

BEAUFORTIA

SERIES OF MISCELLANEOUS PUBLICATIONS

ZOOLOGICAL MUSEUM - AMSTERDAM

No. 96

Volume 9

September 15, 1961

Habits and host-associations of Indomalayan Rhynchophorinae (Coleoptera, Curculionidae)

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INTRODUCTION

The data used in this paper have been mainly collected during prolonged investigations of the forest fauna of Java, particularly with regard to insect species of some economic or silvicultural importance (see KALSHOVEN, 1955). This explains why some special attention has been paid to weevils damaging the rattan palms, a source of very valuable secondary forest produce in the East, as well as to those living on the bamboos, often growing wild or semi-wild in the forests, and to certain species occurring on Zingiberaceae, which plants are such a common feature of the oriental forest vegetation. These investigations formed only a side-line of the programme of forest entomological work and inevitably only yielded fragmentary data, but they could be supplemented to some extent with information found in the files of the former "Instituut voor Plantenziekten" (Institute for Plant diseases and Pests) at Bogor. Moreover the literature was extensively searched for additional data from neighbouring countries.

The identification of the collected species mainly dates from the year 1936 and was much furthered by the cooperation of Mr. F. C. DRESCHER, the diligent and successful collector of *Coleoptera*, who lived at Bandung at the time (LIEFTINCK, 1958). Mr. DRESCHER had recently submitted most of his Rhynchophorine material to Dr. K. GUENTHER at Dresden, Germany, who specialized in the group and published a few papers on its Indomalayan representatives. Mr. DRESCHER sent us a list of some 74 different species, mostly of Javanese and Sumatran origin, in his collection, adding a few notes on the host-plants so far observed by him or reported by his native collectors. Exchange of specimens with known hosts also took place. Recently I studied the *Rhynchophorinae* in the museum at Amsterdam, which possesses Mr. DRESCHER's captures during the first period of his residence in Java. These have not been seen by GUENTHER but a great number have been identified by K. M. HELLER, the well known specialist on oriental *Curculionidae*. I also studied the material at the Leiden Muse-

um, where the rich VETH collection of Indomalayan *Coleoptera* is kept. As a further introduction some general remarks on the *Rhynchophorinae* of rattan palms and bamboos in Java may precede the survey of ecological details on the individual species.

Rhynchophorine weevils of rattan palms

The native woodsmen and collectors of minor forest produce in Indonesia are well acquainted with the occurrence of large weevils living on the sprouts of rattan palms, whose larvae hollow out the core. For these people the insects have a two-fold interest: they destroy the young growth which should grow out into the rattan lianes that may reach a length of some 30 meters and rest with their crowns on the forest canopy and, when mature, yield the valuable canes called 'rotan' in Malay and Indonesian languages. Secondly the fat grubs are appreciated as very nourishing titbits. Being widely known, the weevils and their larvae are called by different names in various areas, for instance 'ulam' or 'olan' in West Java, 'gendon pendjalinan' (pendjalinan meaning rattan palm) and 'bendu' in Central and East Java.

ZEHNTER in 1904 reported on a weevil larva which killed the sprouts of 'pendjalin salang' (presumably *Daemonorops melanochaetes**) in the forests, this palm being of some use in cacao plantations at that time as the spiny fronds were stuck around cacao seedlings to shade and protect them. ZEHNTER erroneously supposed the insect to be identical with the 'gendon' living in the trunks of *Cocos* and *Arenga* palms, viz. the larvae of *Rhynchophorus ferrugineus* (see p. 56). KONINGSBERGER in his zoological survey of Java (1915, p. 203) in consequence mentioned the rattan palm, genus *Calamus*, as one of the food plants of the common red palm weevil, which is not correct.

According to a note of 1918 in my files, W. ROEPKE, on the staff of the Institute for Plantdiseases and Pests at the time, called for the assistance of forestry service personnel in West Java to provide him with specimens of a certain 'ulam rotan' which were reported to be collected regularly in the forest on Mount Salak and brought to the native markets as they were highly esteemed as a restorative. In consequence of this request first two specimens of the giant Brentid, *Eurytrachelus bucephalus* were sent to him, and afterwards a few *Rhynchophorine* larvae, which could, however, not be reared to the adult stage.

In 1935/1936 a request for material and information relating to borers in rattan palms was addressed by the present author to some Conservators of Forests in Java, Borneo and Celebes. This was part of a scheme to gather data on borers, which damage the rattan lianes in the forests as well as on those that live in cut and dried canes. The former insects leave their traces in the canes and lessen their value as an article of export. In addition a short search was made for similar insects in the lowland forest of Bandar, West Java, by my own assistants.

*) All host plants listed in this paper have originally been collected or recorded under their vernacular names and the corresponding Latin names have been taken from the botanical works of S. H. KOORDERS and K. HEYNE. In order to enable any future workers to check the correctness of the interpretation, the local names are mentioned in all cases.

Confirmation was obtained in these ways of the rather frequent occurrence of damage done by the larvae of weevils and other types of borers to sprouting rattan lianes. Thus a note was received concerning borers found in 'pendjalin sepet' (possibly related to *Daemonorops angustifolia*, the 'rotan sepet' of Malaya and Biliton, cf. HEYNE, 1950); 'pendjalin legi', *D. melanochaetes*; and 'pendjalin kokrok' (perhaps *Calamus miranthus*, see KOORDERS, 1911), all growing in the forests on Mount Muriah on the North Coast of Central Java. In the forests of East Brantas young plants of *D. melanochaetes* were found to have been destroyed for 35% by weevil larvae. A short but very useful piece of information was received from a Javanese senior forest ranger in Banyuwangi, East Java. His people brought him specimens of weevils, locally called 'wawung legi', 'wawung glatik' and 'wawung suwat' associated with the rattan species 'pendjalin legi' (*Daemonorops melanochaetes*), 'pendjalin bulu' (*Calamus unifarius*), 'pendjalin glatik' (*C. viminalis*) and 'pendjalin warak' (*Plectocomia elongata*), the larval tunnels being found in the sprouts and stalks. In Bandjar material was collected of beetles and larvae found in 'howé balukbuk' (*Calamus burckianus*), 'howé leuleur' (*C. melanonoma*) and 'howé sèl' (*Daemonorops melanochaetes*), and two species the local names of which did not give any clue as to their botanical identity.

From South East Borneo a report was received about rather severe damage resulting in the death of sprouts in 20-year old rattan plantations near Tandjong Kalimantan in the Berau District. In fact these plantations were natural groves formed by some four commercial species of 'rotan' — including the 'rotan sega' (*Calamus caesius*) and 'rotan semambu' (*C. scipionum*) — which groves were regularly looked after and extended by splitting of stools and the planting of seeds. On every large stool some three or four stalks appeared to have been lost through the damage. No material was sent in but the weevils were described as being brownish or dull black.

Finally a trading firm in Celebes informed us, that newly harvested canes of 'rotan tohiti' (*Calamus inops*), originating from Palopo, were occasionally found holed by weevil larvae. Such canes were immediately discarded.

Parts of rattan plants still containing the weevil larvae and received from Bandjar and Banyuwangi, were kept in the laboratory at Bogor, where it was tried to breed the adult beetles. Although they were repeatedly transferred to fresh cuts of rattan stalks, the breeding was only successful in two cases, the other larvae becoming weak and dwindling away. Therefore the identity of the rattan borers could hardly ever be established in this way.

The late Mr. F. C. DRESCHER provided me with some species of weevils reported by his native collectors as having been caught on rattan palms. Some of these statements appeared to corroborate other data, but in other cases further evidence of the correctness of these reports and observations is needed.

