* LIGHTNING DAMAGE IN RUBBER PLANTATIONS

BY

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In the paper mentioned in the footnote I state the conclusion that lightning is of primary importance in the causation of diseases found on coconut plantations in Malaya. This conclusion naturally brings to a focus the question as to whether similar phenomena are not met with in rubber plantations. When considering this question the difference in structure of the two types of trees must be kept in view. The coconut palm is a monocotyledon and has no stem cambium, the growth initials or bud-tissue being concentrated in the "cabbage" and, if the tissue composing the so-called cabbage is killed, growth in length cannot continue. On the other hand, the rubber tree is a dicotyledon with stem cambium, by means of which it increases in girth year by year. Parts of the stem cambium may be killed or injured but, if healthy cambium remains, growth in general may be continued by the sprouting of a dormant bud which develops as a side-shoot. Therefore, although lightning might cause injury in both coconut and rubber plantations the observed symptoms will probably be very dissimilar. The symptoms on coconut plantations are very striking because the death of the tree follows the injury of the meristematic tissue concentrated in the "bud". But in rubber trees the upper portion of the stem may be killed by lightning while the lower portion is unaffected; in such cases growth can be continued by the shooting of lateral buds from the healthy tissues. There are many references in the standard books (1 & 2) to lightning injury on rubber, but they are generally very indefinite and only record the wound effects supposed to be caused by lightning. The following quotation (5) summarises the position.

"The pernicious tendency of lightning to cause damage to plants has been well shown in rubber. Many cases have been investigated and talks with planters demonstrate the common occurrence of lightning injury to young rubber. The "die-back"

*Largely a copy from a paper entitled "Lightning Storms and their significance in relation to diseases of (1) *Cocos Nucifera* and (2) *Hevea brasiliensis*:" Anns of applied Biology Vol. XX, No. 1, pp. 1—22, February, 1933.

of 4-12 months' old trees wherein the tops wilt, the green bark turns black with the appearance later of three to four different caulicolous fungi, finally resulting in death, is apparently attributable to lightning. The affected trees occur in patches and, when cut back to stump height, regenerate rapidly with a discontinuance of the damage. The influence of lightning on the growth of trees, if the trees are not killed outright, usually takes the form of a modification of the developing wood cells of the season so that the continuity of the normal structure of the wood is broken and a "lightning ring" is formed".

Recent observations prove that lightning effects in rubber plantations are quite as definite as those in coconut plantations and strongly support the observations made and conclusions arrived at by the investigation on the causation of diseases of coconut palms.

The observations on the effects of lightning on rubber plantations can be most conveniently treated under two headings:

(a) Lightning effects and "die-back"; usually found in young trees.

(b) Lightning effects and "claret-coloured bark canker at the collar"; found on trees from 4 to 20 years of age.

Lightning effects as in (a) above:—The symptoms shown by young rubber trees affected by lightning are well described in the quotation already given. The important point is that few losses occur, for young trees are seldom killed outright and, when cut back to stump height, the cut being made through healthy tissue, regeneration is rapid, the growth being continued by the shooting of lateral buds from the unaffected tissues. Careful examination of the root systems of young trees affected by lightning show that they remain healthy; a root examination is necessary to make certain that the symptoms are not the result of an attack by one of the usual root disease-causing fungi.

The following is a record of an area affected by lightning. The area was planted in 1928 and budded in December —January, 1929-30. There were two areas affected, a large area situated on an exposed hilltop, and a small area on the side of a hill, one mile distant.

The lightning storm, which occurred on November 3rd, 1931, was a notably severe one. Nothing unusual was seen until November 11th, 1931 when over 100 trees were found showing the symptons described above. The writer was notified on November 11th, 1931 and inspected the area on November 13th, 1931; on this visit a careful root examination was undertaken, and this showed the root systems to be perfectly healthy. In the large area 121 trees were treated; of this number eight had

to be cut out completely, the rest were treated successfully by pollarding. The number of treated trees in the smaller area was twenty, of which five were total losses. The diagnosis of lightning strike could be made with confidence.

