

## FOREST TREE AND TIMBER INSECT PESTS IN THE TERRITORY OF PAPUA AND NEW GUINEA

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*Abstract:* This is the first comprehensive paper listing the insect pests of commercial forest trees and timbers in the Territory of Papua and New Guinea. Notes on the species distribution, biology and control are given, when possible, together with known records of collection in the Territory. In all, 52+ species are listed, with the following orders represented: Coleoptera (21), Hemiptera (8), Hymenoptera (3), Isoptera (14+), Lepidoptera (5), and Orthoptera (1).

Forests cover more than 70 % (32 to 36 million hectares) of the total area of Papua & New Guinea Territory, and of that area at least 8-12 million hectares have considerable industrial potential. The approximate total of the already investigated resources is 2.6 million hectares carrying some 6,100 million superficial meters of merchantable timber, which represents approximately 25 % of the known merchantable forests of Papua and New Guinea (Anon. 1967). Production in 1965-1966 was more than 41 million superficial meters as compared with 5.5 million superficial meters in 1950-1951.

The Department of Forests has undertaken a reforestation program of harvested productive forests and of rehabilitating low value forests and grasslands since 1948. Major plantations are being established at Brown River, Bulolo, Kerevat and Wau (see map 1). The main species planted are as follows: Hoop pine (*Araucaria cunninghamii* Ait.), Klinki pine (*Araucaria hunsteinii* K. Schum.), Teak (*Tectona grandis* Lin.), Kamarere (*Eucalyptus deglupta* Blume), and *Pinus* spp. Except for Teak and *Pinus*, these species are indigenous to the Territory. The areas planted as of May 1967 are given in Table 1.

Table 1. Plantation areas in the Territory of Papua and New Guinea as of May 1967.

Species	Locality	Hectares planted
Hoop pine	Bulolo/Wau	4,058
Klinki pine	Bulolo/Wau	1,120
Teak	Brown River	726
Teak	Kerevat	630
Kamarere	Kerevat	311
<i>Pinus</i> spp.	Highlands	92
Miscellaneous	All centres	112
Total net		hectares 7,091

Subsequently, with the relatively great increase in timber production and in reforestation there has arisen a number of forest and timber insect problems. Previously, the Entomology Section, Department of Agriculture, Stock and Fisheries (D.A.S.F.) assisted the department with its entomological problems until the establishment of a Forest Entomology Section in 1966.

There has been very little research carried out on forest and timber insect pests in Papua and New Guinea. The biology and control of *Coptotermes elisae* (Ardley, et al. 1964), was studied by Mr J. Ardley, Formerly Entomologist, D. A. S. F., Lae, Mr J. H. Barrett, Formerly Entomologist, D. A. S. F., Aiyura, Mr L. T. Clifford, Department of Forests, Bulolo, and Mr F. J. Gay, Division of Entomology, C. S. I. R. O., Canberra. The biology and control of *Vanapa oberthuri* (Szent-Ivany & Womersley, 1958) was studied by Mr J. H. Barrett, Mr R. S. Carne, Agronomist-in-Charge, Highlands Agricultural Station, D. A. S. F., Aiyura, and Mr J. S. Womersley, Chief of Division of Botany, Department of Forests, Lae,

This paper considers insect pests that have caused some loss in increment and/or the death of living plantation trees and destruction of their seed; and in addition, identified pests of log and sawed timbers. Brief notes on their distribution, biology and control are given when possible, as well as collection data<sup>1</sup>. Since little is known about the biology and control of many of the insects mentioned under Territory conditions, references are supplied in which these are discussed.

The species considered in the paper are arranged alphabetically by order, family, genus and species. The host plant records, localities and districts (see map 1 for boundaries) in which the specimens were collected are included and arranged chronologically. The following abbreviations are used: for collectors - A. C. (A. Catley), J. H. B. (J. H. Barrett), F. C. (F. Coppock), B. G. (B. Gray), and Sz-I (J. J. H. Szent-Ivany); for districts - C. D. (Central District), E. H. D. (Eastern Highlands District), M. D. (Morobe District), N. D. (Northern District), S. H. D. (Southern Highlands District), W. H. D. (Western Highlands District), and W. D. (Western District).

## A. COLEOPTERA

### Bostrychidae

#### 1. *Dinoderus minutus* Fabricius

COLLECTIONS: Boring in stem of *Bambusa* sp., Port Moresby, C. D., 22. I. 1959 (A. C.). In log of *Anisoptera* sp., Killerton Beach, N. D., 13. IV. 1960 (F. C.). In stem of *Bambusa* sp., Laloki, C. D., 1. IX. 1966 (B. G.).

DISTRIBUTION AND BIOLOGY: The species occurs in most tropical countries.

#### 2. *Heterobostrychus aequalis* Waterhouse

COLLECTIONS: In softwood case, Rabaul, New Britain D., 15. VIII. 1957. (G. S. Dun). In timber floor of *Pometia pinnata*, Port Moresby, C. D., 10. II. 1959 (A. C.). In sawed timber of *Anisoptera* sp., Lae, M. D. 9. I. 1964 (J. S. Colwell). In log of *Syzygium* sp., Madang, Madang D., VII. 1966 (D. Reed).

