

The occurrence of the primary twig borer *Xyleborus morstatti* Hag. in Indonesia *)

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by

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FIRST RECOGNITION OF THE SPECIES AS PRESENT IN NORTH SUMATRA

In a report on plant pests in N.E. Sumatra CORPORAAL (1920) briefly mentioned the occurrence on some estates of a twig-borer in coffee, which he assumed to be *Xyleborus coffeae* Wurth, the primary borer of coffee and other plants known from Java since 1906. The damage reported was not severe, for lightly infested twigs recovered and a parasite was decimating the borer. Soon afterwards the identification of the species was corrected by EGGERS (1922) who found the beetle to be actually *X. morstatti* Hag., until then known from Africa only. EGGERS stated that so far he had not seen the true *X. coffeae* (since synonymized with *X. morigerus* Bldf.) from Sumatra.

The labels on CORPORAAL's original specimens as far as represented in the museum of Amsterdam and Leiden give the following details: Medan, 10.XII.1919, a single specimen without host label (Medan is the town where the Deli Experimental Station was situated); in coffee twigs (presumably *Coffea robusta* Ref.), Balimbangan Estate, 370 m, 14.I.1920, 4 ♀♀, 1 ♂; ditto, Poelahan Estate (near Tandjong Balai, Kisaran District), 27.I.1920, 13 ♀♀, 2 ♂♂; Marihat Ulu Estate, 18.I.1921 and II.1921, 7 ♀♀, no host label; in branches of *Coffea quillou*, same locality, 27.I.1921, 5 ♀♀; in the leaf ribs of *Elaeis guineensis* (the oil palm), same locality and date, 9 ♀♀.

FIRST DATA ON THE BORER'S OCCURRENCE IN WEST JAVA

In December 1920 my attention was drawn to the withering of twigs on *Propolis nudiflora* — an imported species belonging to the Leguminosae — on nursery beds at the Forest Research Institute in Bogor. The withering was caused by a small *Xyleborus* sp., that made its brood-chambers in the branchlets in a similar way as *X. coffeae* but which belonged to a different species, being wholly black instead of brown and more elongate, though of about the same size as *X. coffeae* (Fig. 1).

The same beetle appeared to be present in the collection of the Institute for Plant Diseases, Bogor, in a sample dated: ex *Coffea robusta*, Pamanukan & Tjiasem Landen (a large estate in the plains of W. Java, near Djatibarang), I.1919, leg. K. W. DAMMERMAN. These specimens had been wrongly placed under the label *X. coffeae* Wurth.

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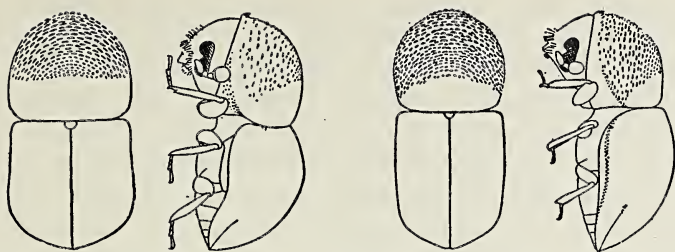


Fig. 1. Outlines of *Xyleborus morigerus* (left) and *X. morstatti* (right) ($\times 20$; from KALSHOVEN, 1926)

Specimens of both Javanese samples were identified as *X. morstatti* Hag. by Col. F. W. SAMPSON in London in 1924. A comparison made by me in the same year between the Javanese specimens and material received from CORPORAAL and identified by EGGERS confirmed their identity.

Since, I have received from Prof. W. ROEPKE a *Xyleborus* specimen labelled 'Tjiastana 1919', which also proved to be a *X. morstatti*. According to a letter dd. 3.I.1919 in the files of the above mentioned institute, this refers to a coffee & rubber estate in the Djampang area, south of Tjianjur, W. Java, on 600—1200 m altitude, where twig-borer damage of coffee trees had been observed. In the material examined by ROEPKE a black species of *Xyleborus*, unknown till then, was found side by side with the common brown species, *X. coffeae*.

