PESTS AND DISEASES.

A DISEASE OF THE BETEL VINE CAUSED BY A SPECIES OF PHYTOPHTHORA.

A. THOMPSON, B.Sc.,

Assistant Mycologist, Department of Agriculture, F.M.S. & S.S.

The Betel Vine or Sirih has been cultivated on a small scale in the Malaya for many years. The plots are usually situated in the neighbourhood of towns or groups of estates employing Indian labour where a ready market is obtained for the sale of the leaves. The latter, along with a little lime and a few slices of arecanut, form a masticatory which is in common use amongst the natives of Eastern countries.

In Pahang East, at Pekan, one of the main sources of income to the Malays is the growing of Sirih. The vines are grown in small plots, usually less than half an acre, in the ground surrounding the growers' houses. The plants are grown 3-4 feet apart in rows, with 4 feet between each row and each vine is supported on a long pole from 10-12 feet high. Sirih has been grown in Pekan for more than 50 years and has provided a comfortable livelihood for the Malay cultivators. The leaves are all consumed locally and are sold under normal conditions at 8 cents per bundle of 50 leaves. At the end of 1923 the leaves were being sold at 40 cents a bundle owing to shortage of supplies, following a disease which appeared in the plots and killed most of the vines. During the North-East monsoon, from October to December, 1923, the rainfall at Pekan was continuous and heavy; over 72 inches being recorded for the three months. This was accompanied by a flood in the Pahang river which inundated the kampongs and Sirih plots.

Sirih requires plenty of water for its successful cultivation, but it is very susceptible to the effects of badly drained, waterlogged soil. Drainage at Pekan during the monsoon is difficult owing to the low lying situation, and by the end of January the Sirih vines began to die off rapidly. In March only a few vines were alive all through the district and specimens suitable for examination were difficult to obtain. Most of the roots were swarming with eel-worms and some of the roots had formed typical eel-worm nodules. Attempts to isolate a fungus were unsuccessful but bacteria developed freely. These however were non-pathogenic.

In October, 1924, the wet weather set in again at Pekan, 18½ inches of rain falling during the month. Minor floods appeared and the replanted Sirih vines began to die off rapidly. Good specimens in early stages of disease were obtained and examined. Sections cut from the stem at ground level, where the disease begins, were stained with cotton blue and lactic acid. Non-septate hyphae were evident running through the tissues and cultures prepared from similar sections yielded a *Phytophthora*, which later obtained in pure culture.

Fungi reported on Piper Betel from other countries.—In his report for 1903, Carruthers (1) in Ceylon mentions. " The disease of the betel pepper plant (*Piper Betel* L.) was brought to my notice from different and widely separate districts. The disease is due to the ravages of a fungus of the family *Perenospora* in the softer tissues of the plant." This fungus does not seem to have been studied further. In 1906 Petch (2) in the Report of the Mycologist writes, " Several specimens of diseased betel leaves and shoots were sent in during the early part of the year." He does not mention any specific fungus but in the same report gives a list of fungi found on specimens and records *Cercospora* sp. on *Piper Betel.* L.

The following fungi have been recorded more recently on Sirih from Ceylon (3)

Leaf diseases:-

Colletotrichum Piperis	(Petch)
Oidium sp.	(Causing Mildew)
Phyllosticta Piperis	(Tarse)
Bacterial Disease.	

A *Cercospora* sp. and a *Colletotrichum* sp. have been found on the leaves in Malaya. They are associated with leaf spots but the damage done is inconsiderable.

In 1924 Mc Rae (4) mentions a disease of the betel vine connected with a *Fusarium* sp. and Hutchinson (5) records from Pusa a disease associated with bacteria in the xylem vessels of the stem.

A species of *Diplodia* isolated for the first time from a wilted betel vine is reported by the Plant Pathologist, Bombay (6).

As far as available literature show the above organisms are the only ones recorded as being associated with diseases of the betel vine. To this list must now be added a *Phytophthora* sp. causing a root and stem disease in Malaya.