1. The data are sometimes incomplete owing to the loss of many of the earlier pre-war records in the D. A. S. F. Repeated collections from the same host and locality are not included.

DISTRIBUTION AND BIOLOGY: *H. aequalis* ranges over East and SE Asian Islands. Froggatt (1927) gives a brief description and some notes on the species.

### 3. *Sinoxylon anale* Lesne

COLLECTIONS: Boring in softwood structural timber, Port Moresby, C. D., 27. I. 1959 (J. S. Colwell).

DISTRIBUTION AND BIOLOGY: The species occurs in several East Asian countries. Froggatt (1927) gives a brief description and notes.

### 4. *Xylothrips religiosus* Boisduval

COLLECTIONS: Port Moresby, C. D., V. 1947 (L. Jones). At lights, Lowlands Agric. Exp. Sta. (L. A. E. S.) Kerevat, New Britain D., 19.VII.1954 (I. Edwards). Bisianumu, C. D., IX. 1955 (Sz-I). Sangara Estate, N. D., 7. XII. 1955 (Sz-I). In light trap, Mamoo Plantation, N. D., 23. III. 1956 (Sz-I). Tapini, C. D., 22. IV. 1956 (R. W. Clark). Biage, N. D., 22. V. 1956 (J. L. Healy). Popondetta, N. D., III. 1957 (Healy). Subitana Estate, C. D., 29. IV. 1957 (J. H. B.). In light trap, Wau, M. D., 29. V. 1957 (Sz-I). At lights, Bainyik Agric. Stat. Maprik, E Sepik D., 18. VI. 1957 (Sz-I). In mercury light trap, Mageri, C. D., VIII. 1957 (E. G. Munroe & Sz-I). Bundikara, Madang D., 6. II. 1958 (Healy). In cut stem of *Pometia pinnata*, Kerevat, New Britain D., XI. 1958 (A. Cameron). Port Moresby, C. D., 27. I. 1959 (J. S. Colwell). In flight, Kerevat, New Britain D., VIII. 1959 (G. S. Dun). Feni Is., New Ireland D., XI. 1959 (G. Carson). Oriomo Agric. Sta., W. D., I-IV. 1960 (G. Rio). Brown River, C. D., 8. III. 1960 (A. C.). In seedlings of *Hevea brasiliensis*, Daradai, C. D., IV. 1960 (A. Eldridge). In log of *Anisoptera* sp., Killerton Beach, N. D., 20. IV. 1960 (F. C.). Haugata Plantation, Popondetta, N. D., IV. 1961 (A. C.). On dead *Eucalyptus* sp., Port Moresby, C. D., 2. VI. 1963 (L. Smee). On foliage of *Theobroma cacao*, Magafin Village near Dagua, East Sepik D., IV. 1964 (Sz-I). In coastal rain Forest near Cape Hoskins, New Britain D., VI-IX. 1964 (P. G. E. Searle). On garden flowers, Popondetta, N. D., 18. XI. 1964 (Sz-I). In plywood *Araucaria* sp., Port Moresby, C. D., 21. I. 1965 (H. H. Stubbs). In *Eucalyptus* sp.- Hohola, Port Moresby, C. D., 2. VI. 1965 (E. Kanjiri).

DISTRIBUTION AND BIOLOGY: *X. religiosus* has a wide range over the Pacific Islands and in the Malay Peninsula. Froggatt (1927) gives a brief description and notes.

## Cerambycidae

### 5. *Diotimana undata* (Pascoe)

COLLECTIONS: In stem of *Araucaria cunninghamii*, Bulolo, M. D., 28. I. 1967 (B. G.); Goroka, E. H. D., 22. III. 1967 (B. G.); Okapa, E. H. D., 16. V. 1967 (B. G.); Kainantu, E. H. D., 20. V. 1967 (B. G.).

DISTRIBUTION AND BIOLOGY: *D. undata* also occurs in northern N. S. W and Queensland. Froggatt (1927) gives illustration, a brief description and notes. In Australia, the species attacks fallen stems and stumps of *A. cunninghamii*, but in the Territory it attacks living trees. Some of the attacks appear to be primary while others are associated with

*V. oberthuri*. More than 50 chambers have been observed in the bole region of severely affected trees which usually die. Many secondary insects invade the attacked trees.

6. **Hoplocerambyx severus** Pascoe

COLLECTIONS: In stem of *Anisoptera* sp., Lae, M. D., 1956 (J. S. Colwell).

Chrysomelidae

7. **Arsipoda** sp.

COLLECTIONS: Dense populations on *Tectona grandis*, Oriomo Agric., Sta. W. D., 30.VII.1960 (Sz-I) (J. J. H. Szent-Ivany, personal comm., 1967).

8. **Rhyparida coriacea** Jacoby

COLLECTIONS: On foliage of *Eucalyptus deglupta*, Goroka, E. H. D., 30. X. 1958 (Sz-I). Gressitt (1963) recorded many collections.

DISTRIBUTION AND BIOLOGY: Szent-Ivany & Stevens (1966) mention that *R. coriacea* caused severe defoliation of *E. deglupta* trees at Wau in 1957 and 1958. Gressitt (1967) illustrates life stages; the larvae recorded from grass roots.

