The occurrence of the primary twig-borer Xyleborus morstatti in Indonesia (continued)

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Infestation of eusideroxylon seedlings in south sumatra

In February 1924 the Forest Research Institute at Bogor received a report about a severe die-back of seedlings of *Eusideroxylon zwageri* — the onglen tree or Bornean ironwood — in the Semandai complex at Batanghari Leko, Banjuasin/ Kubu Districts, near Palembang. Soon afterwards a similar die-back was observed to be prevalent in the experimental plot Bajunglintjir in the same area. The disease was thought to be caused by a blight, but some preliminary material submitted to me showed that the condition was rather to be attributed to the infestation of the plants by small *Xyleborus* beetles. Some additional material, mainly collected and annotated by the Senior Forest Ranger F. A. Schrader was received at long intervals until March 1925. From all the data combined the following conclusions could be drawn.

The damage affected not only 2—3-year-old plants grown from onglen pits, which had been sown on a range formerly used for shifting cultivation, but in like manner the seedlings in the abundant natural regeneration found in the wild forests under large onglen trees.

The die-back of the plants was of a complex nature. Part of it was the result of the attack by the small primary stem-borers, another probably minor cause of the death of tops being a circular puncturing as made by weevils of the genus *Rhynchites*, while still another and not unimportant cause appeared to be of some physiological kind. The presence on the tops of small bright-orange cushions of a fungus— identified as near *Hypocerella* by the mycologists — apparently had nothing to do with the die-back.

The borer infestation had taken place in the woody parts of the stems, where they were 2.75—5 mm thick. It was more frequent in the lower parts of the stems than in the tops, but no bore-holes were to be found in the tap-roots. In no instance were the tender shoots affected, which develop from germinating seeds up to a length of 20—50 cm before any leaves at the top unfold.

Nearly all holes in the plant-material submitted were found to be empty. Only in a very few stems, kept in spirit, a few undamaged specimens of *Xyleborus* were found and they belonged to two species. One proved to be identical with *X. morstatti*, the other, which was in the minority, remained unidentified but looked like a small form of *X. morigerus*. Unfortunately the collector did not succeed in finding more examples of recent attack, although a search for them had been urgently requested.

Often the galleries had the form of a short spiral of one turn running downwards or upwards in the stem, or a brood chamber had been formed with a few short branchlike extensions, or, again, a circular gallery had been cut through the wood almost in a horizontal plane. Apparently the first form in particular was the

work of *morstatti*, but the excavation of the galleries does not follow a narrow singular plan in this species, nor in the other twigborer, *X. morigerus*, as has been observed elsewhere. So the differently shaped cavities gave no clue to the relative abundance of the two species.

As a rule the borer infestation had not resulted in the death of the entire plants, as could be inferred from the numerous old holes, which had been covered by a small strip of callus tissue, forming small swellings on the stems. These thickened parts were a sure sign that a plant had suffered from infestation at some earlier date but had survived the attack. Yet in some of the thinner stems a single bore-hole had killed the plant. More frequently, however, only the top-part of the plant had died under the place of infestation, or the top had snapped off, particularly where a horizontal gallery had been formed. Somewhat similar consequences of *morstatti* attack were reported for cacao seedlings in Nigeria by GREGORY (1954) who observed a swelling or a shrinking of the stem around the brood chamber and, often, the death of the top 1.5—2 cm below the entrance hole.

Fig. 4. "Bayonet-tops" of *Eusideroxylon* seedlings caused by *X. morstatti* infestation (natural size).

Often, right under the bore-hole, a new shoot had been formed, growing erect and closely parallel to the remaining part of the former top, thereby causing a bayonet shape of the plant (fig. 4). The same bayonet-like formation was observed in plants which had their tops killed by some other cause. Undamaged plants appeared to grow up to considerable height without ramification.

The old bore-holes were not always overgrown by new wood tissue and not seldom large scars had been formed on the stems. This may have been caused by the ambrosia fungus or by other fungi with which the plants had become infested.

Furthermore, some old holes were found to be inhabited by ants, which had enlarged the cavities, and in still other cases wood-rot had spread from the holes into the core of the stems.

Several of the larger plants had been attacked repeatedly by the borer, even showing 9 holes over a length of 40 cm, and 7 holes over 20 cm.

Traces of the borer's activities were found in the natural regeneration all over the old forest. Out of 380 plants, standing on 10 square meter, as many as 250 or 66% had been affected. The remaining 34% mostly consisted of small 1—2 year old seedlings.

Discussion. The few details gathered from the observations leave many questions unanswered. Apparently the damage was discovered at a time when an outbreak of the borers had already been nearly extinguished by natural causes.

Outbreak of *Xyleborus morstatti* on a Java-coca plantation

J. P. KLINKHAMER, manager of Tegallega Estate near Tjibadak in West Java, where *Erythroxylon novagranatense* was grown as the main crop, noticed some withering of small branches in 12-year old shrubs for the first time in May 1924.