Symptoms of the disease.—The disease is a typical " wilt " i.e. the leaves of the plant attacked either turn yellow and droop or droop while still green. The stem, which is rotted at the base, turns brown and withers. If a plant in an early stage of disease is examined, it will show that, in the majority of cases, the attack has commenced about an inch or so below ground level. At this point the tissues of the stem are discoloured externally and internally. The colour varies from black to reddish brown and the internal tissues are soft and " gummy " with brownish red streaks. Later on the roots and stem disintegrate into a wet stringy slime and give off an acrid odour. In a few instances the disease appeared in a segment of the stem about a foot above the ground level. The stem was ringed at this point by a discoloured area several inches long and the parts above this area wilted.

Conditions favouring the spread of the disease.—Waterlogged soil due to floods and defective drainage, heavy rains, and misty mornings, the presence of weeds and overhead shade form ideal conditions for an outbreak of a fungus disease. This is especially so when the fungus is a species of *Phytophthora.* On the East coast of Malaya from October to January floods are frequent and heavy rain falls almost every day. The Sirih plots are badly drained and are not kept free from weeds which in some cases

grow to three feet high. It is not surprising therefore that once a plot becomes affected with *Phytophthora*, the disease spreads with great rapidity. The disease has only been reported from the East coast and has not been noticed in other districts where the cultivation of the betel vine is of a higher standard as described by Milsum (7).

MORPHOLOGY.

Mycelium.—The fungus grows well on the usual culture media, especially on maize agar. Mycelium is abundant and similar to mycelium of other species of *Phytophthora*, being coenocytic for the greater part of its growth and forming a few septae when old. The hyphae vary from 3 microns to 7 microns in width with a mean width of 5 microns. Aerial hyphae are sparingly branched and regular in outline; the submerged hyphae are usually more branched and bear protuberances.

Sporangia.—These are produced in large numbers on all media tried. In shape they vary considerably, some being normally ovate with a prominent papilla, others curved, or tapering at base and apex and swollen in the centre. They may be borne either laterally, terminally or intercalary. The intercalar sporangia differ from chlamydospores in their irregular shape and from the fact that they frequently possess a papilla.

Production of zoospores.—This occurs after the sporangia are suspended in tap water at 25°—27° C for ½—1 hour. No definite vesicle has been observed such as occurs normally in *Pythium*. The protoplasm splits up into zoospores which escape from the sporangium through the papilla. Two methods of liberation were observed. In one case the protoplasm when segmented, suddenly rotates inside the sporangium and the whole mass is expelled violently through the papilla. Once outside the zoospores separate almost immediately, although one or two may remain fused for ten or twenty seconds before separating, or they may remain fused and disintegrate. In the other case the zoospores emerge one at a time in the normal manner from the sporangium. Those which fail to emerge may germinate inside the sporangium. The zoospores are not very active and rarely swim for more than a few minutes. They round off early and germinate quickly.

Zoospores measure from 12 microns to 16 microns in diameter when they round off. About 16—20 zoospores emerge from each sporangium and of these about one quarter disintegrate soon after emergence. The smaller sporangia are more apt to function as zoosporangia than the larger ones. Those sporangia measuring between 25 microns to 30 microns in length usually produce zoospores while the larger ones, germinate as conidia, producing germ tubes and forming secondary sporangia.