Curculionidae

9. **Barinae** sp.

COLLECTIONS: In seed cone of *Araucaria hunsteinii*, Bulolo, M. D., 29.VIII.1967 (J. Thompson).

DISTRIBUTION AND BIOLOGY: The weevil honeycombs extensively the cones of *A. hunsteinii* seeds in the virgin forest (Havel 1962). Up to 30-40% of the seed may be damaged; the damage varies considerably from area to area in the Wau-Bulolo area (J. Thompson, pers. comm., 1967).

10. **Oribius cruciatus** Faust

COLLECTIONS: Szent-Ivany (1959) listed many collections. On the leaves of *Tectona grandis*, Dept. of Forests nursery, Brown River, C. D., 9.VII.1957 (Sz-I & M. L. Szent-Ivany).

DISTRIBUTION AND BIOLOGY: Marshall (1956) gives a description and records the species as being endemic to the Papuan region. Recently, the species has been observed in the Wau-Bulolo area by the author.

11. **Oribius destructor** Marshall

COLLECTIONS: Marshall (1957), Szent-Ivany (1958, 1959, 1961, 1965) and Szent-Ivany & Catley (1960b) recorded several collections. Feeding on foliage of *Eucalyptus deglupta*, Goroka, E. H. D., 21. I. 1965 (Sz-I). On branchlets of *Araucaria cunninghamii* seedlings, Okapa, E. H. D., 21. III. 1967 (B. G.); Kainantu, E. H. D., 7. VI. 1967 (B. G.).

DISTRIBUTION AND BIOLOGY: The species is polyphagous and occurs throughout much of

the Highland region of New Guinea. At Okapa and Wabag, *O. destructor* had severely defoliated some *A. cunninghamii* seedlings in the Dept. of Forests nurseries. Marshall (1957) gives a description and some notes.

#### 12. *Oribius inimicus* Marshall

COLLECTIONS: Dense populations feeding on foliage of *Eucalyptus deglupta*, Kandep, W. H. D., 12. II. 1964 (Sz-I & F. J. Simmonds). (J. J. H. Szent-Ivany, pers. comm., 1967).

DISTRIBUTION AND BIOLOGY: The species has only been found in the Eastern and Western Highland Districts where it is a major pest of *Coffea arabica* (Szent-Ivany 1958, 1961, 1965). Barrett (1966) gives some notes on the species.

#### 13. *Oribius* sp.

COLLECTIONS: Causing some shot-hole damage to seedlings of *Tectona grandis*, Oriomo Agric. Sta., W. D., 13. X. 1960 (Sz-I). On branchlets of *Araucaria cunninghamii*, Okapa, E. H. D., 21. III. 1967 (B. G.). On leaves of *Crotalaria anagyroides*, Okapa, E. H. D., 17. V. 1967 (B. G.).

DISTRIBUTION AND BIOLOGY: At Okapa, the species in association with *O. destructor* had caused considerable damage to a few *A. cunninghamii* seedlings.

#### 14. *Vanapa oberthuri* Pouillaude Fig. 2a-e.

COLLECTIONS: In stem of *Araucaria cunninghamii*, Aiyura, E. H. D., 4. III. 1960 (J. H. B.); Kainantu, E. H. D., 18. I. 1962 (J. H. B. & K. Anesbury); Goroka, E. H. D., 2. III. 1962 (J. H. B. & G. N. Vickers); Bulolo, M. D., 16. III. 1962 (E. C. Gray); Black Cat near Wau, M. D., 13. II. 1966 (R. M. Stevens); Okapa, E. H. D., 16. V. 1967 (B. G.).

DISTRIBUTION AND BIOLOGY: The weevils seems to be distributed in random pockets in the planted and natural stands of *A. cunninghamii* in the Eastern Highlands and Morobe Districts; in some areas, such as Goroka and Kainantu, it is in most of the small stands of planted trees and has killed many of them.

The note below on the length of the life cycle was extracted from a departmental report submitted by Mr J. H. Barrett. The egg stage takes about 10 days, larval stage 5 months, pupal stage 1 month and the adults probably live up to 6 months. The eggs are creamy in color and between 3-5 mm in length (fig. 2a). They are laid in the outer bark, often in the node region, usually in a crevice or on the margin of a resin flow; they are also laid in the internode region under loose bark. The eggs are covered with a cement layer of masticated bark or by resin and bark. More than 1 egg may be laid in an egg-laying site.

The newly hatched larvae excavate a tunnel into the cambial region. On reaching the 3rd stage, after roughly 5 weeks, the larvae enter the fibrous bark and wood to a depth of up to 5 mm. The gallery extends vertically and, then curves laterally for up to 5-10 centimeters; it is occasionally branched. After 5 months or so a hole, the pupal chamber, is dug into the wood to a depth of 3-8 centimeters; it extends upwards and then outwards in a rough semi-circle. The vertical portion is plugged with thin slivers of wood, 1-2 centimeters in length; these are cut out from the sides near the entrance.