This brings the earliest records of the presence of *X. morstatti* in W. Java to three in widely separated localities.

RECORDS OF *X. morstatti* FROM SUMATRA SINCE 1921

In the following enumeration the dates found on the labels of submitted specimens are mentioned as well as the particulars about the occurrence of the coffee twigborer found scattered in annual reports. It is assumed that the latter all refer to *X. morstatti* though this has not always been specified at the time.

Records: beetles found boring in coffee berries in Palembang, leg. Ch. BERNARD (no year, but not later than 1923); species causing die-back of seedlings of *Eusideroxylon zwageri* in forests near Palembang, reported by the Forest Service, IV.1924 (for further details see later chapter); boring twigs of *Coffea robusta* on Subanajam Estate near Tjurup, Benkulen district, VI.1926 (submitted by H. BEGEMANN); continued and frequent damage on the coffee estates of N.E. Sumatra in 1927, in one case an unusual attack on the main trunks resulting in infestation by *Botryodiplodia* blight and the death of trees (VAN DER GOOT, 1928, p. 72); damage reported from estates along the West Coast, particularly severe in Painan and Balai-Selasa in 1928 (LEEFMANS, 1929 p. 53); occurrence on the N.E. Sumatra estates less than in the preceding year, though locally persistent, parasites always found present, borer also observed on several estates along the West Coast, from Tapanuli southward, particularly between Tapan and Painan, as well as on estates in S. Sumatra, where it was often successfully parasitized by a Chalcid, all in 1929 (LEEFMANS, 1930, p. 52, 54, 86, 90); in stem

of two-year old sapling of the shade tree *Leucaena glauca* on Pageralam Estate in the Palembang Highlands, 800 m, VII.1930 (leg. A. KEUCHENIUS); some increase of the damage in neglected plantations on the West Coast, no important occurrence near Palembang, in 1930 (LEEFMANS, 1933, p. 43, 45); borer again observed in several plantations along the W. Coast, particularly at Muara Labuh near Surian and at Painan, situation stationary near Palembang, in 1931 (id. 1934 p. 49, 51); no decrease of the occurrence on the W. Coast estates in 1932 (VAN DER GOOT, 1934, p. 39, 42); routine mention of the borer over the whole coffee producing area in 1933 and 1934, in Benkulen some increase due to the neglect of the plantations (id. 1935a p. 36, 1935b p. 43, 44); loss of twigs through borer attack still considerable in S. Sumatra in 1935 (id. 1936 p. 93); damage mainly of minor importance in the same area in 1936 (id. 1937 p. 53, 54, 60); borer regularly found in the Lampong district in 1937 (id. 1939 p. 53, 59); minor occurrence of the borer reported from the East Coast estates in 1938 (id. 1940 p. 105).

These occurrences of the borer in Sumatra will be further discussed in the chapter: Is *X. morstatti* indigenous in Indonesia or an introduced species.