Size of Sporangia.—Measurements of sporangia were obtained from sporangia growing on maize-meal agar and green pea agar. No natural sporangia were obtained from the affected betel vines, but measurements were made of 60 sporangia grown on fresh rubber pods and areca-nuts as a result of inoculation. Sporangia grown on maize and green pea agar were little different in size. Those obtained naturally from rubber pods and areca-nuts were slightly smaller. Measurements extended over a period of 3 months, care being taken to measure sporangia from 5 day old cultures on each occasion, as it was found that secondary sporangia were liable to be

produced in older material. Up to the present 200 measurements have been made of sporangia from maize agar, the mean dimensions being

Length ..	—	41·99 ± 0·479	microns
Width ..	—	27·25 ± 0·228	,,
Standard deviation length	—	10·05 ± 0·338	,,
,, ,, width	—	4·79 ± 0·162	,,

Other measurements from 150 sporangia grown on green pea agar, 60 on rubber pods and 60 on areca-nuts are

		Length x Width	
Green Pea Agar	...	40·36 x 28·43	microns
Rubber pods	...	39·62 x 24·35	,,
Areca-Nuts	...	39·42 x 24·35	,,

Chlamydospores.—These vary in diameter from 18-38 microns the mean for 100 measurements being 24·45 microns.

No sexual spores have yet been found either in culture or in nature although cultures were grown on maize, green pea, potato, and lima-bean agar and examined during eight months. A series of transfers of the fungus from one medium to another, single spore cultures, and mixing of cultures obtained from different inoculated hosts, is being tried to see if antheridia and oogonia will develop.

Inoculation Experiments.—The fungus has been proved to be parasitic on *Piper Betel* by means of inoculation experiments. These inoculations have only been successful when the weather was continuously wet or when artificially moist conditions were set up.

1. Shortly after the fungus was obtained in pure culture, six betel plants growing in pots were inoculated. Three of the plants were lightly wounded at soil level and mycelium, sporangia, and zoospores applied to the wounded surface. The remaining three plants were not wounded but were otherwise treated similarly. Six control plants were kept, three wounded and three unwounded. The weather continued wet during the experiment and at the end of nine days the inoculated, wounded plants all wilted. The unwounded plants remained apparently healthy for 13 days when two of them succumbed. The remaining plant did not show any signs of wilt after three weeks and all the controls remained healthy. The fungus was recovered from two of the wilted plants.

II. A similar experiment with three wounded plants and three controls was made save that the plants were kept indoors during showers and were not watered. After 10 days the inoculated plants and controls began to droop and were then watered daily. All the plants recovered.

III. During a period of dry weather three plants were wounded and inoculated. A pad of cotton wool was placed over the inoculation and kept moist for 10 days. All the plants wilted and controls remained normal.

IV. One pot plant was put into a bath of water with water ½ inch above the level of the soil. After five days' immersion the plant wilted.

V. One pot plant was put into a bath of water, as in IV. and inoculated below soil level. After two days the plant was removed from the water and kept in the open air during dry weather. The plant wilted in six days and the fungus was recovered from the stem. A control was kept and the plant remained healthy.

VI. Six young rubber pods were obtained and sterilised by soaking them for 10 minutes in corrosive sublimate solution (1 : 1,000), and washing them in sterile water for a few moments. They were then wounded and placed in sterile glass dishes and inoculated with a suspension of the fungus in sterile water. After 4 days a slight aerial growth of mycelium and sporangia was produced and the pods rotted after 6 days.

VII. A bunch of green areca-nuts was sterilised and treated as in VI. In 4 days a copious growth of mycelium and sporangia appeared over the nuts. Penetration of the mycelium into the nuts was slight.

VIII. Three young papaya fruits were inoculated as in VI, no growth resulted.

IX. Six Brinjal (*Solanum melongena*) fruits were treated as in VI, but became contaminated with moulds; no *Phytophthora* mycelium appeared.

X. The tapping cuts of six rubber trees were inoculated with the fungus and the inoculation kept moist. No result.

XI. Virgin bark of six rubber trees was scraped and inoculated. The inoculation was kept moist by fastening a watch glass, containing water, over the inoculation for a few days. A diseased patch similar to Patch Canker was produced after 14 days in 2 of the trees. Controls were unaffected.