In the dead branchlets he found a small borer, in its shape resembling the coffee berry borer, *Stephanoderes hampei,* a species present in a plot of coffee trees on the same estate. Little attention was paid to the matter as the borer's occurrence in the coca-plants was thought to be of a secondary nature only. For conscience sake, however, the coffee trees were stumped in order to remove a possible source of borer-infection of the coca plants.

Nothing particular was observed in the following dry season but some time after the beginning of the rains, about in October, the number of dead twigs on the coca-shrubs appeared to be on the increase, 3—4 withered tops being present on many plants. This baffled the expectation that, after the passing of the dry season and the periodical flowering stage, the plants would put on vigorous shoots and an abundance of new flush, needed for the harvest. It was then found, that sound twigs were attacked and that they could be broken easily at the place where a borer had made a cavity (KLINKHAMER 1925).

Then, in December an alarming loss of 1—1½ year old seedlings on the nursery beds was suffered, which was due to the attack of a little borer, similar in size to that of the twigs in the older plants but making its cavities in the roots of the seedlings. The manager sent material of these infested seedlings to Bogor where I found them to be attacked by the brown twig- and stem-borer *Xyleborus morigerus.*

More material was requested for examination and in January 1925 I received a sample of the borer-infested twigs. Contrary to expectation these twigs all proved to be attacked by a small *Xyleborus* species, since identified with *X. morstatti,* with one exception only where *morigerus* was found.

The manager reported that the infestation of the twigs occurred on a much larger degree than had recently been suspected. Even part of the main branches, constituting the frame of the shrubs, had a sickly appearance showing yellowish leaves, and when bent with force breaking in places where a bore-hole appeared to have been excavated. Twigs and branches showing signs of infestation were regularly removed and kiln-heated in quantities of 200—250 kg daily, in the hope that this would be an effective method of control.

In May some decline of the infestation was reported, probably due to the prevailing dry and sunny weather, but still some 100—125 kg of infested branches were gathered daily, and towards the end of August it was detected that the borer had made its first appearance in the 2-year old plantation on the youngest clearance.

The dry season was unusually severe in 1925, practically no rain falling until the middle of October, and the regular harvest of leaves had ultimately to be stopped. The manager reported at that time that the infestation was much on the decline, many of the branches on examination containing only a very few living beetles. No more reports were received after that date.

Additional note on local conditions

I visited Tegallega Estate on 2/3 July 1925 to get some first hand impression about the situation. Coca growing had been started on the hilly terrain 16 years

ago. The area planted had been regularly extended with new clearances, and had reached a size of some 250 ha in 1924. Part of the coca was growing under a rather heavy shade of wide-spaced rubber trees (*Hevea*), part under a light shade of *Albizzia chinensis*, and part without cover. The soil was rather poor and badly eroded in places. The borer was said to be thriving particularly in the middle-aged plots, infestation being less in the oldest gardens, which were in a somewhat poor condition bearing thin foliage. There was no apparent difference in the rate of attack in shrubs growing with or without cover of shade trees.

The pruning of infested twigs and branches as a method of control was carried out by a gang of native boys who completed their rounds over the area to be treated in about 3 weeks. However, there was no strict scheme, and plots where the damage appeared to be severe were revisited more frequently. The oldest parts of the plantations were not included in the rounds. The cost of the treatment was more than balanced by the value of the leave-produce collected from the pruned material after kiln-heating in the factory.

Attemps were also made to fight the borer attack by cultural practices, such as tilling of the ground, the use of green manuring plants between the rows, and a reduction of the amount of flush to be picked for the harvest, all these measures aiming at the improvement of the growing conditions and the health of the plants.

Data gathered from the material examined

Additional samples of the twigs delivered by the control gang were received for examination in February, June and September.

The *morstatti* galleries in the coca twigs were of the same general shape as those observed in other plants, forming an irregular cavity at the place of entrance, and extended with short branches upwards and downwards in the axis of the stem, the whole system not exceeding 20 mm in length.

The holes still inhabited contained very different quantities of brood as is usually the case in similar infestations. Some of the broods extracted rather completely from the first sample of twigs received in December 1924 were composed as follows:

mother beetle	larvae	pupae		young adults		number of offspring
		♀	♂	♀	♂	
1	19					19
1	10	6				16
1	6	6	1			13
1	8	3	1	16	3	31
1	15	10	1	20	4	50
(1)	2			12		
(1)				15	1	

The total population found in 100 branches received in February consisted of ca 136 mother beetles, 377 larvae, 242 pupae, 387 young ♀ ♀ and 83 ♂ ♂. The sex-ratio in the broods therefore appears to be about 1 ♂ against some 4 to 5 ♀ ♀.