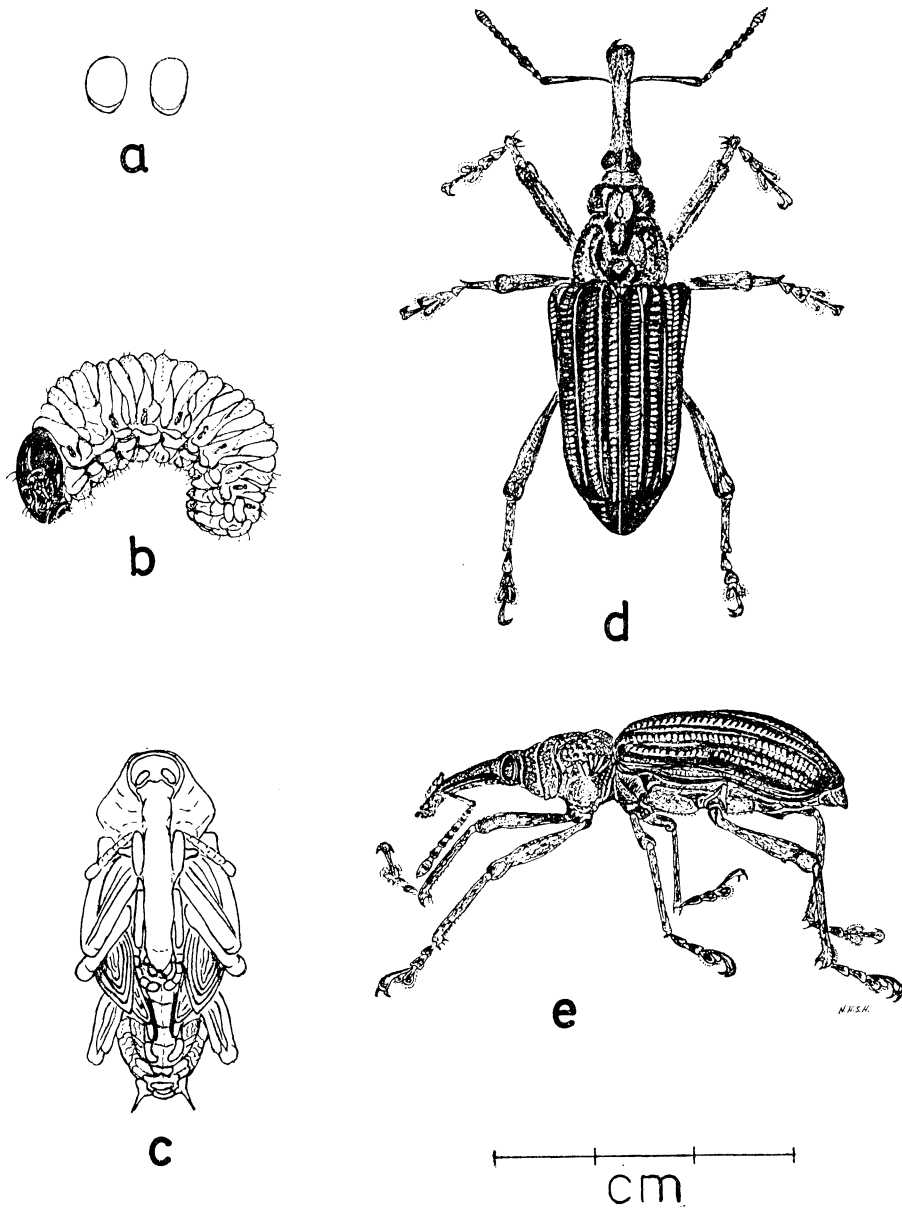


Fig. 2. Stages in the life history of *Vanapa oberthuri* Pouill.: a, egg; b, larva; c, pupa; d, dorsal view of adult; e, lateral view of an adult.

The emergence hole ranges in diameter from between 8 to 20 mm depending on the size of the adult.

The adults are shiny black with a very long rostrum (fig. 2 d-e). They are large, varying in length from 2-6 centimeters. They are commonly found in the upper branches of *A. cunninghamii*; in 1 tree, about 10 m high, 17 adults were collected on 17. IX. 1967. Two pairs of these adults were observed mating at a height of 3 m. In an area of 0.8 hectares being thinned adjacent to the Bulolo Forestry Office, some 200-300 adults were collected in 3 days under the fallen logs and debris; few trees had been attacked in this area.

*V. oberthuri* was first reported in *A. cunninghamii* plantations at Aiyura in 1940, and at Bulolo in 1951. The trees are attacked in small groups. Up to 100 chambers may be made in a single tree and these trees usually die; however, the healthy ones sometimes survive when the larvae are drowned by the resin flow. Several secondary insects are associated with the attack, these hasten the death of the trees considerably.

CONTROL: Barrett (departmental report, 1963) mentions that an elaterid larva may be a predator of *V. oberthuri* larvae. Control measures presently used in the plantations aim at destroying the population in affected trees. These are cut down and debarked, and the pupal chambers destroyed. Allowing the barked trees to lie on open ground normally ensures the death of all individuals.