Lightning effects as in (b) above:—This case of lightning injury, on rubber trees 4-5 years old, was investigated in March, 1931. The trees were planted on a hilly slope on contours; the ground was covered by a thick cover crop of *Centrosema pubescens*.

A lightning storm in close proximity was noted 5 days before the affected trees were found. Trees on two contours were affected; on the lower contour only two dead trees were found, but on the upper, one dead tree and in addition seventeen neigh bouring trees, all slightly affected at soil level, were observed.

The dead trees were taken out immediately. The seventeen trees, presumably slightly affected by lightning, showed discoloured cortical tissues at ground level. This discoloured tissue formed a patch about 6 ins. square and extended through the thickness of the cortex. The discoloured patches of cortical tissues showed symptoms exactly similar to those described for the cortical disease of Hevea, long known as patch canker or claret-coloured bark canker. A discoloured patch was stripped from the wood and isolations were made in the laboratory in various ways. Thirty hours after setting in the culture media a profuse growth of white mycelium was evident, which ultimately proved to be a species of Pythium.

The obvious point is that, if the trees with the bark attack at the collar had remained unnoticed at the time the dead trees were taken out, and had been left untreated, there would have been a peculiar outbreak of root disease reported a few months later, for which it would have been difficult to provide the correct explanation. This is a parallel case with the delayed effects observed in the coconut palm investigations. Later investigations, described below, provide further evidence showing that the discoloured tissue at the collar is typical of claret-coloured bark canker.

Before describing other recent interesting cases of the association of lightning effects on rubber trees and claret-coloured bark canker at the collar a few remarks on the disease may be of interest. This disease, known variously as claret-coloured bark canker, purple canker or patch canker, is a well-known disease of *Hevea brasiliensis* and was first discovered on this host in 1903. Petch records that it has been found in Java, Sumatra and Fiji, and that it is said to be of rare occurrence in the Federated Malay States. Recently (1933) it has been reported that patch canker is common and does considerable damage in rubber plantations

in Kedah, but this report has not been actually verified. The following remarks, with reference to this disease, are taken from the same authority (1).

"The most serious cases of claret-coloured bark canker are those in which the tree is attacked at the collar. The disease may then run rapidly round the base of the tree and kill it in a few weeks.

"Bark attacked by claret-coloured canker has a peculiar smell, which soon attracts boring beetles, particularly a small brown beetle about the size of the shot-hole borer. When the disease has been in progress for a few weeks, the decayed patches are usually riddled with this borer.

"The Phytophthora which causes claret-coloured bark canker is identical with that which causes the similarly coloured canker in cacao."

The cases of claret-coloured canker in Malaya recently found associated with trees affected by lightning are invariably those in which the trees are attacked at the collar. The chief danger in such cases is that boring beetles, which are attracted by the peculiar smell of the affected tissue, may enter the tree and, if this happens, such trees succumb in the majority of cases.

With reference to the fungus causing the symptoms, the position was not clearly understood until 1929, when Thompson (3) showed that two species of Phytophthora and one species of Pythium are direct causes of patch canker in Malaya; further, that seven other species of Phytophthora isolated from host plants other than Hevea are capable of causing patch canker symptoms if artificially inoculated into the bark of rubber tree. Thus it seems obvious that more than one species of Pythium or Phytophthora may be found to be involved in the production of the diseased, claret-coloured, cortical tissue which has been found at the collar of trees affected by lightning.

The most noteworthy occurrence of the association of lightning and claret-coloured bark canker at the collar can now be described. During the investigations on lightning effects the writer has noted the dates of lightning storms occurring in the vicinity of Kuala Lumpur. Two heavy thunderstorms were noted on November 18th and 19th, 1931; both took place between the hours of 1.30 and 4.30 p.m. On December 2nd, 1931 a report of lightning damage was received from an estate only 3 miles from the Rubber Research Institute. A visit was made and several lightning patches were found on trees 20 years of age. There was no cover crop present.

Fig 1. shows the patches situated on a direct north and south line. The distribution of the affected trees in each block is shown

in Fig. 2. The total number of affected trees was 56. Of these 8 were killed outright and 48 were treated for claret-coloured bark canker at the collar.