From the inoculation experiments enumerated above, it would appear that the fungus is not a vigorous parasite, save when climatic and soil conditions are favourable to its spread. This is also suggested by the behaviour of the fungus after it has been grown in culture for some months. When sub-cultured the fungus continues to grow vigorously, but inoculations indicate that it tends to lose its virulence. Furthermore the tendency of the sporangia is to germinate directly and zoospore production is difficult to bring about.

Texonomy.—In this preliminary note it is not intended to discuss at length the systematic position of the fungus in the genus *Phytophthora.* The absence of antherridia and oogonia prevent the fungus being placed for the moment in the Cactorum or Phaseoli groups established by Rosenbaum (8). It is well known that environmental conditions exert a considerable influence on the size of sporangia of species of *Phytophthora.* A change of environment frequently results in an appreciable change in dimensions. This makes it a matter of some difficulty to assign a specific name to a *Phytophthora* isolated for the first time from a certain host.

It is necessary to grow the fungus in comparision with other known species under identical conditions and for a prolonged period before deciding whether it is a new species or an old one or a variety of an old one. The betel vine fungus is morphologically dissimilar to type cultures of *P. palmivora*, *P. Faberi*, and the Malayan Black Stripe and Patch Canker fungi, all of which have been grown in culture in this laboratory under identical conditions. Owing to lack of other type species it is not possible at present to deal with the matter. Further work is proposed along these lines.

Note:—Since going to press the writer has received the *Review of Applied Mycology*, Vol IV, No. 12, December, 1925, containing an abstract

of the Report of the Government Mycologist (J. F. Dastur), Central Provinces, India, for 1924-25. The report mentions a disease of *Piper Betel* due to a *Phytophthora* sp. causing losses amounting to 80% of the plantations.

REFERENCES.

1. Carruthers, J. B.
   Cirs. and Agr. Jour. Roy. Bot. Gard., Ceylon, Vol. II, No. 16, August, 1904.
2. Petch, T.
   Cirs. and Agr. Jour. Roy. Bot. Gard., Ceylon, Vol. III, No. 21, December, 1906.
3. Bull. 52, Dept. Agr., Ceylon, 1922.
4. Mc. Rae, W.
   Economic Botany: Part III, Mycology—Ann. Rept. Board Scientific Advice, India, 1922-23 pp. 31-35, and Rev. Apl. Myc. III, 10, 1924.
5. Hutchinson, C. M.
   Scientific Rept. Agr. Res. Inst. Pusa 1923-24, pp. 37-39 and Rev. Apl. Myc. IV, 8, 1925.
6. Ann. Rept. Plant Pathologist, Dept. Agr. Bombay Presidency, 1923, and Rev. Apl. Myc. IV, 6, 1925.
7. Milsum, J. N.
   Agr. Bull. F.M.S. and S.S. Vol. VI, Nos. 7 & 8, 1918.
8. Rosenbaum, J.
   Jour. Agr. Res. Vol. VIII, No. 7, 1917.

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THE PINK BOLL WORM.

(*PLATYEDRA GOSSYPIELLA* SAUNDERS)

E. BALLARD, B.A., F.E.S.,

Commonwealth Cotton Entomologist. *

HISTORICAL.

The insect which is now known as the Pink Boll Worm was first recorded as a pest of cotton in India in 1842. For sixty years or more nothing was heard of it until a German paper, published in 1904, described its depredations in German East Africa. In 1909 an account was given of loss caused by it to cotton in the Hawaiian Islands, into which it had been introduced from India. Cotton-growing in Hawaii was subsequently abandoned on account of it. In 1906-7 it was introduced into Egypt, and since that date has done some £50,000,000 worth of damage.

It was frequently reported as damaging cotton in India, Burmah, and Siam, affecting exotic cottons more than indigenous varieties. This selection of plants by the insect is still made in India. Numerous papers have been published dealing with the life-history and control of the Pink Boll Worm, Egypt, United States of America, and India all contributing their quota, the most exhaustive research having been done in Egypt.

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* In a pamphlet published by the Home and Territories Department for circulation in Papua and Mandated Territories under Commonwealth control.