse edge of damaged area with "blue stain" effect.

CONDITION OF TREES ON 2ND JULY, 1965.

The junior author again visited the area on 2nd July, 1965, and reported that no further cacao had died at Site 1, although two trees did not look vigorous. It is not known, of course, whether the seedlings sent to Port Moresby and the six partially alive seedlings out of the seven uprooted and studied by the senior author on 28th May would have recovered. Four of the remaining seedlings which had been partially affected were showing vigorous new shoots from near the base, one up to 12 in. (0.3 metres) long.

Two *Leucaena* were completely dead (marked * in *Figure* 1). No other dying back of branches or trunks had occurred, however, and the regrowth noted during the visit on 28th May was now vigorous and up to six ft. (1.8 metres) long.

No further dead wood was found on cacao or *Leucaena* at Site 2 and regrowth on the *Leucaena* was up to five ft. (1.5 metres) long.

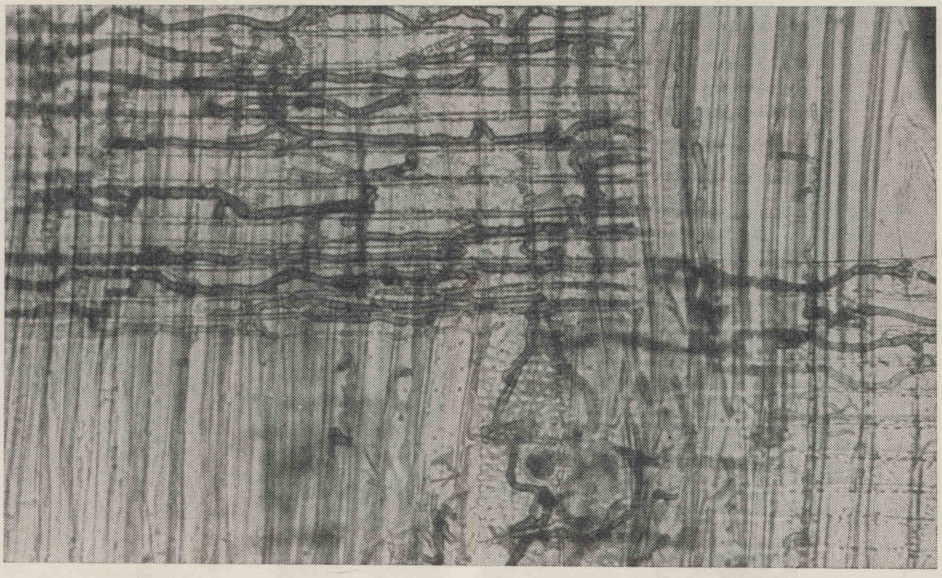

Plate V.—Section through "blue stain" area of damaged *Leucaena*, showing strongly orientated brown hyphae in the parenchyma but relatively few hyphae in fibres and xylem. x 250.

DISCUSSION.

The condition described herein is not similar, as far as the authors are aware, to any condition described for cacao or *Leucaena leucocephala* overseas.

While the abrupt junction between the dead and the healthy cacao wood recalls the Ghana dieback described by Crowdy (1947) and Owen (1956), it differs in the quickness of the death of the tissue (according to the planter and staff) and the fact that the condition was confined to one large and one very small area, in several hundred acres of non-affected cacao.

The condition differs from tip dieback with abrupt junction found occasionally in New Guinea (Shaw unpublished), which usually occurs on overexposed cacao and again is not confined to a precise area amply shaded by *Leucaena*, as was the case on the plantation under discussion at least until the *Leucaena* was affected at about the same time as the cacao.

The condition also differs from progressive "New Guinea dieback" as this is characterized by indefinite margin, brown streaking of the healthy wood below the dead tissue, slow defoliation, stimulation of lateral buds, shortening of internodes and other symptoms (Shaw 1963 and unpublished).

No apparently sudden defoliation of *Leucaena* with death of branches has been recorded in the Territory previously, either in conjunction with a similar condition on cacao or separately.

It seems unlikely to the authors that the present condition was progressively pathogenic because of the quick recovery of both the cacao and the *Leucaena* and the fact that no spread occurred to neighbouring plants.

From the evidence of the owners and staff, and from the information obtained in the macroscopic examination of the sites and the specimens and the microscopic study, it is considered that the dead and damaged cacao and *Leucaena* especially at Site 1 could well have been the result of lightning strike.

ADDENDUM.