Rhynchophorine weevils of bamboo

Fair-sized weevils which breed in the sprouts of bamboo culms and destroy them have been mentioned in the literature of South East Asia for a long time (COTES 1893). Important observations on their life history have been

made in India and China. A summary of the principal facts found was given by BEESON in his handbook on the Forest Insects of India and the Neighbouring Countries (1941). They deal with a few species of *Cyrtotrachelus* which present many interesting features concerning their morphology (for instance the much elongated front legs of the males, tufted with brown hair on the inner side of the tibiae) as well as their ethology (the occasional pupation outside the foodplant in the soil), and their ecology which is characterized by their exclusive association with bamboos, though of various botanical types.

Bamboo as a food plant of *Cyrtotrachelus* weevils indigenous to Java, was first reported by LEEFMANS and KALSHOVEN (1931). Further studies have taught us that the allied genus *Otidognathus* (*Litorrhynchus*), including species of much smaller build, belongs to the same morphological/ecological group.

A species of *Periphemus*, a genus of quite different type with small, very slender beetles, has also appeared to live on bamboo tops, but further details on its life history are lacking.

I have found no evidence that the bamboo weevils and their larvae are as well known to the native population as the species living at the expense of rattan plants and other palms. On Mount Wilis I was told that a borer, 'bendu', living on 'pring wuluh' (*Schizostachyum blumei*), eventually turned into a 'tjuwat' beetle.

SPECIAL PART

In the following survey the division into subtribes is used as found in CZIKI's treatment of the Rhynchophorinae in the *Catalogus Coleopterorum* (1936). Some alterations have been made however, in the sequence of the genera in order to bring forward apparent relationships from the ecological point of view.

Rhynchophorini

Protocerus SCHÖNH., 1838, giant palm weevils, restricted in their distribution to South East Asia.

In answer to a request of Dr. S. LEEFMANS for informations about the identity of Indonesian representatives of this genus, Sir GUY A. K. MARSHALL wrote under date April 22, 1920: "The identification of the genus is a matter of considerable difficulty, and, after a full study of the large amount of material from various localities contained in the British Museum Collection, I must confess that I am quite unable to find any definite character for the separation of the species. I fear, that before this can be done satisfactorily, it will be necessary to make a good number of preparations of the genitalia of both sexes." Provisionally he gave the name *Protocerus purpuratus* DOHRN, to a male from Java, *P. aemulus* DOHRN to a male from Sumatra, and *P. ? molossus* OL. small variety, to a female from Sumatra. Later, in 1934—1935, however, specimens from Java were labelled by him: *P. colossus aemulus* DOHRN, and *P. c. molossus* OL.

In a letter of April 2, 1936 addressed to Mr. F. C. DRESCHER, Dr. K. GUENTHER wrote. "Ob auf Java und überhaupt auf den Grossen Sunda-Inseln westlich der Wallaceschen Linie mehr als eine Art der Gattung

Protocerius SCHÖNH. vorkommt ist mir zweifelhaft; herkömmlicherweise werden die grossen Tiere... als *P. colossus* GYLLH. (oder *P. molossus* GYLLH. oder *grandis* GUÉRIN) bezeichnet, die kleinen, wenigstens auf Java, als *C. praetor* FAUST."

Protocerius colossus OL., 1790. Specimens of this large weevil were first observed by S. LEEFMANS on nursery plants of *Cocos nucifera* at Padang, East Coast of Sumatra, in 1917, at the time when he stayed there for the completion of his investigations on the red palm weevil, *Rhynchophorus ferrugineus* (see KALSHOVEN, 1954). LEEFMANS added some observations on the beetles at Bogor in 1931 and read a short report on his findings at the meeting of the local Entomological Society at Bogor of April 17, 1931 (LEEFMANS 1931). A few additional data extending to 1932 were found by me in the portfolios that he left behind him. A summary of all the available data is given here.

Freshly captured beetles have a fine velvety gloss or lustre (fig. 1), and a vivid reddish tinge, which turns into a dull red-brown or greyish shade after the death of the specimen. The largest specimens from Java and Sumatra have a length of 8 cm (exclusive of the rostrum which is 2 cm long) and a breadth of 2.5—3 cm, their front legs having a length of 5 cm. In the Amsterdam Museum is a ♂ of 8.5 cm from Tandjong Amuntai, South East Borneo.

The weevils live near the ground on young sprouts of palms and have been mainly found on varieties of the sago palm, *Metroxylon* sp., the 'rumbia' or Sumatra (LEEFMANS) and Malaya (MILLER 1932), and the 'kirai' of West Java (LEEFMANS). This palm occurs in large, more or less natural groves in the plains and valleys of the region. Incidentally the weevils occur on coconut plants not older than 18 months. The beetle has also been seen on a *Raphia vinifera* (not indigenous to Java) in the Experimental Garden at Bogor (1932). A couple of the weevils ('wawung legi') reported to have been observed with their snout bored into sprouts of *Daemonorops melanochaetes* in the Tjuralele forest near Banyuwangi, February 1936, were submitted by Forestry personnel.

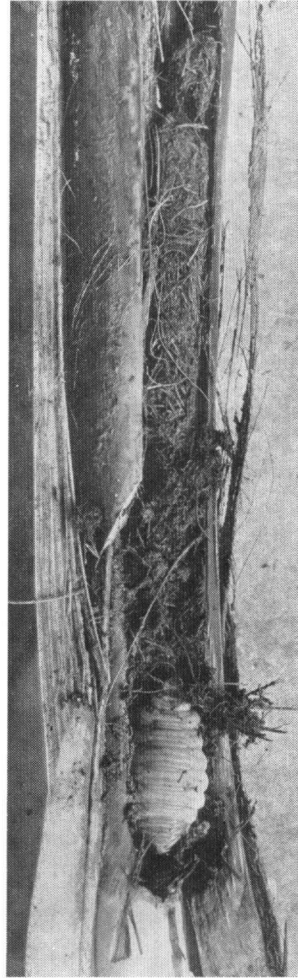
For the purpose of feeding the beetles dig their strong rostrum into the still folded top-leaves, and this results in holes and shredded spots in the unfolding fronds. In ovipositing the beetle lays its large eggs — 7.2 x 2.4 mm — into similar holes, made just beneath the place where it has bitten through the core, causing the top-part to break and droop.

According to observations in the laboratory, egg laying may continue for a fortnight. The beetles cannot be kept alive longer than a month. The eggs hatch in 5-6 days. The larva eats its way into the tissues, the core of the plant being totally destroyed (fig. 2) and the sprout ultimately killed. In *Cocos* seedlings the older, outer leaves may still remain green for a rather long time. Contrary to the larvae of *Rhynchophorus* which will generally occur in numbers, there is only a single *Protocerius* larve in one top.

In two cases observed in the laboratory the development of the larvae took from 8 to 9 months, the pupal stage, in a cocoon of shredded fibres, was passed in 3 weeks, and the period of maturation of the beetle before emerging extended over another 4 to 6 weeks. Therefore the total development required more than ten months.



1



2

Photo VAN HEETEREN, Bogor 1932.

- FIGURE 1. Male of *Protocerius colossus* climbing an unfolding frond of a young *Cocos* plant. Note that the front legs, with their powerful tibial hooks, are not used in moving but are ready for clawing. ($\times \frac{2}{3}$).
- FIGURE 2. Exposed burrow in the core of a young *Cocos* plant showing a *Protocerius* larva in situ and its frass consisting of fibrous mouldy matter. ($\times \frac{2}{3}$).

The male beetles appear to use their powerful fore legs (fig. 1) as a means of defence, throwing them up and moving them to and fro in a threatening manner and they strongly grip any disturbing object. When caught with the hand they press the large, curved apical spine of the tibiae into the fingers. The tubercular rostrum of the males (in the females the rostrum has a smooth upperside) is used in fighting for a female with a rival and they can dethrone a competitor who has already mounted his partner.