#### Platypodidae

##### 15. *Crossotarsus mniszehi* Chapuis

COLLECTIONS: Kikori, Gulf D., (G. N. . . ., W. W. Froggatt). In cut stem of *Pometia pinnata*, Brown River, C. D., 11. VI. 1959 (E. Kanjiri).

DISTRIBUTION AND BIOLOGY: The species also occurs in the Malay Archipelago and Australia.

##### 16. *Platypus jansonii* Chapuis

COLLECTIONS: In stem of *Hevea brasiliensis*, Koitaki Estate, C. D., 18. III. 1956 (Sz-I); Subitana Estate, C. D., VI. 1957 (J. H. B.). In stem of fallen *Artocarpus incisa*, Baubauguina via Abau, C. D., 10. VI. 1959 (B. G. Griffiths and A. C.). In stem of *Hevea brasiliensis*, Itikinumu Estate, Sogeri, C. D., 31. VII. 1963 (Sz-I, L. Smee & E. Kanjiri). In commercial timber kept in salt water for a long period, Bamguina River area, Abau, C. D., 3. XI. 1963 (H. Booth). In stem of *Hevea brasiliensis*, Bisianumu Agric. Exp. Sta. C. D., 13. I. 1964 (A. J. H. van Haaren). In logs of *Polyalthis* spp. and *Planchonella* spp., Wewak, East Sepik D., XI. 1965 (E. Fitzgerald).

DISTRIBUTION AND BIOLOGY: Recorded from the Celebes, Moluccas, Philippines, Solomons, New Hebrides, Admiralty Is., Bismarck Arch., and Australia. Froggatt (1927) gives a brief description.

##### 17. *Platypus selysi* Chapuis

COLLECTIONS: Kokoda, C. D., VIII. 1933 (L. E. Cheesman). In stem of *Hevea brasiliensis*, Sangara Estate, C. D., 7. XII. 1955 (Sz-I); Koitaki Estate, C. D., 18. III. 1956 (Sz-I). In log of *Pometia pinnata*, Brown River, C. D., 11. VI. 1959 (E. Kanjiri). In stem of

*Hevea brasiliensis*, Kokoda, N.D., 18. II. 1960 (G. Gaskell); Itikinumu Estate, Sogeri, C. D., 31. VII. 1963 (Sz-I, L. Smee & E. Kanjiri).

DISTRIBUTION AND BIOLOGY: So far restricted to New Guinea.

18. **Platypus solidus** Walker

COLLECTIONS: In tapping area of *Hevea brasiliensis*, Itikinumu Estate, Sogeri, C. D., 31. VII. 1963 (Sz-I, L. Smee & E. Kanjiri).

DISTRIBUTION AND BIOLOGY: The species is widely distributed throughout the Indo-Malayan region, Formosa, Philippine Is, Japan, Korea, Guam, Aru I., Mariana I. and Australia. Browne (1961) gives details of the species biology.

Scolytidae

19. **Hylurdretonus araucariae** Schedl Fig. 3a-e.

COLLECTIONS: In branchlets of *Araucaria cunninghamii*, Wau, M. D., II. 1963 (K. J. White); Henganofi, E. H. D., 7. VI. 1967 (B. G.); Chuave, Chimbu D., 9. VI. 1967 (B. G.); Kundia-wa, Chimbu D., 13. VI. 1967 (B. G.); Wonenara, E. H. D., 24. VI. 1967 (B. G.); Erave, S. H. D., 16. VIII. 1967 (B. G.).

DISTRIBUTION AND BIOLOGY: *H. araucariae* is most probably distributed sparsely in the larger natural stands of *A. cunninghamii* throughout the Territory, and possibly in West Irian. The species is very small, 1.6-2.2 mm long, and black (fig. 3 d-e). It is different from *Hylurdretonus piniarius* Schedl, the only other species in the genus, for the latter bores into the stem cortex of *A. cunninghamii* and *Araucaria bidwilli* trees in Queensland (Brimblecombe 1953).

Dr J. J. H. Szent-Ivany collected several branchlets in 1963 from Wau and bred adults from these in air-conditioned premises at Konedobu. Recent studies show the life cycle to be very short, taking from 3 to 6 weeks. Larvae have been found 8 days after initial infestation, pupae 17 days after and immature adults 24 days after. It is doubtful whether there is much variation in the length of the life cycle, owing to the almost constant monthly temperatures in the Territory.

All stages—eggs, larvae, pupae, immature adults and mature adults—are found together in the branchlets. The size of the community varies considerably; the largest counted to date had 62 individuals (51 eggs and 11 adults), and the next largest 58 individuals (16 larvae, 19 pupae, 15 immature adults and 8 adults). The average size community consists of between 10 and 15 individuals. There appears to be considerable variation in population size from area to area. For example, in April 1967 counts of the number of individuals in 250 branchlets taken from 25 trees in small sample areas were 4210 individuals in Taun L. A., Bulolo and 2291 individuals in Andersons L. A., Wau.

The eggs are usually laid in the partly hollowed out needles or at their base; occasionally, an egg or a few eggs are found in the needles amongst the frass. They are often laid in batches of 4 to 10; in 1 branchlet 51 eggs were present. The eggs are white, ellipsoidal and 0.6-0.9 mm in length (fig. 3a).