While this paper was in press Mr. C. A. Thorold kindly drew to the authors' attention the reference by Entwistle, P. F., in *Ann. Rept. W.A.C.R.I.*, 1958-59 (pages 37-38) 1960, listing borers recorded on cocoa following damage either by root fungus or lightening strike, and the reference of Wharton, A L., *Agriculture and land use in Ghana* Ed. J. Brian Wills, Oxford Uni. Press, pp. xviii + 504 (p.341), 1962. Wharton described the circular patches of blasted trees, with wilt, the dead leaves remaining attached to the trees, followed by invasion by borers and secondary fungi and recovery of peripheral trees.

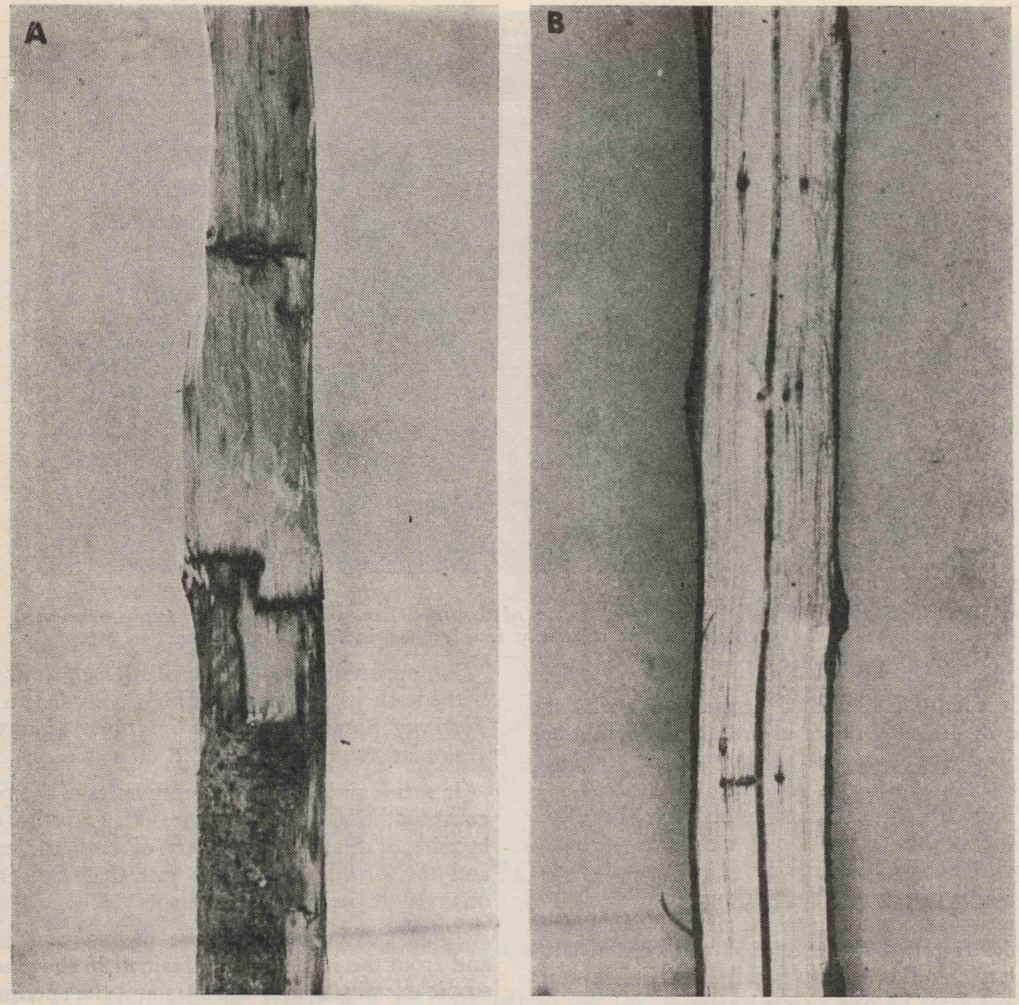

Plate VI (A) Portion of peeled *Leucaena* branch showing damage by scolytids and blackening of the tissue surrounding the holes.
(B) Split *Leucaena* branch showing internal position of the scolytid holes with blackening of the surrounding tissue and longitudinal staining from the holes.

ACKNOWLEDGEMENTS.

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Mr. A. W. Charles kindly read the manuscript.

The owners and staff of the plantation are thanked for assistance given during the visits to the sites.

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