The symptoms shown by the affected trees could not be mistaken. The badly affected trees which had to be cut out were killed as a result of the scorched cortical tissues being rapidly invaded by the Diplodia sp. which is the cause of "die-back" in rubber trees. This black, discoloured cortical tissue proves attractive to boring beetles, and the rapid penetration of these insects into the stem results in the early death of the tree. The borer attack on badly affected trees is of importance when considering treatment of the slightly affected trees, which again showed typical symptoms of claret-coloured canker at the collar, because, as mentioned above, such affected cortical tissue attracts boring beetles, and on this account it is imperative to remove it as quickly as possible to prevent penetration by the insects.

The slightly affected trees all showed the typical symptoms of claret-coloured bark canker at ground level, in greater or less degree. Figs. 3 and 4, show the appearance of an area of discoloured cortical tissue, 10 in. by 5 in. which was stripped from the wood at the collar of one tree. Fig. 3 shows the extent of the discolouration of the affected area when the outer bark layers are scraped away. Fig. 4 shows the appearance of the inner surface of the affected cortical tissues; this surface is directly in contact with the wood, and a reflection of this appearance is found on the wood surface. The white patches are pads of coagulated latex which has infiltrated from the attacked cortical tissues; these rubber pads lie in shallow depressions on the inner surface, which are formed as a result of the pressure set up.

The photographs illustrate an extreme case in which a comparatively large bark area is affected, with the fungus penetrating to a slight depth into the wood beneath. The more numerous cases are those in which a smaller patch of cortical tissue is involved and, though the wood surface beneath is discoloured, there is no penetration of the woody tissues by the fungus.

The effects of lightning in rubber and coconut plantations are quite opposite in one respect. In rubber plantations the secondary symptoms are caused by fungi which have been long known as probable causes of specific diseases of rubber trees. On the other hand, the secondary bud-rot symptoms in Malayan coconut plantations cannot be connected up with any disease-causing fungus. *Marasmius palmivorus,* Sharples, simply accelerates defoliation and has nothing to do with the actual rotting of the bud tissues.

There is nothing unexpected in the association between lightning and the Diplodia sp. commonly found attacking rubber trees suffering from "die back." The partiality of this fungus for scorched cortical tissues has been proved (4), and this feature has been amply demonstrated in trees scorched by lightning which have been examined during the present investigation.

The treatment of the trees showing the small patches of diseased tissue at the collar is simple. The bark area affected is delimited by light scraping with a chisel or a similar instrument; when this has been accomplished, the diseased area with about one inch of surrounding healthy tissue is stripped from the wood. From the theoretical point of view, scraping the diseased bark should be avoided as much as possible, for it is quite impracticable to prevent minute traces of the scrapings falling into crevices at the base of the tree or on the soil to become mixed with the latter. If this occurs, the danger of reinfections at the collar are obvious. Reports have been obtained to show that stripping away the disease patches is very difficult in certain districts, and this may be the case but, except on very rare occasions, the writer has experienced little difficulty in carrying through the stripping operation. There is no doubt that reinfections at the collar are commonly found if scraping is undertaken, but there is little chance of reinfection if the whole of the diseased tissue is stripped away in one piece. After stripping, the diseased tissue should be destroyed as quickly as possible; it is advisable to have a container handy containing a small amount of kerosene or copper sulphate or any strong disinfectant in which the diseased tissue can be soaked prior to burning. After stripping, the exposed wood surface should be painted first with a suitable disinfectant and later covered with a permanent wound dressing; a coating of tar or of Asphaltum-Kerosene mixture are quite suitable for the purpose.

The species of Pythium isolated from the diseased cortical tissues will be reported on subsequently. The occurrence of this Pythium species which causes the claret-coloured canker at the collar of rubber trees slightly affected by lightning is difficult to explain. The difficulty might be overcome if claret-coloured bark-canker of the tapping panel was a common disease in Malaya, as it is reported to be in Ceylon. This disease of the tapping panel is rarely met with in Malaya, so this cannot be considered as a source from which the Pythium sp. would be derived. This fungus might escape notice on areas carrying a heavy cover crop, for the cover plant would provide the desirable humid conditions for growth and spread, and it may be submitted that the fungus might be present without special symptoms becoming prominent on

the cover crop. If evidence was forthcoming to support this suggestion an acceptable explanation of the observed phenomena could be provided. But in several mature areas recently found affected by lightning, where the slightly affected trees were all found to be suffering from claret-coloured bark canker at the collar, no cover crop was present, so that this suggestion cannot be accepted.