INCIDENCE IN WEST JAVA SINCE 1921

Records (if not otherwise stated the samples were collected by the author): a few specimens labelled 'Tjibugel coffee', no date, but submitted to SAMPSON, VI.1922 and probably collected by LEEFMANS, the locality referring to an estate between Sumedang and Tjibatu, 800—1200 m altitude; twigs in the lower crown level of *Swietenia mahagoni* trees killed by the borer, a few broods present, one mother beetle found drowned in the resin filling the hole, Experimental Garden, Bogor, II.1924; die-back of a few twigs and thin shoots in a group of ornamental *Acalypha* shrubs, caused by the borer, recent and old galleries present, Botanical Gardens Bogor, II.1924; very harmful outbreak of the borer in plantations of *Erythroxylon novagranatense*, the 'Java-coca', on Tegallega Estate, S.E. of Tjibadak, first reported by J. P. KLINKHAMER, XII.1924, *X. morigerus* being also present in small numbers, some observations made by me and material investigated at intervals in 1925 (see later chapter); renewed infestation of the *Acalypha* shrubs in the Bot. Gardens, several twigs, tops and suckers newly killed with withered leaves, one specimen of *X. morigerus* without brood in a separate hole, Bogor, II.1925; death of twigs on inner side of the crown of a healthy, free-standing tree of *Cryptocarya* sp. (fam. Lauraceae), same locality, III.1925; further infestation detected in a group of Lauraceous trees, recent holes with brood in twigs of *Nectandra angustifolia* and *Haasia* sp., which had the tops killed, traces of former infestation, holes overgrown, in twigs of *Cinnamomum iners*, *C. zeylanicum* and *Litsaea cassiaefolia*, same locality, IV—V.1925; mixed infestation by *morstatti* and *morigerus* of naturally grown seedlings of *Swietenia macrophylla*, several plants killed, inhabited and empty galleries found, Experimental Garden, Bogor, XI.1925; a few holes with a beetle without brood found in stems of young *Crotalaria* which were mainly infested by *X. morigerus*, this species having normal broods, Tjikompai Estate, XI.1926 (material submitted by SPECHT GRIJP); severe attack by *morstatti* and *morigerus* in 5 mm thick stems of one year old *Cassia* mul-

tijuga, Experimental Garden, Bogor, XI.1929 (leg. VERBEEK); boring in the stalks of an orchid, *Dendrobium* sp., Bot. Gardens, X.1931 (leg. DAKKUS); in *Coffea robusta* on Tjirandoh Estate, Palabuan Ratu near S. Coast, XI.1931 (leg. H. R. A. MULDER); in twigs of *Sambucus javanica*, Pantjasan near Bogor, 300 m, XII.1931 (leg. MULLER); in *Coffea robusta* in the experimental garden Tjibinong near Bogor and on Pitjuung Estate near Pandeglang, Bantam, III, V. and VI.1932 (leg. KALSHOVEN/MULLER); a single specimen in an old stem of *Eupatorium pallescens* at Tapos, 800 m, VII.1932 (mentioned in SCHEDL 1942); ditto in twigs of *Bauhinia* sp. in the Bot. Gardens, V.1940; recent infestation of the twigs on a *Sambucus* shrub, a few twigs broken at the bore hole, same locality, III.1950.

RECORDS OF *X. morstatti* FROM CENTRAL JAVA

There is a specimen in my collection dated Prumpang 18.II.1924, leg. SPECHT GRIJP. The locality refers to an estate near Karanganjar on the N. slope of the Dieng Plateau at 450 m altitude. Probably it had been found boring the twig of a coffee plant.

In published papers the species was first mentioned for C. Java in an annual report of the year 1927 (VAN DER GOOT 1928 p. 70, 71), where it was stated that twig-borer damage had been severe in several coffee plantations at the end of 1926 and the beginning of 1927, whereby the brown species, *X. morigerus*, and the black species, *X. morstatti* had been found side by side. In 1930 *morstatti* was reported to be the more prevalent of the two (LEEFMANS, 1933 p. 75) and the same was said for 1932 (VAN DER GOOT 1934 p. 68). No particular localities were mentioned, but in April 1932 we had specimens submitted found attacking the *robusta* branches in an experimental plantation Bumidjawa, situated in the hills above Tegal. In 1936 *morstatti* was the only twig-boring species reported from C. Java (VAN DER GOOT 1937 p. 92).

SPREAD OF *X. morstatti* OVER EAST JAVA

In 1927 *X. morigerus* was still considered to be almost exclusively responsible for the twig-borer damage in coffee plantations in E. Java, while *morstatti* — then mentioned for the first time for that area — was still very rare (VAN DER GOOT 1928 p. 70, 71). Systematic investigations carried out by BEGEMANN in 1928, showed that *morstatti* already occurred on the Wlingi side of the Mount Kawi complex but not on the Malang side (LEEFMANS 1929 p. 78). In November 1929 a sample was submitted of *morstatti*, including males, and taken from the green manure plant *Tephrosia maxima* in the Malang district. BETREM in a lecture delivered in March 1931 reported that the black twig-borer had been observed in plantations on Mount Kelut before it had appeared on Mount Kawi and that it had invaded the hilly country south of Malang, Gunung Kidul, quite recently. In 1930 it was also found on some estates on the South slope of Mount Semeru and in one place on the East Semeru. In the Malang district it had been found attacking *Indigofera arrecta* and *I. suffruticosa* in addition to coffee plants (LEEFMANS 1933 p. 62, 72). Infestation of the whole Gunung Kidul area and a pressing on of the borer to the neighbourhood of Pasirian in the Semeru area was reported in