The adults burrow first into the needles close to their junction with the branchlet; sometimes they burrow in a distance from the base. A small entrance hole, about 0.5 mm



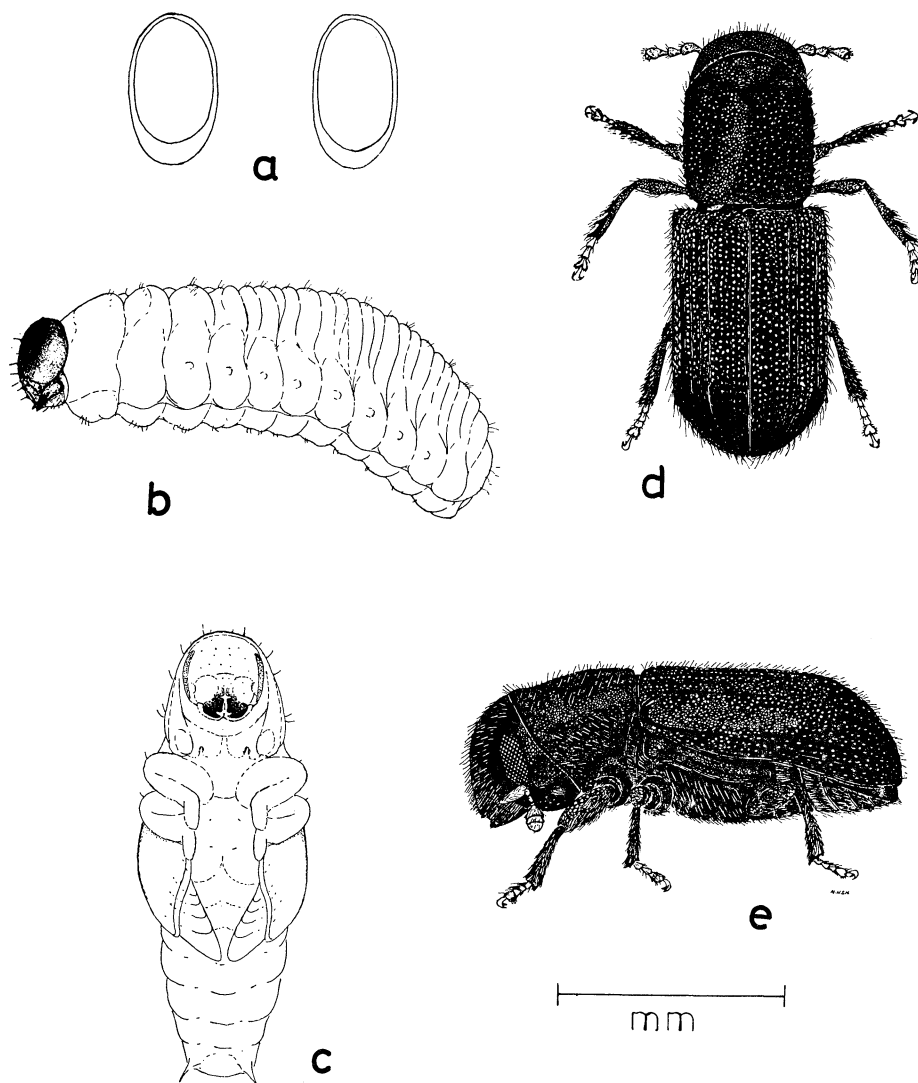


Fig. 3. Stages in the life history of *Hylurdretonus araucariae* Schedl: a, egg; b, larva; c, pupa; d, dorsal view of adult; e, lateral view of adult.

in diameter, is made and much frass is extruded through the entrance. Usually, the middle or lower portion of the branchlet is infested first. A branchlet may be infested several times. Owing to the presence of leaf bracts, and not needles, on *A. hunsteinii* branches, *H. araucariae* rarely infests the species successfully since the adults cannot burrow into the thin leaf bracts.

The frass accumulates inside the branchlet as the larvae and adults masticate the tissue. When they are finished only a skeleton of epidermal tissue and most of the woody core

remains. In old infested branchlets, the larger-sized larvae, pupae and immature adults are found towards the rear while the eggs, smaller larvae and adults are found at the front. Sometimes dead adults are found at the rear, near the entrance.

In previously uninfested plantation areas, several hundred trees may exhibit signs of initial attack. This is identified by the light brown discoloration of a few branchlets on the trees. The attack is very random on the trees but, later, a pattern emerges. The lower crown is severely infested at first, then the middle and upper crown regions and finally the leader. Much of the foliage dies and falls off, and the foliage changes color from green to brown black or brown gray. On some trees the upper crown has been severely affected first. There is often considerable coppice growth on defoliated trees and less vigorous trees mostly die after 2-6 years of severe attack. Most trees that survive display very poor form. All trees in a plantation area are eventually affected.

The remnant *A. cunninghamii* adjacent to the plantation provided the adults responsible for the infestations. This is strongly suggested by the following evidence: a/ the species has only been collected off *A. cunninghamii* in the virgin forest; and b/ no attacks have been observed on planted trees more than 3 km away from virgin trees. In contrast to trees in the plantation, no infestations have been observed on *A. cunninghamii* less than 6 m high in the virgin forest. On taller trees in the virgin forest no more than 30 branchlets were found infested on a tree. No predators or parasites appeared to be active.