P. ?praetor FAUST, 1895. Two larvae found boring in 'howé sèèl' (*Daemonorops melanochaetes*) in the Bandjar forests, June 26, 1936, were kept in the laboratory, the sprouts being several times replaced by pieces of 'howé balukbuk' (*Calamus burckianus*). On November 7 one of them appeared to have turned into a pupa, from which a male beetle emerged on November 25. The specimen has the following measurements: length 27 mm, breadth 9.5 mm, length of rostrum 9 mm. The colour of the beetle, which appears to have been killed when not fully mature, is brownish. Another male beetle, 32.5 mm long, 11 mm broad, length of rostrum 12 mm, upper side blackish brown, under side black, was captured by me on rattan in the forest near Tapos, south-west slope of Mount Gedé, at 800 m, November 1940.

These beetles appear to resemble *P. grandis* Guér. or *P. praetor* Faust. The latter was described from four specimens, 41—51 mm long, and 14—20 mm broad, collected near Bogor, West Java. The smallest and slenderest specimens of *Protocerius* in the Amsterdam and Leiden Museums*) are: 4 ♀♀, 30—37 mm long, 10.5—14 mm broad, from different localities in Java; 4 ♂♂, 35—41 mm long, 13—15.5 mm broad, also from Java (RMNH); a ♂, 31 mm long, 10 mm broad, from Bengal, India (RMNH); a ♀, 32 mm long, 11 mm broad, from Padang, West Sumatra (RMNH); a ♂, 38 mm long, from Nias (RMNH); a ♂, 39 mm long, from Pulau Tello, Batu Islands (RMNH); a ♀, 40 mm long, 13 mm broad, from Riouw Island (ZMA) and a ♀ of 39 mm, 14 mm broad, from the Raya Islands (ZMA). Most of these specimens have been placed in these collections under the name *P. grandis*. Several have a warm reddish-brown colour with a clearly contrasting black margin of the elytra.

P. laetus VOLL., 1866 was described from Celebes. According to the author it agrees in all respects with *colossus* but for the coloration. The beetles have a more or less distinct dark blotch on the pronotum (see the coloured illustration published by VAN VOLLENHOVEN), which is very rarely to be seen on the specimens from the Western part of the Indonesian Archipelago. VAN VOLLENHOVEN himself suggested that *laetus* might be only a local variety or race of *colossus*.

MOHNICKE (1883) who published a woodcut of a *Protocerius colossus*, apparently copied from the drawing of VAN VOLLENHOVEN, drew the attention to the fact that the specimen figured by OLIVER, 1790 is a female with the head of a male implanted on it.

From the data on the host-plants occurring in the preceding paragraphs it may be concluded that the unidentified larvae found in rattan plants in Java and Borneo in earlier times, as mentioned on pp. 50—51, mostly if not all, belonged to *Protocerius* species.

Omotemnus serrirostris (FABR., 1801) is a large weevil 40—45 mm in length and 15—20 mm in breadth. The males have a rhino-like process near the tip of the rostrum, which is 11—12 mm long. This process is much smaller in the females. Most specimens have a velvety appearance;

*) RMNH and ZMA respectively stand for collections Rijksmuseum van Natuurlijke Historie, Leiden and Zoologisch Museum, Amsterdam.

the colour may be dark reddish with four black maculae or two longitudinal streaks on the pronotum and a pair of humeral and ante-apical marks on the elytra; other specimens are dull black all over.

At the Institute for Plantdiseases and Pests it was found that the weevil is a borer in the 'salak', *Zalacca edulis*, a trunkless, very spiny palm occurring in semi-cultivated groves near Bogor, West Java. LEEFMANS (1931) mentions it very shortly by the name *O. miniatocrinitus* Chevr., and I have inserted both names side by side in my handbook (KALSHOVEN 1951). As no specimens labelled *miniatocrinitus* are to be found in the Amsterdam and Leiden Museums, I have not been able to study this matter. Several other *Omotemnus* species have been listed as occurring in Java but it may be doubted whether they are all good species (cf. GUENTHER 1934).

Rhynchophorus ferrugineus OL., 1790, the red palm weevil. The principal particulars about the habits of this species, one of the best known in South East Asia, were given in my handbook (KALSHOVEN 1951). LEEFMANS (1920) listed five different kinds of palms (*Arenga pinnata*, *Cocos nucifera*, *Corypha gebanga*, *Elaeis guineensis*, *Metroxylon sagu*) observed as hosts in Java and Sumatra. In addition it can be mentioned that the beetle and its larvae have since been found in the top-parts of *Oreodoxa regia* near Bogor, January, 1928; killing the tops of the 'sadeng' palm, *Livistona rotundifolia*, at Rambipudji, Besuki, and of *Areca catechu* in Banyuwangi (both submitted by the Forestry Service of East Java); and in a dead stump of 'sarai', *Caryota mitis*, a wild palm in the lowland forest near Bandjar, July 1936. CORBETT (1932) dealing with the hosts of *Rhynchophorus* in Malaya lists five of the species already mentioned and adds to them *Livistona cochinchinensis*, *Oncosperma tigillaria* and *O. horrida*, while BEESON (1941) gives a list of twelve hosts in the Indian region of which six are additional to our enumeration, viz. *Arenga saccharifera*, *Caryota urens*, the date palm and three other species of the genus *Phoenix*. This totals 18 species in the list of recorded hosts.

Some *Rhynchophorus* beetles were once discovered while they were engaged in boring into the stumps of cut leaves on the trunks of oil palms (*Elaeis*) in North East Sumatra. However, the species did not develop into a pest of this introduced crop (CORPORAAL, 1920). In Malaya the same observation was made, and a few oil-palms were reported to have been killed by the larvae which had hatched from eggs laid in these places (CORBETT 1931).

As a rule the weevils deposit their eggs in wounds of the trunks and crowns of standing palm trees, as well as on felled trunks, the larvae often breeding subsequently in dying and dead tissues of the core.

There are many mentions of the larvae of *Rhynchophorus* being used as human food (RHUMPHIUS, 1750; SALOMON MULLER, 1857; JACOBSON, 1927; VAN DER MEER MOHR, 1941; GHÈSQUIÈRE in LEPESME, 1947; DE WILJES, 1950).

Cyrtotrachelus bipartitus HART., 1899, a highly polished brown beetle of 25—30 mm, with a large black patch, often divided into two halves, on the pronotum, occurs in Java, Sumatra, Borneo and Malaya. Some variety in colour and markings has led to the description of five forms.

In several localities of Java, ranging from the plains and low hills to an altitude of some 1000 m on the mountain slopes, the beetle has been seen on the wing in the months December to July; this period includes the second half of the rainy season and the first half of the dry season. Female beetles have been collected in greater numbers than males.

Among the specimens in the Amsterdam Museum there is a couple taken by LEEFMANS, at Sukamadju in West Java, May 1915, with the note 'on bamboo'. In the teak forest of the Semarang District the beetles have been invariably found since 1923, on 'pring apus' (*Gigantochloa apus*), a strongly tillering and much cultivated species of bamboo, which plays an important part in rural economy all over Java. The beetles make slits in the tops of the sprouts for feeding and oviposition. The larvae hollow out and kill the sprouts. It is most likely that the general life history of the species will be the same as that of the better known *C. longimanus* F. (BEESON 1941).

Seven adults taken in the forest near the field laboratory Gedangan were caged and two couples, found in copula, were set apart and given material for oviposition, but they succumbed within a week (January 1937).

A large larva, with a conspicuously big head, the body yellowish, sharply curved, showing brownish chitinous patches on the thoratical segments, was found boring the sprouts of 'awi tamiyang' (*Schizostachyum blumei*) in the forest near Bandjar, West Java, May 1936. It could not be bred to the adult stage but was considered to belong to *C. bipartitus*.

Otidognathus myrmidon Buq., 1829/1844, has the habitus of a small *Cyrtotrachelus*. It is 10—18 mm in size and appears to be limited in its distribution to Java, where it occurs from the plains up to some 1000 m. *O. collaris* Jord. 1894 must be considered a variety, differing only in the extent of the dark markings on the pronotum. GUENTHER's treatise (1934) on the Philippine *O. elegans* Fairm. in which he described and named no less than 15 varieties, shows how great a variation in extent and placing of the markings may occur in a species of this genus.