1931, while *Cassia tora* and *C. birta* were added to the list of hosts (BETREM in ULJÉE 1932). In the same year considerable damage was mentioned for the coffee lands on the S. and W. slopes of the Yang mountain complex in the Besuki district. The borer had not been found at that time in the somewhat isolated complex of plantations on Mount Wilis, West of Malang, near Madiun (LEEFMANS 1934 p. 79, 81). In 1932 *morstatti* was observed for the first time on coffee estates S. of Djember where it caused a loss of as much as 20—40% of the branches. In the beginning of 1933 it had spread to the neighbourhood of Kalibaru and Glenmore in Banjuwangi (VAN DER GOOT 1934, p. 70), but the estates of N. Banjuwangi and a few plantations near the South coast had still remained free from the infestation (id. 1935 p. 69). However, the borer was noticed on the N.W. slope of Mount Wilis for the first time in 1933, at which time it did not yet occur on the S. slope (l.c. p. 67). In 1934 the whole of the Banjuwangi district had been invaded (id. 1935b p. 84). No mention was made about the progress of the borer in 1935 but in 1936 it was reported to be more and more taking the place of *morigerus*, even in the most eastern part of Besuki (id. 1937 p. 92, 93). In the reports of 1937 and 1938 *morstatti* was the only twig-borer species of coffee mentioned for E. Java (id. 1939, 1940). Finally, similar notes about the general distribution of *morstatti* over the eastern-most district of Java, and its superseding *morigerus* appeared in the annual reports of the Besuki Experiment Station for 1938 and 1939 (DE FLUITER 1939, 1940).

OCCURRENCE OF *X. morstatti* IN CELEBES

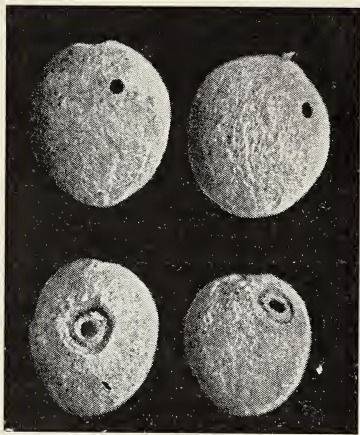


Fig. 2. Bore-holes of *X. morstatti* in coffee-berries. Note the callus ring around the holes in the two lower examples ($\times 2$; from LEEFMANS, 1928)

The government report on pests in 1927 for the first time mentioned considerable damage done by the species on coffee estates in the Minahassa district of N.E. Celebes (Motoling) as well as in S. Celebes (VAN DER GOOT 1928, p. 46, 70). Dr. H. BEGEMANN of the Experiment Station at Malang had carried out the identification.

In Bogor we received twigs cut from three-year old *Coffea robusta* infested by *X. morstatti*, from Tiniawangko Estate, near Amurang, at 1000—1600 m altitude in the Minahassa, VIII.1927. It was reported that the borer infestation had been present there already for several years, killing about 10% of the young twigs. In the same year another estate in Celebes sent a sample of coffee berries which showed borer-traces different from those of *Stephanoderes hampei* (fig. 2). In this material a few damaged specimens of *morstatti* were found

besides a single specimen of a variety of *X. morigerus* (see LEEFMANS, 1928b).

Later records of the coffee twig-borer incidence in Celebes — to day called Sulawesi — taken from the official reports on plant pests follow here. It is

assumed that all these records exclusively refer to *X. morstatti*, notwithstanding the fact that they were mentioned, apparently by mistake, under the heading *X. morigerus* in 1929 and 1932, and that we had no specimens submitted for examination in Bogor.