The incidence of *H. araucariae* in the plantations was first noted in 1960 at Wau, and in 1963 at Bulolo. Initially, there appeared to be a correlation between the infestation and poor site areas. However, this would seem incorrect since all trees in an area become infested, but the less vigorous trees succumb more easily to attack while healthier trees are able to survive longer. Trees less than 2 years old seem capable of resisting infestation since their resin flow drowns the invading adults. Trees producing adult foliage are not severely attacked.

The beetle has dispersed rapidly in the past few years from at least 6 foci into the Wau-Bulolo plantations of which, some 2400-2800 hectares are now affected. There has been considerable mortality in small areas at Wau and a serious loss in increment in over 200-280 hectares Wau and Bulolo. A survey of the mortality and foliage loss was carried out on 6 September 1966. The results are summarized in Table 2.

Table 2. Foliage and mortality loss caused by *Hylurdrectonus araucariae* on *Araucaria cunninghamii*. The sample areas ranged from medium to very heavy infestation.

Sample	20% of foliage on tree dead	20-80% of foliage on tree dead	80% of foliage on tree dead	Tree dead	Total
1	99	153	41	15	308
2	31	52	29	10	122
3	13	70	89	127	299

CONTROL: To date, no control measures have been found for *H. araucariae* in infested areas. The avoidance of new infestations in recently planted areas is being attempted by falling virgin *A. cunninghamii* trees that are adjacent. The growing of non-susceptible tree species and the isolation of future plantings of *A. cunninghamii* have been recommended.

20. **Xyleborus bidentatus** Motschulsky

COLLECTIONS: Samarai, Milne Bay D., 10. VI. 1939 (R. G. Wind).

DISTRIBUTION AND BIOLOGY: The species is widely distributed throughout the tropics in Africa and Asia. Schedl (1962b) gives notes on its biology.

21. **Xyleborus perforans** Wollaston

COLLECTIONS: Finschhafen, M. D., 2 & 12. V. 1944 (E. S. Ross). In sawed timber of *Octomeles sumatrana*, Brown River, C. D., 8. III. 1960 (A. C.). In stem of *Hevea brasiliensis*, Itikinumu Estate, C. D., 31. VII. 1963 (Sz-I, L. Smee & E. Kanjiri).

DISTRIBUTION AND BIOLOGY: *X. perforans* occurs throughout the tropics and in many subtropical countries. Froggatt (1925, 1927) and Browne (1961) give illustrations, descriptions and notes on its biology. The species swarms between 6.30 PM and 10.00 PM almost daily at Bulolo in large numbers. It is a very common borer of timbers in the area.

## B. HEMIPTERA

## Coccidae

22. **Chrysomphalus aonidum** (L.)

COLLECTIONS: Causing severe damage to the needles and stems of *Pinus* seedlings, Dept. of Forests nursery, Bulolo, M. D., 18. IV. 1965 (Sz-I).

23. **Maconellicoccus hirsutus** (Green)

COLLECTIONS: Attacking seedlings of *Tectona grandis*, Dept. of Forests nursery, Konedobu, C. D., 13. IV. 1955 (Sz-I) (Szent-Ivany 1956).

DISTRIBUTION AND BIOLOGY: The species has also been found in the Madang and New Britain Districts, as well as the Central District on *Hibiscus rosa sinensis* and in the Northern District on *Theobroma cacao* (Szent-Ivany 1956; J. J. H. Szent-Ivany, pers. comm., 1967).

24. **Saissetia coffeae** (Walk.)

COLLECTIONS: Szent-Ivany (1956) recorded some collections. On foliage of *Eucalyptus deglupta*, (associated with sooty mold), Popondetta, N. D., 23. V. 1965 (C. J. Choat).

DISTRIBUTION AND BIOLOGY: The species is widely distributed throughout the tropics. Other recorded host plants in the Territory are as follows: *Acalypha* sp., *Camellia sinensis*, *Coleus* sp., *Coffea arabica* and *Plumeria acutifolia* (J. J. H. Szent-Ivany, pers. comm., 1967).

## Coreidae

25. **Leptoglossus australis** (Fabricius)

COLLECTIONS: Szent-Ivany & Catley (1960) record several collections. *Passiflora* sp. Goroka, E. H. D., 7. VII. 1954 (Sz-I). Lowlands Agric. Exp. Sta. Kerevat, New Britain D., 1. VIII. 1954 (I. Edwards). *Coffea arabica*, Ovihaka Plantation, E. H. D., 3. X. 1954 (Sz-I). *Eucalyptus deglupta*, Brown River, C. D., 19. IV. 1955 (Sz-I). *Passiflora foetida*, Lagakot, New Ireland D., 14. VII. 1955 (Sz-I). *Tectona grandis*, Oriomo Agric. Sta. W. D., 29. VII.

1960 (Sz-I); Kerevat, New Britain D., 27.VI.1966 (B. G. & Alikana).