Gregory (1954), during his investigation of a severe *morstatti* infestation

of cacao seedlings in Nigeria, found similar figures about the number of offspring and the ratio of males to females.

The contents of the galleries in the June and September material were not counted accurately but they seldom surpassed 10 individuals of different stages, the largest number noticed being only 20. Eggs were rarely met with and never more than 12 in number.

A parasitic wasp was found in the first sample of December 1924 and in all material received subsequently but in strikingly small numbers. The percentages of inhabited galleries harbouring stages of the parasite was 6% in the June sample and 2% only in the September material. The largest number observed in one gallery consisted of 3 adult wasps and 7 pupae. In this cavity no stages of *morstatti* had been left. In most cases, however the parasite had not destroyed the entire brood of the borer. In one instance 2 pupae and 2 larvae of *morstatti* were still present in the same cavity together with 3 adults and 3 pupae of the parasite.

Recent and complete bore-holes were found only in twigs and branches of 3—7 mm diameter, very rarely in material of smaller or larger dimensions. The galleries encountered when splitting thicker stems were all old and often covered with new wood.

Among the twigs recently attacked 73% showed one bore-hole, 22% two holes, 4% three holes and 1% four or five holes.

The thinner twigs appeared to be less suitable for successful breeding than the thicker ones. This is shown in the figures, given in the next table, about the average size of the broods occurring in twigs of different sizes in the June sample.

	diameter of twigs				
	3 mm	4 mm	5 mm	6 mm	7 mm
average number of borer-stages in all holes found inhabited	0.75	1.75	3.8	5.2	6.0

The same is also apparent from the proportion of mother beetles found with and without brood in their holes in the twigs of the September material:

	diameter of twigs			
	3 mm	4 mm	5 mm	6 mm
mother beetles without brood	81 %	41 %	34 %	25 %
mother beetles accompanied by brood	19 %	59 %	66 %	75 %

In all samples inspected there was a strikingly large number of very small empty holes of about 1—3 mm in height, indicating that the mother beetle had not succeeded in rearing its brood. In the samples taken in the beginning of February these unsuccessful borings amounted to $^1/_5$ or $^2/_5$ of all cavities present.

In the sample of about equal size examined at the end of June the abortive borings totalled up to $^3/_5$ of the whole number.

In the smallest twigs affected the bore-hole almost pierced the wood cylinder from the entrance to the opposite side. So it was no wonder that the top-parts of these twigs had died or had snapped off as a result of this injury.

Where the stems contained old holes left by the borer some time before, only $^3/_5$ of them had healed normally, while in $^2/_5$ of the instances the holes had not been covered by callus and new wood, but large scars had been formed. In these latter cases the ambrosia fungus or secondary organisms had apparently killed comparatively large strips of the cambial zone. It is easy to understand that this bad healing must have contributed to the damage done to the plants.

In the extensive quantities of material examined in June 23% of the twigs contained old holes only, 67% showed recent infestation besides old traces and 10% had only recent holes.

In a few instances some other species of ambrosia beetles, besides *X. morstatti,* were found in the coca twigs. Among them *Cnestus bicornis* (Egg.) was the more frequent, making galleries of greater length and width, *X. parvispinosus* Egg. was collected in some numbers, particularly in a stem infested with the salmon-coloured *Corticium* blight, while *X. haberkorni* Egg. and *X. morigerus* Bldf. — mentioned before —, were observed in a few specimens only. Except the latter these borer species have secondary habits.

Attack on other plants

During my visit to the estate in June 1925 I paid particular attention to signs of borer-attack on other plants.

A thriving population of *morstatti* was found in the small plot of *Coffea robusta* which had grown shoots up to 2 m in length after having been stumped about a year previously. The borer was mainly attacking the lowest side branches. Out of 66 bore-holes examined 35 were found inhabited by brood, 8 contained

stages of the borer								stages of the parasite				
mother beetle	eggs	larvae	pupae		young adults		number of offspring	larvae	pupae		adults	
			♀	♂	♀	♂			♀	♂	♀	♂
1	9											
1	21						21					
1	18	4					22					
1		13										
1	2	25					27					
1		32	4				36					
1		10	30	3	4		47					
1			11	2	2							
(1)									5			
1		16	3					2				
1		3									5	
1	2	2	5						2	4		
1		1							6	11		
—		2				1		5				
1		3				1		4	3			
1		1						•			1	3

stages of the parasite mixed with the brood, 18 had been left by the borer — possibly partly as a result of the activities of the parasite —, and in 5 the mother beetle had just entered.

Some data are given in the table on the foregoing page about the composition of the broods, which had been collected practically complete, and of broods attacked by the parasite.

Typical traces of successful *morstatti* infestation were also found on a few *Cinnamomum zeylanicum* trees.