Records since 1927: twig-borer damage experienced in the coffee plantations near Menado in the Minahassa in 1928, two parasites found to be associated with *Xyleborus* twig-borers in Sumatra and Java were shipped to two estates in S. Celebes, and one of them, a Chalcidid, was reported to have established itself soon afterwards (LEEFMANS 1929, p. 58, 78); infestation in the same area in 1929 less than in the preceding year though wide-spread (id. 1930 p. 60); routine mentions of the borer for the same area in 1930 and 1931 (id. 1933 p. 52, 1934 p. 62); the same and report of the borer having been found in Poso in Central Celebes in 1932 (VAN DER GOOT 1934 p. 54); occurrence mentioned for the Minahassa, including Gorontalo, and for Poso in 1933 (id. 1935a p. 50); same areas mentioned besides Palu and Kolonedale in C. Celebes in 1934 (id. 1935b p. 60); borer incidence in the Minahassa of no importance in 1935 (id. 1936 : 68); the same and borer incidence mentioned for Mambi in the Toradja lands in C. Celebes and for Ereng-Ereng and Kasi near Bonthain in S. Celebes in 1936 (id. 1939 p. 71, 73); borer mentioned without further particulars in 1937, 1938 and 1939 (id. 1938, 1939, 1940); severe damage by the twig-borer, indicated as 'bubuk ranting' reported for the native coffee plantations at Lamatti, district Sindjai in S. Celebes in 1940 (typed report).

Finally C. F. C. FRANSSEN in an unpublished report of 1.III.1948 mentioned heavy losses again afflicted by the black twig-borer to important native plantations in Ereng-Ereng, S. Celebes.

OCCURRENCE OF *X. morstatti* IN BORNEO

A brief note about the common occurrence of a twig-borer in coffee in W. Borneo appeared in the survey of crop pests for the year 1932 (VAN DER GOOT 1934 p. 45). This referred to *X. morstatti* as was proved by my identification of a sample, collected near Pontianak by the Agricultural Officer DE MOLL, III.1932.

A repetition of the note was inserted in the annual report of 1933 ((id. 1935 p. 42).

Any further particulars about the incidence of *morstatti* in the vast areas of Borneo (to day called Kalimantan) are lacking.

Xyleborus morstatti INDIGENOUS IN INDONESIA OR INTRODUCED ?

In AULMANN's publication of 1911 the coffee twig-borer of E. Africa — at that time still identified with *X. compactus* Eichh., described from Japan in 1875 — was considered to have originally come from the Orient. In 1912 HAGEDORN concluded that the borer in Africa, though closely allied to *compactus*, still could be distinguished from it, and he described the beetle as *X. morstatti* n.sp.

EGGERS (1923 p. 129, 130) after his identification of the twig-borer in N.E. Sumatra as the African *morstatti* did not suggest a recent introduction into the East but included the species among the examples of Scolytids having their range of distribution extending over equatorial Africa as well as over tropical Asia.

This viewpoint of *X. morstatti* as being indigenous, or at least of long standing in Sumatra appears to have found confirmation by the later observations. In fact, *morstatti* was found to be present in all coffee cultivating areas in the South, West and North of the large island rather soon after its having been recorded from the N.E. Coast, and these discoveries can be explained by an intensification of the activities of the Experimental Stations rather than by a recent spread of the borer.

However, the main evidence for the assumption that *morstatti* was already more or less at home in Sumatra before it was detected in the coffee plantations may be seen in its occurring in 1924 as a common borer in the *Eusideroxylon* seedlings in natural forests newly taken into exploitation in the neighbourhood of Palembang.