A specimen of *O. myrmidon* was found beneath the leaf-sheath of a 'pring ori' (*Bambusa bambos*), a few sprouts of which plant had deep slits cut in the tops, apparently made by the beetle while feeding. In two fresh holes a few eggs were found (teak forest near Semarang, May 1931). Another beetle was bred from one of three larvae found boring the sprouts of 'pring ampel' (*Bambusa vulgaris*), in the same locality, June 12, 1931, and taken to the laboratory. One of them turned into a pupa, June 19, which yielded the beetle on July 15. The other larvae succumbed.

KONINGSBERGER's (1915) record that the larvae of this species, mentioned as 'Lithorynchus myrmidon', occur in the soft tissues of a few species of Palmae in the mountain forests of West Java at altitudes between 800 and 1500 meters, must have been based on incorrect information.

Macrochirus praetor GYLL., 1839, a large black weevil, in habitus somewhat like a *Cyrtotrachelus*, occurs in the forests of Sumatra and Java, but, so far, has been seldom met with. The Leiden Museum has only 10 specimens and the Amsterdam Museum 7 specimens. The ♀ — the only

sex originally described by GYLLENHAM — varies in size from 28 to 42.5 mm, the rostrum measuring 12—21 mm. It was figured by HEYNE/TASCHENBERG. The ♂ — of which RITSEMA 1891, gave the first particulars — is 28—40 mm long, with a rostrum of 11—20 mm. The front legs are very long, up to 60 mm in the largest specimens, and have a fringe of reddish hairs on the inner side of the apical half of the tibiae. A female was found by me resting on the top of a rattan palm on Mount Salak, on the edge of the crater field, at 1200 m, August 1928. A couple of the beetles was collected on the Puntjak Pass of Mount Gedé at 1500 m, October 1949. On this occasion I noticed the menacing attitude, with front legs stretched out, displayed by the beetle when disturbed (fig. 3). This is similar to the behaviour observed by LEEFMANS in *Protocerius colossus*.

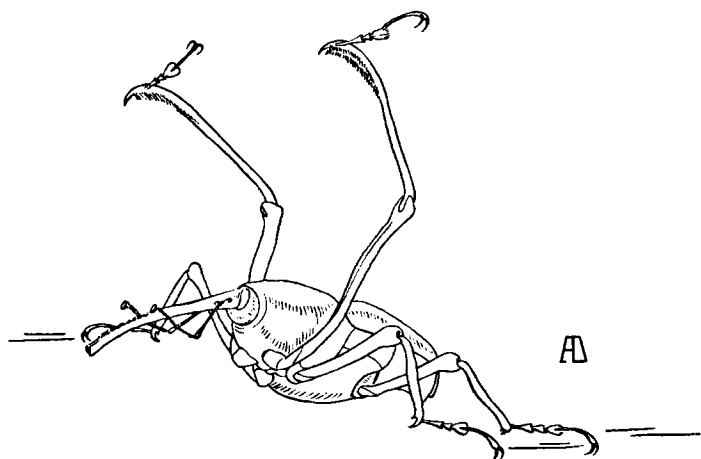


FIGURE 3. Male of *Macrochirus praetor* in prancing attitude. (Natural size). Drawn after a mounted specimen by VAN DREVELDT, 1961.

Mahakamia kampmeineri RITS., 1913, is a still more remarkable and rare weevil, elongated in habitus and with very thin and long, spider-like fore-legs. It was described from a single male — preserved at the Leiden Museum — from Upper Mahakam. Another specimen from Bukit Gabah, Sumatra, June 1918, coll. LUCHT, is in the Amsterdam Museum.

GUENTHER (1941) found a male and female of this species, from Mount Malang in West Java, in the Dresdener Museum. The male, of which he gives an excellent drawing has still more elongated fore-legs than the type specimen; they measure about 11 cm, that is nearly twice the length of the body plus rostrum.

The species has been omitted in the *Catalogus Coleopterorum*, as GUENTHER has already noticed.

Paratasia rubiginea (WIED., 1819), a reddish species with black markings, 25—35 mm in size. One specimen was found by the Forestry personnel on the search for borer damage to living rattan palm, on a rattan plant

in a plot of virgin forest, Lembu Lampang, in the southern part of Banyuwangi, East Java, January 1936, and another specimen was caught on the wing in the close neighbourhood of a stool of 'pendjalin wuluh' (*Calamus unifarius*, according to HEYNE) in a similar plot, Tjuralele, in the same district, February 1936.

Ommatolampini

Ommatolampus germari BOH., 1845, a slender black species of 25 mm. A specimen taken by F. C. DRESCHER on Mount Tangkuban Prahū at 1250/1500 m, January 1936, has the host label 'rotan'.

O. tetraspilotus GUÉR., 1829/1844, a reddish species with markings resembling those of *Paratasia rubiginea*, but of slenderer build, 19—26 mm. One specimen emerged from a borer-infested stem of the 'bingbing' palm (*Pinanga javana* according to KOORDERS), found in the forest near Bandung, June 8, 1936, the beetle making its appearance on August 14. The same stem also harboured *Rhabdoscelus leprosus*.

Sphenocorynini

Sphenocorynus cinereus (ILL. 1800), a 12—20 mm sized black and slender beetle, mostly covered with specks of greyish tomentum, very common in the Indonesian Archipelago. Synonyms are *S. melanaspis* Fabr. 1885 and *S. seminudus* FAUST 1892. Some other species listed may probably be local races only. The species is abundantly represented in the museum collections.

Its host plants are tall Zingiberaceous herbs, belonging to the genera *Achasma*, *Alpinia* and *Amomum*, which grow profusely, up to a height of 3 to 5 m, along the forest borders and in the ravines at various altitudes. The beetles can easily be discovered by unfolding the rolled-up top-sprouts of the plants on which they hide (KONINGSBERGER 1915, p. 484). They feed on the young tissues, and the lesions caused by these activities become visible when the leaf-blades expand. The same biotope is used by Hispine beetles of the genus *Anisodera* (KALSHOVEN 1957). The breeding place of the larvae of *Sphenocorynus* is not known but must presumably be sought in the rhizomes or corms.

S. impluviatus FAUST, 1894, breeds in *Alpinia allunghas* in India (BEESON 1941).

Prodiocetes geminus FAUST, 1895, a brownish beetle with three black streaks on the pronotum and four spots on the elytra. A specimen was bred by C. F. C. FRANSSEN at Bogor, February 1939, from larvae living in *Elettaria cardamomum*, an introduced Zingiberaceous plant cultivated on the Governmental Tjipetir Estate near Sukabumi, West Java, December 1937. The larval tunnels had been started near the bases of the stems and continued upwards in the core. They had also been found in the rhizomes. Therefore the species appears to have about the same habits as *P. haematicus* Chevr., which is injurious to cardamom plants in India, many particulars on its life history having been published by JONES (1945). The latter species is wrongly cited as "*Cossonus* (*Prodiocetes*)

bimaculatus var. *haematicus* Faust" by DOSE in the Handbuch für Pflanzenkrankheiten, 1954.

P. dehaani GYLL., 1838, 12—14 mm. A specimen caught by F. C. DRESCHER on Mount Slamet, Central Java, October 1925, has the host label 'pandan' (*Pandanus*). However, two specimens were collected from a 'patjing'-plant, *Costus speciosus*, in the company of *Cercidocerus schönherri*, in the teak forest of Semarang, February 1925, and I have seen another specimen collected by Fr. VERBEEK from a tall Zingiberaceous plant (? *Amomum*) at Tjisarua, on the forest-covered slope of Mount Gedé, West Java, 1200 m, August 1930. This makes it rather probable that this *Prodiocetes* species is also associated with Zingiberaceae and not with Pandanaceae.

In the *Catalogus Coleopterorum* the species is listed under *Anagyrus*. GUENTHER (1937) assigned it to the genus *Pleurothorax*.