Two alternatives are available.

(a) That the organism is a soil-inhabiting fungus.

(b) That the fungus is commonly present in the interstices of the bark, where it may be able to live saprophytically for a time, and later may be washed down to the collar during heavy rains, where, under more favourable growth conditions, infection may take place.

No evidence has been obtained, as yet, to support either alternative.

Summary

1. Lightning has been proved to be of importance in the causation of disease on rubber plantations.

2. The typical effects on rubber plantations are described, and attention is specially directed to the association of claret-coloured bark canker at the collar of trees slightly affected by lightning.

Acknowledgment

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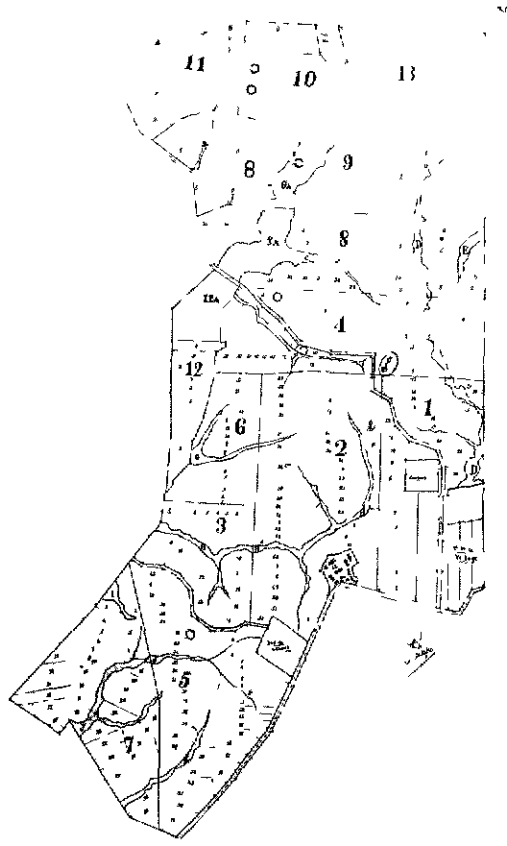
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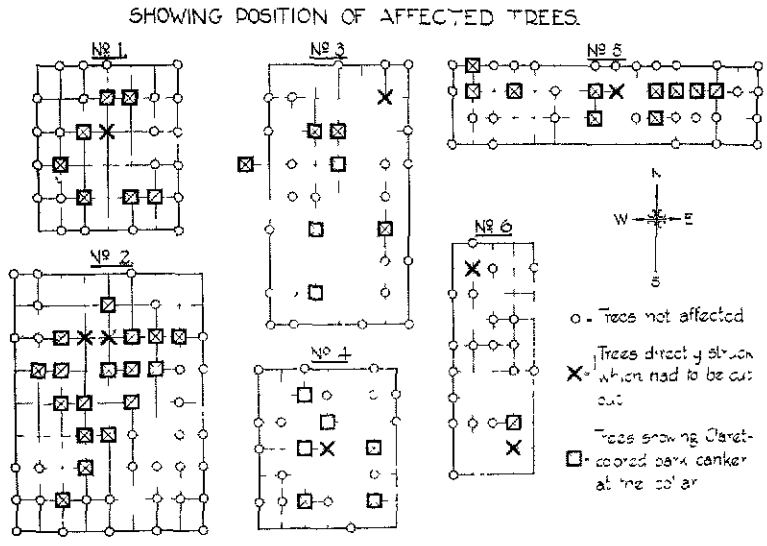
FIG. I


SHOWING POSITION OF AFFECTED TREES.
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№ 3.
№ 5.
№ 2.
№ 4.
№ 6.
N
W
E
S
o - Trees not affected
Trees directly struck which had to be cut out
Trees showing Claret-coloured bark canker at the collar

FIG. II

FIG. III

FIG. IV