In this connection it must be related that, according to the files of the Institute for Plant Diseases in Bogor, twig-borer infestation of coffee was already reported from Tambunan Estate, Sumatra's East Coast, in 1913 and from Korintji in October 1915. The first case was attributed to *X. coffeae* (= *morigerus*) at the time, but there is no evidence that specimens were submitted and examined by an entomologist, and in the second instance no material was submitted at all. Therefore these records can not be used as proof of prevalence of *morigerus*, nor of possible presence of *morstatti* in those early years. It can only be stated here, that since 1919 *X. morigerus* has been found only very incidentally and in small numbers in some places of Sumatra.

As regards Java it is more difficult to decide whether *morstatti* had been present already for a long time or not, before it was recorded, and in any case a distinction must be made between the western part of the island and the central and eastern parts.

There are three records of the occurrence of a Scolytid twig-borer in coffee in West Java before 1919. ZIMMERMANN (1899) published the discovery of such a borer as attacking hybrids of *Coffea arabica* \times *C. liberica* in the Experimental Garden Tjikeumeuh, Bogor, in 1898. The same author gave a few additional dates in 1901, at which time he had found the same borer also on several coffee estates, both in healthy and diseased trees of the same hybrids and of pure *C. arabica*, sometimes even attacking the main trunk. In view of the biological particulars mentioned there is no doubt at all that these observations relate to a *Xyleborus* species, but from the meagre morphological details given in the text and shown on the small and primitive drawing in ZIMMERMANN's first paper it cannot be ascertained with absolute certainty which species was actually meant. However, the colour was described as brown which is applicable to *X. morigerus* and not to the black *morstatti*. The mentioned occurrence of the borer on coffee plantations which were mainly situated in C. and E. Java, and therefore in parts of the country where *X. morstatti* was not found before 1924, also justifies the assumption that ZIMMERMANN had only *X. morigerus* before him.

A further confirmation of this view may be seen in a note of ROEPKE, who studied Scolytids of various cultivated plants in W. and C. Java some years later, and reported in 1909, that the coffee twig-borer of C. Java — then still listed as

X. coffeae and well known to him — had been found in W. Java too.

In the third place an outbreak of a twig-borer in three year old coffee on Sukakaret Estate near Tjibadak was reported in February 1914, and the species was identified as *X. coffeae* by K. W. DAMMERMAN, as was found in the files of the Institute for Plant Diseases in Bogor.

The situation appears to have changed in W. Java before 1919, the year that *X. morstatti* was first found in two places in this region. It was about the time I started studying the Scolytids in Bogor. Though no systematic search was made about the occurrence of twig-boring species at that time, it still is of some significance that the first material which came to hand in 1920 did not belong to *morigerus* but to *morstatti*. In 1924 the latter species was found to be of rather frequent occurrence in the Experimental Garden Tjikeumeuh as well as in the Botanical Gardens. I did not collect *X. morigerus* until 1924 in this locality and then only in one instance, viz. in a dying cacao tree at Tjikeumeuh. In later years *morigerus* was also found only occasionally in Bogor and in its immediate neighbourhood. Furthermore, the discovery of *morstatti* between 1919 and 1922 in four places in W. Java, situated at considerable distance from one another and including three coffee estates — where the occurrence of pests as a rule is closely watched —, may be considered as an indication that the species had been introduced in the country not long before, but that it was spreading rapidly and had already taken the place of *morigerus* to some extent.

In 1924 and 1925 the occurrence of the beetle in the Botanical Gardens and in the Java-coca estate near Tjibadak showed the characteristics of local outbreaks similar to those observed after a recent introduction of a foreign species into a new country.

The regular spreading of *morstatti* into Central Java since 1924 and into Eastern Java since 1927, where it reached the most eastern parts in 1936, is rather well documented as has been described in previous chapters. In these regions *X. morigerus* (formerly *X. coffeae*) had been known as the common and only twig-borer in coffee plantations since 1906 and as a borer in twigs and seedlings of mahogany and other plants in the teak area since 1915 (KALSHOVEN 1926, 1931, 1951).

This fact that *morstatti* was certainly not indigenous in the larger part of Java is to be considered as another indication that the species had not been living a very long time in the western part, for else it would have spread over the whole island at a much earlier period.