P. quinquepustulatus FAUST, 1895, is a dull brownish red beetle with inconspicuous markings, 9—11 mm. It has been collected in small numbers — up to 6 at the same time and place — on Zingiberaceous plants in the teak forests of Central Java. The species appears to be equally associated with *Zingiber aromaticum* (locally called 'lireh', cf. HEYNE p. 474) and *Kaempferia pandurata* ('kuntji'), and has been found in copula on both plants. It has also, occasionally, been collected from other plants of the soil covering vegetation. Probably the larvae live in the rhizomes of the Zingiberaceae. The beetles are on the wing in the months November till February, that is in the middle of the rainy season.

Megaproctus exclamationis WIED., 1823, so called after the mark on its pronotum, a very elongated beetle, of widely different sizes, viz. from 8—21 mm, the rostrum of the largest specimen up to 9 mm in length. It has been repeatedly collected in the teak-forests of Central Java, some with the following notes: resting along the mid-vein of a leaf of 'bolang' (*Alpinia malaccensis*) and on young top-leaves of 'elo' (*Amomum gracile*) at Subah, East of Pekalongan, North coast of Central Java, July 1919; on 'lireh' (*Zingiber aromaticum*) in the teak plantations near the field laboratory of Gedangan, April 1926. It was also observed on the tops of small-leaved Zingiberaceae at Takoka, South of Sukabumi, November 1918, and at Tapos on Mount Gedé, 900 m, June 1932, one of them boring a hole in the stem. In the Amsterdam Museum is a ♀ ♂ couple labelled as having been found 'on a leaf of Scitamineae' at Fort de Kock (now Bukit Tinggi), 920 m, by E. JACOBSON, 1925. The wild growing Scitamineae of the Indonesian region mainly consist of Zingiberaceae. All these notes therefore agree as to the association of the species with his family.

Periphemus superciliaris PASC., 1874, a very slender, parallel-sided weevil, the Javanese specimens measuring 8.5-10 mm. Sir GUY MARSHALL who identified the species for me in 1926, added the note 'probably noxious to bamboo'. In the literature I could not find a reference to the food-plant of the beetle, but MARSHALL's remark has been confirmed. Single specimens have been found on bamboo at Bogor (leg. VAN DER VECHT, June 1929) and on young sprouts of *Gigantochloa apus* in the

teak area of Central Java, December 1924, Februari-March 1925. The beetle has also been found, but always in small numbers and without indication of the host, in other parts of Java, in the plains and lower hills up to some 900 m.

Calandrinia

Tetratopus sericans (WIED., 1823), a blackish or dark-brown weevil with reddish markings of various sizes on pronotum and elytra, sometimes wholly velvety (or greasy), 16—23 mm, the rostrum 3—5 mm. One specimen in my collection has the host-label 'tepus' — the name for tall Zingiberaceous plants —, Mount Salak, June 1928, leg. DRESCHER. Another specimen was found feeding on 'pendjalin glatik', the rattan palm *Calamus viminalis*, by Forestry personnel in Besuki, February 1936. MILLER (1932) has reported the beetle from banana, *Musa*, in Malaya. The main host of this, not uncommon species, is therefore not yet clear.

Cercidocerus SCHÖNH., 1838. The genus is characterized by its males having a broadened, pickaxe shaped, antennal club.

C. chevrolati FAUST, 1890, 11—13 mm, nearly black, the elytra with large velvety spots on a reddish field, inhabits the mountain forests of West and Central Java at 900—1500 m. A specimen received from Mr. F. C. DRESCHER and collected on Mount Tangkuban Prah, December 1934, has the host-label 'rotan'.

C. fabricator GYLL., 1838, 11.5—14 mm, has a wider range of distribution. A specimen was caught on a tepus plant — one of the large Zingiberaceae, probably *Amomum* sp. — on Mount Salak, West Java, 900 m, May 1922. However, to a specimen collected near the Bayukidul Estate on Mount Raung, East Java, coll. H. LUCHT, November 1921, Mr. F. C. DRESCHER had attached the host label 'pandan' (*Pandanus*).

C. schönherri GUÉR., 1844, 11—13 mm, distinguished by the conspicuous white stripes along the lateral sides of the pronotum, has often been found singly or in a few specimens on the Zingiberaceous plant *Costus speciosus* in the teak forests of Central Java, and incidentally on other plants of the low vegetation, including *Kaempferia pandurata*, belonging to the same family. Apparently the breeding place of the larvae must be looked for in the *Costus* plants. The beetles are on the wing from the end of December to the beginning of April, therefore in the middle of the rainy season.

C. erythroceus GYLL., 1838, 14 mm, with small, whitish elongated specks on the elytra, is only known from Java. A couple was found in copula on the flowers of *Eupatorium pallescens* (certainly not its foodplant), at Takoka, South of Sukabumi, West Java, November 1918.

C. nervosus PASC., 1874, 12.5—16 mm, is marked by white lines and spots on the pronotum and elytra. It is quite unlike the other species of *Cercidocerus* and reminds one of *Poteriophorus isabellinus*. The species occurs in the mixed forests of West and Central Java from ca 250 to 900 m. A specimen received from Mr. F. C. DRESCHER and collected on Mount Slamet, October 1925, has a host label 'rotan' affixed by him. In the large

series of beetles of this species in the Leiden Museum the specimens are rather uniform in appearance, but for the black median band on the pronotum which varies in breadth.

C. securifer GAEDE, 1833, 12—13 mm, decorated in black and white, and reminding one of a small *Poteriophorus niveus*, occurs in Java from the coast up to some 1200 m altitude. A specimen taken on Nusa Kambangan — the islands off the South Coast of Java near Tjilatjap — October 1925, again has the host label 'rotan' (rattan palm) attached to it by its collector, F. C. DRESCHER. Both these records need further confirmation.

Poteriophorus niveus GYLL., 1838, is a remarkable weevil, 22—23 mm in size, covered with white tomentum; the stout beak of the male is strongly curved, its under side, the inner side of the tibiae and the prosternum are covered with a brownish filament. F. C. DRESCHER mentioned this species as living on rattan palms on Nusa Kambangan, 1926—1927. A dead beetle was found by me in a hollowed rattan sprout (*Daemonorops* sp. or *Calamus* sp.) submitted by a forest officer and collected on the slopes of Mount Muriah, North East Java, June 1936. A female was reared from a larva found boring near the top of a 'howé bogo' (*Calamus aspersus*) in the forest near Bandjar. The pupa was seen June 13, and the adult appeared August 6, 1936.

P. isabellinus FAUST, 1896, a much smaller species, 13—15 mm in size, with white tomentous stripes, the under side not hairy, also occurs on rattan palms, according to Mr. F. C. DRESCHER's information. It has been collected in the forest of the plains and hills in several parts of Java, including the teak-forests of Rembang (leg. VERBEEK, January 1925). That species of *Poteriophorus* are apparently associated with rattan palms is further substantiated by the record of *Calamus* sp. as host of *P. plagiatus* Roel. in the Philippines (SCHULTZE 1915, p. 188).

Odoiporus longicollis OL., 1807, the wide-spread secondary borer of banana, *Musa paradisiaca*, to be found in old declining stems and not in the corms. For further details on its occurrence in Indonesia see KALSHOVEN 1951, p. 814.

Cosmopolitus sordidus GERM., 1824, the well-known primary borer in the stem and corm of banana, *Musa paradisiaca*, and abaca, *M. textilis*, widespread in the Indo-Australian region (see KALSHOVEN 1951 p. 810). The beetle was found by CORPORAAL, probably incidentally, on *Agave* in a plantation in N.E. Sumatra (see HELLER 1925, p. 23).

Rhabdoscelus. The original name of this genus is *Rhabdocnemis* FAUST 1894. This name was preoccupied and in 1943 MARSHALL replaced it by the former.

R. leprosus (FAHRS., 1845), a weevil 12—13 mm in size, the elytra showing rows of whitish, elongated specks. In the *Catalogus Coleopterorum* the species is listed as *Calandra leprosa*.