Furthermore a number of withering leaves were observed on *Spathodea campanulata*, an ornamental tree, this being the result of the boring of *morstatti* beetles into the leaf-stalks. Several beetles were still living but no brood was formed. The manager had observed a similar attack on the inflorescenses of a *Mangifera odorata* tree in the neighbourhood. Parts of these inflorescenses which had snapped off where the little borer had entered into the stalk, had been found on the ground. Both cases may, in my opinion, be looked upon as stray occurrences of the borer near an outbreak place.

Clearly abortive borings were also found in twigs of *Cassia siamea* where the establishment of the borer had been prevented by the flow of a dark sap.

I could not find any signs of attack on trees of *Adenanthera, Deguelia, Erythrina, Melia* and *Toona*, a small number of which were grown on the estate, nor on the *Albizzia* and *Hevea* trees mentioned before.

Discussion

The investigations were of too superficial a nature and too short a duration to give sufficient insight into the course of the outbreak. Although the first dead twigs were observed in May 1924 the infestation may have been of longer standing, as the manager afterwards remembered having noticed cavities on cross sections of pruned stems at an earlier date. In the rainy season of October 1924 to April 1925 the infestation appears to have been in full swing. The decrease in the borer activities reported for the dry season and substantiated by the larger percentage of unsuccessful borings, may have been caused directly or indirectly — via the host plants ! — by the climatological conditions. No difference was apparent in the borer population found in the samples of infested twigs collected in June and in September. But this material was not very suitable for comparison as it had not been collected from exactly the same plots and in the same manner, and no full details were given about the treatments the various plots had received. Therefore no evidence was obtained about any decline in the borer's activities by possible internal physiological changes as has been observed in outbreaks of the primary branch-borer *Xyleborus fornicatus* (KALSHOVEN 1958). As no reports of borer-damage were received any more after the middle of October 1925, it is likely that no revival of the borer incidence did occur in the following wet season. It may be clear from the figures given that the parasite did not play a role of any importance in diminishing the borer population. No evidence was obtained either that the regular removal of borer-damaged twigs had had the favourable effect expected from it.

Appendix

Malayan records of Xyleborus morstatti Hag.

Mr. F. G. Browne has kindly given his consent to publish here the data at his disposal about the occurrence of *X. morstatti* in Malaya. His list of samples collected runs as follows:

1. Perak. Sitiawan, 14.VII.'37, ex stem of *Desmodium ovifolium* (Leguminosae).
2. Dept. Agric. 05922. Singapore, 24.IX.'49, ex dry stem of *Theobroma cacao* (Sterculiaceae).
3. F.G.B. 4488. Selangor, Kepong, 25.XI.'48, one female ex twig of *Adenanthera pavonina* (Leguminosae), cut some time.
4. F.G.B. 4637. Selangor, Kepong, 5.II.'49, one female ex shoot of *Swietenia macrophylla* (Meliaceae), cut recently.
5. F.G.B. 4655. As 4637, on 14.II.'49.
6. F.G.B. 4849. Selangor, Kepong, 4.V.'49, ex *Shorea sumatrana* (Dipterocarpaceae), diameter 2″, cut a few weeks.
7. F.G.B. 5075. Selangor, Kepong, 29.X.'49, one female ex irregular chamber in cut pole, diameter 1″.
8. F.G.B., 5404. Selangor, Kepong, 22.VII.'54, fairly numerous in small logs of *Shorea* (Dipterocarpaceae), K. D. Menon coll.
9. F.G.B. 5405. Selangor, Kepong, 7.IX.'55, ex 8-month seedlings of *Muntingia calebura* (Tiliaceae), K. D. Menon coll., with note: „There are at present about 1440 young seedlings of *M. calebura* in the nursery, and 30% of these have so far been attacked and killed. In most cases there is only one beetle gallery per plant at the base."

These data contain some interesting additional information about the borer's habits and selection of host-plants (see p. 228).

Two more species of Leguminosae are added to those already recorded. The susceptibility of the mahogany trees to infestation is confirmed. Dipterocarpaceae as hosts of *morstatti* are recorded here for the first time. The attack on cacao-trees, so far not published for the Indomalayan region, is of wide-spread occurrence, particularly on seedlings, in West Africa (Gregory 1954). The outbreak on nursery beds with seedlings, this time recorded for *Muntingia,* an introduced species probably grown for its produce of insecticidal matter !, may be considered quite characteristic for *X. morstatti.* Tiliaceae are related to Ternstroemiaceae.

The borer's presence in small logs, mentioned under nr. 8, seems to be a-typical, as *morstatti* in the first place is a twig- and stemborer. However, Mr. Browne informs me that the dimensions of the *Shorea* pieces might have been quite small, say 12 cm. in diameter. It is also likely, according to his opinion, that the beetles were collected before they had a chance to breed, even if they could have.

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