Our final conclusion, therefore, is that *morstatti* must be looked upon as an introduced species in Java.

For the isle of Celebes it must be assumed, contrary to the situation in East Java, that *X. morstatti* had been present for a considerable time before the borer was detected and recognized in plantations in the most northern and southern parts of the large island in 1927. In fact it was reported at the time at least for one estate that the borer had been prevalent already for several years. The successive reports of the borer's occurrence in the other parts of Celebes again may be attributed — as in the case of Sumatra — to more intensive inspections

of the plantations or to the extensions of the planted coffee areas rather than to a recent extension of the distribution of the borer.

With regards to Borneo, where coffee is scarcely grown, the observations of the borer's presence in one locality in 1932—1933 is insufficient to draw any inference about its longer or shorter occurrence in that area.

Further insight into the early distribution of *morstatti* and its possible more recent spreading over different parts of Indonesia might be obtained perhaps from a study of the occurrence of the borer in neighbouring lands, like Malaya and Indochina. However, it is doubtful whether sufficient reliable data can be traced. The matter is further complicated by the fact that in the early years the species has been identified with *X. compactus*, from Japan, a species which appears never to have become well known.

The presence of *morstatti* in far away Fiji, known since 1930 (GREENWOOD), points to a certain suitability of the borer to being transported over large distances. Theoretically it is likely that this transport may occur with coffee seedlings, fresh coffee berries, as well as orchid plants.

HABITS OF *morstatti* COMPARED WITH THOSE OF *morigerus*

The host-plants of *morstatti* recorded for Indonesia in the first four chapters belong to very different families. The Leguminosae figure with 9 species, nearly all green manuring plants used in the plantations. The Lauraceae are well represented by some 7 species, including the forest tree *Eusiderxylon zwageri*, and, according to observations in Fiji, the avocado, *Persea gratissima*. Next the Orchidaceae may be mentioned. FRANSSEN & TIGGELOVEND (1935) have observed in Bogor, that *Dendrobium phalaenopsis*, *D. veratrifolium*, *Vanda coerulea*, and *V. tricolor* are very susceptible to the infestation by the twig-boring *Xyleborus* species, *morigerus* and *morstatti*, and that *V. teres* and *Cattleya* spp. are so in a lesser degree. They did not specify in which species *morstatti* had been found. The Rubiaceae are represented among the host-plants by some species of *Coffea*, the Meliaceae by the mahogany trees, *Swietenia* spp., Caprifoliaceae by *Sambucus*, Euphorbiaceae by *Acalypha*, and Erythroxylaceae by the Java-coca. It is still doubtful whether *morstatti* can raise its broods in *Eupatorium pallescens*, fam. Compositae, in which plant a single specimen was once found.

This list shows quite a number of plants which can serve as true hosts for *morstatti*. However, the borer will not nearly attack all plants indiscriminately. Still, where it is very numerous, it apparently makes attempts to establish itself in other plants in the vicinity. This has been shown by finding the borer in the large ribs of fronds of oil palms in an infested plantation of Quillou coffee on Sumatra's East Coast. Some beetles were also found in the veins of the palm leaflets, piercing them almost from one side to the other. No brood was present in the holes (CORPORAAL 1921). It appears to be quite evident here, that a surplus of swarming beetles had been led to an attack on plant-parts unsuitable for breeding. Some other instances of unsuccessful attack on various plants will be given in the later chapter on the borer's outbreak in the Java-coca plantation in 1924—1925.

It is not clear at all what properties the true host-plants have in common

which make them suitable for breeding mediums of the twig-borer. The structure of orchid stems seems to be rather different from that of the woody plants, and one can scarcely imagine that the chemical constituents and attractants are similar for all these plant species. In any case the susceptible plants must agree in a lack of defence against the borer's activities which enables the mother beetles to enter into the living tissues. Furthermore, there must be a general suitability for the growth of the ambrosia fungus in these tissues.