KEUCHENIUS (1915) found this species — recorded by him as *R. interruptocostalis* Schauf. — in the company of *Diocalandra frumenti* in young

fruits of the coconut palm which had been spoilt by an infestation of the Pyralid *Tirathaba rufivena* Walk., in the Besuki District in East Java. In the Zoological Museum, Amsterdam, is a specimen labelled 'in decaying *Caryota*', Sumatra, Fort de Kock (now Bukit Tinggi), 920 m, coll. E. JACOBSON, 1924.

F. C. DRESCHER (in litt.) reported the beetles as having been found on rattan palms at Baturraden, Mount Slamet, 900 m, April—May 1925, January 1926, January 1927. This host record was confirmed by the find of larvae and pupae in the 7 cm thick stem of a 'rotan bubuwai' (*Plectocomia elongata*), in the forests of Bandjar, May 1936. The plant had a rotten core and was also tunnelled by pin-hole borers (*Xyleborus* spp.). The larval galleries were filled with frass and the pupae rested in cells made of compressed fibres. The beetles appeared 3 to 4 weeks later. Another couple of the beetles was bred from the trunk of 'bingbing', *Pinanga javana*, which also harboured *Ommatolampus tetraspilotus*, Bandjar, June 1936.

At Bogor the larvae have repeatedly been found boring into originally sound, ornamental palms, grown in tubs in the verandahs. They started at the bases of the leaf sheaths right above the short stems and continued tunnelling mainly upwards, finally hollowing out the heart of the crown. In a sprout, 12.5 mm thick, a tunnel of 12 cm had been made. The tissues were turned into a mass of mould and frass. Pupation took place in a thick-walled cell made of fibres near the surface. Two or three larvae were sometimes found in the base of the same vigorous sprout. Occasionally a top of a tiller was still green while its lower half was already grey and dying, and the core gnawed through. Small holes in the leaf sheaths apparently resulted from the activities of the adult beetles (cage slip of May 1941).

On an estate in North East Sumatra a few beetles were found in young fruit bunches of the oilpalm, *Elaeis*, which showed borer damage. An isabelline coloured larva, with long stray hairs on its body and most probably belonging to the same species, had been encountered before in a similar bunch on the same plantation. It had been feeding on the semi-liquid kernels and the hardening outer layer of the young fruits, and had already destroyed six of them. The information accompanied the specimens submitted by the Rubber Experiment Station AVROS at Medan, February—March 1930.

R. lineatocollis HELL., 1912, the 'bonga weevil' of the Philippines, was first described and figured in all its stages and in many particulars by BANKS (1906) under the incorrect name '*Cyrtotrachelus* sp.'. He had found that it damaged the trunks of the betel palm, *Areca catechu*, and occurred also in considerable numbers in coconut trees. The cocoons, frequently encountered in the company of those of *Rhynchophorus ferrugineus*, in decaying betel palms and coconut trees of 6—8 years old, were 35 mm long and 15 mm in diameter. It was later listed as *R. lineatocollis* by SCHULTZE (1915) and WOODSWORTH (1921).

R. maculatus (GYLL., 1838), 9.5—11.5 mm, in fresh condition with 5 black linear markings on the pronotum and 7 spots on the elytra. The beetles have been reared from larvae living in the dead trunks of 'sarai'

(*Caryota mitis*), a tillering palm forming stems of 10—15 cm in diameter, and the 'langkap' palm (*Arenga obtusifolia*), with trunks up to 22 cm thick, which had been cut in the forest area of Bandjar. From four pieces of 'sarai', containing larvae and caged June 8, 1936, ten beetles emerged between July 10 and August 5. Pupae were already observed on July 1, 1936.

A single beetle was caught on *Musa paradisiaca* at Bogor, by J. VAN DER VECHT, October 1948. The species occurs in all areas under cultivation in Java.

R. obscurus (BOISD., 1835), has become known as 'the New Guinea Cane Borer'. Its area of distribution includes the islands of East Indonesia and the South West Pacific. Many particulars of its life-history were published by MUIR and SWEZEY (1916) who had made a search for the natural enemies of the borer in its original habitats, with the purpose of introducing them into Hawaii, where the borer had become particularly destructive to sugar-cane. In East Indonesia the weevil was found mainly on sago-palm (*Metroxylon sagu*) and very rarely on other species of palms, among others on *Areca catechu*. The specific predators and parasites include the Histerid *Platylister abruptus*, the Elaterid *Simodactylus* sp. and a Tachinid *Ceromasia phenophori*.

In the Minahassa (North East Celebes) the beetle has since been found associated with diseased *Cocos nucifera*. It occurs in holes made by *Rhynchophorus ferrugineus* and in parts infested by the *Thielavopsis* fungus (A. REYNE in an unpublished annual report of 1932/1933).

Sphenophorus basilanus (HELL., 1921), subsp. *javanensis* GUENTH. is a dark-grey weevil, 7—8 mm in size, adorned with 5 white-rimmed spots on the elytra. I have in my files a note, that is not fully reliable, about a specimen taken from *Politia thyrsifolia* on the S.slope of Mount Salak, West Java, at 800 m, April 1922. This plant belongs to the Commelinaceae and has a specific Hispin beetle, *Prionispa fulvicollis*, associated with it (KALSHOVEN 1958).

Aplotes carinicollis (GYLL., 1938), a dark greyish species, 6—9 mm in size, with eight black spots of different sizes on the elytra. It lives in the mountain forests of Java up to 1500 m. According to Mr. F. C. DRESCHER the beetle is to be found on rattan palms, an observation that has still to be verified. I collected a specimen on the flower heads of *Eupatorium pallescens*, at Tapos, Mount Gedé, July 1952.

Trachoropalus strangulatus GYLL., 1838, a rather common species in South East Asia and on the islands of the Indian and Pacific Oceans, 9—9.5 mm. In Java and Sumatra it has been observed, sometimes in fairly great numbers, on dead trunks of *Arenga saccharifera*, *Cocos nucifera* and *Metroxylon sagu* palms, and occasionally in holes of different sizes in the stem of young coconut plants, this latter occurrence suggesting a tendency to primary attack (LEEFMANS 1920, KALSHOVEN 1951). It has also been reported from rotten stems of *Musa* spp. (banana and abaca). In Malaya it has been included in a list of insects found on *Elaeis* (SOUTH 1927) and in Mauritius it has been seen gnawing at the roots of sugar-cane (HUSTACHE 1958, p. 814).

UICHANCO (1928) recorded the species from the Philippines under a wrong name (see Review of Applied Entomology, vol. 17, p. 903), stating that it is often found there in dead stems of the royal palm, *Oreodoxa regia*. In East Negros, however, numerous larvae, pupae and adults occurred in sugar cane. This infestation was easily detected because the affected stalks were torn up in places by rats, which apparently fed on the insects. Two further enemies of the species became known: a capsid bug preying on the eggs, and a Larrid wasp.

T. sacchari Mshl., 1932, was described from beetles bred from stems of sugarcane in Burma.

T. dipterocarp MSHL., 1928 is recorded as a borer in the wood of a *Dipterocarpus* and a *Swintonia* (BEESON 1941) and *T. balwanti* Mshl. as a borer in the stem of a creeper, both in India. These occurrences appear to differ from the main association of the Rhynchophorinae with Monocotyledons.

Sitophilini

Polytus mellerborghi (BOH., 1838), is a small greyish-black species, 3.4—4 mm long (excl. rostrum). It was characterized by ZIMMERMAN (1942 p. 144) as an almost tropicopolitan weevil feeding in the corms of banana plants. It has been described originally from Java, but, curiously enough, only few specimens are to be found in the collections of Indonesian Coleoptera in the Netherlands museums; nor is it mentioned in the local literature on economic entomology, although the fauna of healthy and diseased *Musa* spp. has had much attention, particularly in Java and Sumatra. In the Philippines the beetles have been found also in cane stalks (UICHANCO 1928).