It is interesting to note that the list of host-plants of *morstatti* in many respects is the same as that of *morigerus* for the region in question, as can be deduced from published and unpublished notes about the occurrence of the latter species in Indonesia. The similar breeding of both species in the stems, bulbs, and roots of epiphytic orchid plants is rather noteworthy in this respect (fig. 3).

X. morstatti also selects the same parts of the woody plants for its boring activities as does *morigerus*, viz. the slender twigs and branchlets, and less often, the stems of seedlings, which probably have the same structure as the twigs.

However, *morstatti* never has been observed boring into the main root of seedlings, a habit common to *morigerus*, which species even penetrates into the soil as deep as 16 cm below the surface.

Another difference between the two species is that *morigerus* occasionally may be found in diseased trunks, infested with blights, whereas *morstatti* appears to be restricted to sound twigs, uninfested by other organisms.

On the other hand both species have been observed occasionally to bore into fruits, viz. the berries of *Coffea*.

ECOLOGICAL RELATIONS BETWEEN *X. morstatti* AND *X. morigerus*

The investigators of the twig-borer incidence in coffee plantations in Central and East Java have been positive in their opinion that the black species, *morstatti*, while extending its area, mainly took the place of the indigenous brown species, *morigerus*. These observations appear to be well founded and it is not sur-



Fig. 3. Stem of an orchid-species, *Dendrobium phalaenopsis*, split into two halves to show the signs of infestation by *X. morstatti*; the tissue bordering the holes is discoloured. (natural size; from FRANSSEN & TIGGELOVEND, 1935).

prising at all, in connection with its rather similar habits and host selection, that the intruder acted as a keen competitor for *morigerus*. Therefore, the relative scarcity of *morigerus* in West Java as observed since 1919 can be explained by its having been superseded to a large extent by *morstatti* since the latter's introduction. BETREM, in one of his papers (1931 p. 441) already expressed the opinion that in Java *morigerus* was being brought into the position of a 'relict species' in those years. The even greater scarcity of *morigerus* in plantations in Sumatra and Celebes observed when investigations were started there, might also find an explanation in the same direction, because *morstatti* probably had been thriving in these regions for a still longer time.

Several observations in W. Java have shown, however, that *morigerus* was not completely supplanted by *morstatti* and that some coexistence remained possible. Our records mention several cases in which both species were found simultaneously in the same plantation or garden plot, and in the same group of host-plants, perhaps even in the same specimens of the host. A typical instance is the presence of both species in mahogany seedlings (Bogor, XI.1925). In the *Cassia multijuga* plants (Bogor, 1929) *morigerus* was far more numerous than *morstatti*, as shown by a sample of the beetles, taken at the time, which consisted of 915 specimens of the former species (82%) against 205 of the latter. In the *Crotalaria* plants (Tjikompai 1926) no broods were found with the *morstatti* beetles while normal broods had been raised by *morigerus*. In the Java-coca plantations (1924) *morigerus* lived in the tap-roots of the seedlings on the nursery beds, and *morstatti* was practically dominating in the twigs and stems of older plants in the plantations.

All in all there is sufficient evidence that *morigerus* still has a chance to survive and even to build up a large population in places where *morstatti* is present too. This survival may find a ready explanation in the fact that the latter species is not able to use all the niches to which *morigerus* is adapted.

Another ecological relation between *morstatti* and *morigerus* consists in their being attacked apparently by the same parasitic wasps, the main species being a Chalcidid, indicated as *Tetrastichus* sp. In this connection BETREM (1932) made the following interesting observation: During initial occurrences of *morstatti* in newly invaded coffee plantations many specimens of the parasite were found infesting the broods. However, as soon as *morigerus* became extinct in the localities by the competition of *morstatti*, generally no parasites were found any more with the latter. After some time the wasp — at least a species undistinguishable from it — again made its appearance in the *morstatti*-broods, but this parasite would not attack *morigerus*. BETREM hesitated to draw a definite conclusion from these observations, but he suggested that the *Tetrastichus* might have developed a form which was adapted to *morstatti* and followed the invading borer where it expanded its area.

(to be continued)