Sitophilus oryzae L., 1763, the very well known rice-weevil and corn-weevil. I may be allowed to mention in passing that the beetles can travel some distance on the wing and may be met with on flowers. In the forests of Central Java they have been observed repeatedly as visiting the inflorescences at the tops of teak (*Tectona*) trees up to 20 m high (KALSHOVEN 1931). Here they were also found in the inflated calyx of young fruits.

S. linearis HERBST, 1795, 'the tamarind seed-weevil', occurring in various tropical countries. At Bogor, W. Java, it was for the first time found breeding in stored seed of 'asem djawa' (*Tamarindus indica*) in 1918. At Medan, North East Sumatra, it was once found in a shed where tobacco leaves were cured, coll. FULMEK 1925.

Recently it was imported together with tamarind pods into the Netherlands from Curaçao (WIEBES, 1961).

Diocalandra frumenti FABR., 1801, 'the four-spotted coconut weevil', 5—7 mm in size; well known all over South East Asia and the Pacific Islands. In Java the beetle and its larvae were first reported as occurring in young fruits of coconut which had been spoilt by the Pyralid borer, *Tirathaba rufivena* and in the petioles of the same palm which had been stripped of

the rind (used for plaiting by the native population) in Besuki (KEUCHENIUS 1915). A few years later it became known that they were to be found in numbers in the core of felled trunks of *Cocos nucifera*, and that the dying parts of standing living trees sometimes were riddled with their tunnels. Thereby the weevils were attracted to the cross sections of newly cut petioles (LEEFMANS 1920).

In India larvae and adults have occasionally been found in semi-decomposed leafbases of *Borassus flabelliformis* (FLETCHER 1922). In Malaya it has been observed that the weevils are attracted by the fermenting sap of the fruit bunches of the nipah palm, *Nipa fruticans* and by the exudation on the inflorescences of this palm (CORBETT 1935 p. 117). The beetles have also been collected from the royal palm, *Oreodoxa regia*, in Malaya (MILLER 1932 p. 12) and in Hawaii (ZIMMERMAN 1942 p. 145), and from *Areca catechu* in Langsa, North Sumatra, June 1940.

Somewhat aberrant occurrences of the species reported are: on rotting palm fibre and on ear-heads of *Sorghum* in India (R. AYYAR 1922), and in a stored pharmaceutical product 'Rhizoma galangae' (= *Alpinia officinarum*), probably originating from the East Indies and imported into Germany (VAN EMDEN, 1923). Although in the latter case only dead beetles and larvae were found the extensive galleries and the exit-holes showed that the weevil had successfully bred in the material.

In West Java the larva is parasitized for 35—40% by *Spathius apicalis*. The Histerid *Plaesius javanus* and its larvae and the maggots of the Leptid *Chrysophilus ferrugineus* have been observed to prey upon the *Diocalandra* larvae (KALSHOVEN 1951).

D. rugosula (PASC., 1885), described from New Guinea. The Zoological Museum, Amsterdam, has a series of these beetles (det. MARSHALL), 3.5—5 mm in size, labelled 'in decaying *Caryota* sp.', Sumatra, Fort de Kock (now Bukit Tinggi), 920 m, coll. E. JACOBSON, 1924.

Myocalandra exarata BOH., 1838, is another wide-spread and fairly common species in Indonesia and neighbouring countries. In Java it has been found in dry bamboo at Bogor, March 1936, June 1937; boring in the pith of split rattan cane at Singaparna, July 1936; and on the bark of *Acacia decurrens* infested by the *Corticium salmonicolor* fungus, in a forest plantation on Mount Tangkuban Prah, February 1937.

FLETCHER (1916) has recorded the species as riddling a newly constructed fence formed of strips of bamboo, the weevils being attracted in large numbers by the newly cut wood, in Ceylon. BEESON (1941) mentions it as boring in living bamboo which had been primarily attacked by the Hispin *Estigmene chinensis*, and he gives several particulars of the weevil's way of living in the weakened tissues.

Microspathe fuliginosa PASC., 1885. The slender beetles visited the flower heads of *Eupatorium pallescens* at Tapos, South West slope of Mount Gedé, West Java, November—December 1932.

Timiotatus longicollis PASC., 1885. Several specimens of this slender beetle, ranging in size from 4—7 mm, were bred from dead parts of a rattan palm, received from Banyuwangi, East Java, February and May 1936.

Trypsetus incarnatus GYLL., 1938, the pod-borer of the *Pithecolobium lobatum* fruit tree with its strongly smelling seeds, was investigated by VAN DER GOOT (1940) in West Java. The insect lives on wild and cultivated trees of this species in the teak area of Central Java, as has repeatedly been observed at the field laboratory for Forest Entomology at Gedangan, January 1925—December 1932.

DISCUSSION

Host-selectivity of the Rhynchophorinae

The preceding survey shows that most of the Oriental Rhynchophorine species with known food-plants have their hosts among the Monocotyledons, particularly the Palmae, the Zingiberaceae/Musaceae (= Zingiberales), and to a lesser extent the Graminaceae. Right here it may be stressed that only the tree-like representatives of these botanical groups serve as hosts. The Zingiberales are herbaceous but here we find the insect in the pseudo-stem formed by the long leaf-sheaths. Among the Graminaceae they attack the Bambuseae with their woody stems, and tall grasses like *Saccharum*.

That the Rhynchophorinae present an important group in the fauna of the Palmae has already been pointed out in the remarkable book 'Les Insectes des Palmiers', in which LEPESME and his collaborators have compiled and elaborated an enormous number of data from all over the world. In the diagram of the insect population of palm trees (p. 120/121) the *Rhynchophorinae* together with the *Cossoninae* are figured as secondary insects living on the trunks. The present paper gives many supplementary notes on these palmicole habits of the Rhynchophorinae. Our study further confirms the opinion of LEPESME c.s. that these weevils are not limited in their occurrence to a single species or genus of the Palmae but apparently use representatives of different genera as hosts. They may therefore be regarded as oligophagous or sub-polyphagous. The same holds good for the Rhynchophorinae associated with other plant families. The Pandanaceae also rank among the host plants of Indomalayan *Rhynchophorinae* for MUIR (1916 p. 6, 69) encountered many larvae of a beetle borer, 'probably a *Rhynchophorus*' in the branches of a *Pandanus* in West Borneo, which, however, he did not succeed in hatching out. The same scientist (ibid. p. 77), in search of *Rhabdoscelus obscurus* and its parasites in Amboina, found a large black borer, different from the weevil just mentioned, in *Pandanus*. In this connection is of much interest that a *Diathetes* sp. (subtribus Calandri) has been described as a major pest of *Pandanus* on the Fiji Islands (ZIMMERMAN 1939). This genus is represented by many species in the Moluccas and in New Guinea, but does not occur in Borneo. For Java we have DRESCHER's records of species said to have been captured on *Pandanus*, but these observations have not been substantiated.

As far as we know only the Rhynchophorine genera *Sitophilus* and *Trypsetus* have their hosts mainly or exclusively among the Dicotyledons. These genera have another main characteristic, viz. that they exclusively comprise seed-borers. Besides the species listed in our survey the following species occurring in various tropical countries may be mentioned in this respect: *S. glandium* Mshl., *S. rugicollis* Casey, *S. vateriae* Mshl. (cf. BEESON 1941), and *S. rugosus* Thunb. (see SCHEDL 1960).

Portions of the host-plants used by the weevils

The parts of the plants utilized for breeding places consist of (1) the rather soft inner portions of trunks and petioles of *Palmae*, (2) the tops of sprouts and buds of palms and bamboos, (3) the core of stems, and the rhizomes and corms of *Zingiberales*, and finally (4) fruits and seeds. All these parts are rich in nutritious matter, even in many cases providing food for men and higher animals (viz. sago, palmite, bamboo sprouts, grains).

With regard to the palms my survey shows that we may add another subdivision to the eight 'milieux biologiques' mentioned by LEPESME as constituting special biotopes for different insect groups, viz. the sprouts growing on budding stools. This biotope has some special features but it may be considered as a subdivision of the biotope formed by the heart or growing point of the crown ('le bourgeon terminal') of high palm-trees, indicated by LEPESME as the only really vulnerable portion of the trees. The weevils that attack and destroy these parts, as well as palm seedlings with tender stems, are more or less primary in their habits, and they are apparently more restricted (oligophagous) in their host preference.

Biological groups among the Rhynchophorinae

Outlining more precisely which ecological groups can be distinguished, I have come to the following scheme:

(a) Species with secondary habits:

- (a 1) Species which live as borers in dead trunks and other decaying parts of *Palmae*. They belong in the genera *Diocalandra*, *Myocalandra* and *Timiostatus* which are placed close together in the subtribus *Sitophilini* in CZIKI's systematic arrangement.
- (a 2) A species with similar habits but feeding on old decaying *Musaceae*, *Odoiporus longicollis* (*Calandrini*). Perhaps *Polytes mellerborgi* (*Sitophilini*) should be included in this category.
- (a 3) A species less discriminating in its choice of the decaying host is *Trachoropalus strangulatus* (*Calandrini*), found mainly in *Palmae*, but also in *Musa* and *Saccharum*.

(b) Species with more or less primary habits:

- (b 1) The weevils start their activities in dead or decaying parts of living *Palmae* but their brood is able to penetrate into originally healthy tissues, thereby sometimes affecting the condition of the host. This kind of 'wound parasitism' is found in *Rhynchophorus* (*Rhynchophorini*).
- (b 2) The adult weevils feed and oviposit on young tops, sprouts and seedlings, thereby damaging the originally healthy plant to such an extent that the larvae can develop in severed and decaying tissues. This is the case in *Protocerius* and *Omotemnus* spp. which live on the sprouts of low-growing and recumbent *Palmae*. The adults are equipped with a very long, needle-like rostrum with which they pierce the tops and can even reach sprouts of very spiny palms, which are difficult of access. *Macrochirus* probably also belongs to this group.

- (b 3) Species with similar habits but living in the sprouts of *Bambuseae*, the adult weevils piercing the bracteae that cover the tops. They include the nearly related genera *Cyrtotrachelus* and *Otidognathus* (*Rhynchophorini*)
- (b 4) Several medium-sized species, the life history of which is insufficiently known but probably with habits similar to those of the preceding group and all associated with *Palmae*: *Ommatolampus* (*Ommatolampini*), *Tetratopus*, *Poteriophorus*, *Rhabdoscelus* (in part) and perhaps *Cercidocerus* (in part) (*Calandrini*).
- (b 5) Species which attack living *Pandanus* plants like *Diathetes* sp. of the Fiji Islands. Other species of this genus may well have the same hosts.
- (b 6) Species mainly associated with the *Zingiberales* and living in the stems, rhizomes and corms: *Sphenocorynus*, *Prodiocetes*, *Megaproctus* (*Sphenocorynini*) and *Cercidocerus* (in part) of the *Calandrini*.
- (b 7) Species less exclusive in their association with *Palmae*, *Zingiberales* or other plant families: *Rhabdoscelus* (in part) of the *Calandrini* (and *Polytes* of the *Sitophilini*?).
- (b 8) The carpophagous species belonging to *Sitophilus* and *Trypsetus*, both *Sitophilini* but placed far apart in the sequence adopted by CZIKI.

Of course, the scheme is artificial and some species occupying intermediate positions outlined here may still be found.

Congruences and discrepancies between the ecological and taxonomic groups.

For this comparison CZIKI's systematic arrangement is again followed here.

From an ecological point of view the *Rhynchophorini* appear to present a rather uniform group, being completely composed of large weevils which visit the living parts of *Palmae*, and a few interrelated genera similarly holding to *Bambuseae*.

As far as the association with *Palmae* goes there are affinities between the *Rhynchophorini* on the one hand, and the *Ommatolampini* — a subtribus only including four genera, — and the *Calandrini* on the other.

The *Calandrini* form an extensive group with more divergent, secondary as well as primary habits. Their hosts in the Indomalayan region include the *Palmae* and the *Zingiberales*. Neotropical genera like *Scyphophorus*, *Cactophagus* and *Metamisus* appear to be associated with *Agavales*, *Bromeliales*, *Cactales* and *Zingiberales*, and probably with other plant groups. In Australia *Trichonorhynchus rugosus* is associated with the archaic looking grass tree (*Xanthorrhoea*, fam. *Liliaceae*) and the Fijian *Diathetes* has *Pandanaceae* as hosts. All these hosts, however, belong to the *Monocotyledons*.

The *Sphenocorynini* are predominantly associated with *Zingiberales* and therefore again form an ecologically distinct group. However, the genus *Periphemus*, living on *Bambusaceae*, rather stands apart.

Finally the *Sitophilini* include two different ecological groups, viz. several genera with clearly secondary habits, their hosts occurring among the Palmae, and two carpophagous genera frequenting several Dicotyledons and a few Graminaceae.

The various genera appear to include species of similar habits, with the exception of *Cercidocerus* and *Rhabdoscelus*, which are rather heterogeneous.

All things considered there is, with few exceptions, a satisfactory correlation between the morphological and the ecological characters.

Evolutionary trend in Rhynchophorinae

A few tentative remarks may be made concerning this speculative subject, in the same way as it was done before for the Indo-malayan *Hispinae* (KALSHOVEN, 1957).

The saprophagous habit as found in some genera of the *Sitophilini* may be looked upon as a primitive character, in my opinion. The ability to attack living plants requires further specialization, for the insect has to become adjusted to the particular morphological structure of the host as well as to the chemical components and the sap content of the host's tissues. It is interesting to see that some intermediate (transitory) stages between truly secondary and primary occurrence have been found where species behave as wound parasites or where the plants are damaged and weakened by the parent beetles so that they become better suited for the development of the brood.

The borers in dead trunks and stalks may have developed from a more indifferent saprophagous stock already living on the hosts. As tissues used for breeding dry up, some adaptation on the part of the insects to a low sap-content of the medium becomes necessary.

The development into primary borers in stems of herbaceous plants appears to be a small step, particularly so where senescent and declining plants are used for breeding.

Primary attack to woody plants by *Rhynchophorinae* is confined to buds, sprouts and seedlings. It does not occur directly on the trunks of living palm trees and the mature bamboo culms. The core of the palm trunks, often rather soft, is only reached via wounds and vulnerable points in the crown. This is very different from the development into borers directly affecting the trunks and branches of Dicotyledon trees as has not seldom occurred in other families of *Coleoptera*. Here the borers have to pierce a more or less thick and fibrous bark, often containing defensive substances. Moreover the wood of the trees is often rather hard and it contains its own preservative substances which counteract the deterioration by organisms of various kind. Therefore, in these cases, we may conclude to much more 'reciprocal selection' to have taken place than in the Rhynchophorine wood borers and their hosts.

The carpophagous habit is certainly a further 'progressive' specialization needing several adjustments, for instance a reduction in size, an ability of the adult weevil to perforate a hard or leathery shell, and the larva being content with little moisture in the food. It often involves the gradual adaptation to living under the dry atmospheric condition of storage. Though the latter suggests a development of the carpophagous genera

from saprophagous ancestors, it is more likely that they represent a more specialized form of boring into tops, buds and sprouts, a habit which is found in so many *Rhynchophorinae*. However, no transitional stage is known between the highly specialized carpophagous forms and the last named ecological group.

As a general conclusion it may be suggested that the *Rhynchophorinae* as a whole during long geological periods have lived as saprophagous and phytophagous species on Monocotyledons, The adoption of Dicotyledons as hosts may be regarded as a more recent development.

ACKNOWLEDGMENTS

The preparation of this paper was begun at a time I still enjoyed an annual subsidy of the Netherlands Organization for Pure Research (Z.W.O.). Its completion was facilitated by a grant I received from the Uyttenboogaart-Eliassen Stichting.

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