DISTRIBUTION AND BIOLOGY: The species has been recorded from several South Pacific Islands. Szent-Ivany & Womersley (1958) and Szent-Ivany & Catley (1960a) give illustrations, descriptions and notes.

26. **Pternistria levipes** Horv.

COLLECTIONS: Causing considerable damage to the stems of *Tectona grandis* seedlings, Oriomo Agric. Sta. W. D., 29. VII. 1960 (Sz-I).

27. **Pternistria macromera** Guerin

COLLECTIONS: Causing considerable damage by feeding off the stems of *Tectona grandis* seedlings, Oriomo Agric. Sta. W. D., 29. VII. 1960 (Sz-I).

Flatidae

28. **Paratella errudita** Melichar

COLLECTIONS: On leaf of *Eucalyptus deglupta*, Brown River, C. D., 24-25. IX. 1955 (Sz-I).

DISTRIBUTION AND BIOLOGY: In 1955 Szent-Ivany observed a serious outbreak by the species in association with the pentatomid *Austromalaya* sp. and the coreid *Leptoglossus australis* on *E. deglupta*. They had caused considerable defoliation (Szent-Ivany & Womersley, 1958; Szent-Ivany & Catley, 1960a).

Pentatomidae

29. **Austromalaya** sp.

COLLECTIONS: On leaves of *Eucalyptus deglupta*, Brown River, C. D., 24-25. IX. 1955 (Sz-I).

DISTRIBUTION AND BIOLOGY: Details on damage caused by *Austromalaya* sp. to *E. deglupta* were described by Szent-Ivany & Womersley (1958).

C. HYMENOPTERA

Apidae

30. **Lithurge scabrosus** Smith

COLLECTIONS: Lorengau, Manus D., 23. XI. 1951 (C. Goddard). *Pterocymbium beccarri*, Port Moresby, C. D., 19. I. 1961 (N. Munroe). Port Moresby, "17-mile", C. D., IV. 1961 (G. Rio). Nests in rafters, Golden Pine Sawmill, Bulolo, M. D., 6. XI. 1961 (J. H. Ardley).

DISTRIBUTION AND BIOLOGY: The species ranges from India to Tahiti (Michener 1965). The species was damaging *P. beccarri* as a structural timber in a house.

31. **Megachile frontalis** (Fabricius)

COLLECTIONS: Michener & Szent-Ivany (1960) list collections.

**DISTRIBUTION AND BIOLOGY:** *M. frontalis* extends from Celebes across the Moluccas to the Solomon Is. Michener & Szent-Ivany (1960) give the species distribution within and outside the Territory of Papua & New Guinea and notes on its biology. Szent-Ivany & Womersley (1958) report that when *M. frontalis* and *Synthereta janetta* together attack *E. deglupta* the defoliation may be serious.

32. **Xylocopa aruana** Ritsema

**COLLECTIONS:** Damaging timber stocks, Popondetta, N. D., II. 1959 (B. Bergin).

**DISTRIBUTION AND BIOLOGY:** The species is widely distributed in the Papuan Territory and causes considerable damage to untreated softwoods.

D. ISOPTERA<sup>2</sup>

Kalotermitidae

33. **Cryptotermes domesticus** (Haviland)

**COLLECTIONS:** In softwood battens, Konedobu, C. D., 9. II. 1959 (A. C.). In timber, Port Moresby, C. D., XII. 1963 (J. B. McAdam). In plywood panel on ship, Rugen Harbor via Rabaul, New Britain D., 16. III. 1964 (J. R. Masters). In wooden bedframe, Port Moresby, C. D., 17. IX. 1965 (D. L. Cook & D. F. O' Sullivan). In woodwork of building, Kerevat, New Britain D., 24. XI. 1965 (G. S. Dun).

**DISTRIBUTION AND BIOLOGY:** The species is widely distributed in the SW Pacific area. It is commonly found damaging furniture, woodwork in buildings, *C. nucifera* and *Tournefortia* logs (F. J. Gay, pers. comm., 1967).

34. **Glyptotermes taveuniensis** Hill

**COLLECTIONS:** In native softwood, Kurakakaul Plantation, New Britain D., 5. V. 1952 (J. H. B.).

**DISTRIBUTION AND BIOLOGY:** Also found in the Fijian Is. of Taveuni & Viti Levu.

35. **Neotermes schultzei** Holmgren

**COLLECTIONS:** In native softwood, Kurakakaul Plantation, New Britain D., 5. V. 1952 (J. H. B.). In ground, Mendi and Tari, S. H. D., XII. 1955 (D. Johnston)

**DISTRIBUTION AND BIOLOGY:** This species is also known from the Sepik River area of New Guinea (F. J. Gay, pers. comm., 1967).

36. **Neotermes** spp. (Several species)

**COLLECTIONS:** Biage Valley, N. D., III. 1957 (J. Healy). From branch of *Theobroma cacao*, Kerevat, New Britain D., 13. VI. 1957 (J. H. B.). Alate at light, Aiyura, E. H. D., X. 1957 (J. H. B.). In rotting wood, Goroka, E. H. D., Kefano, Goroka, E. H. D., 1. XII. 1958 (J. H. B.). In stem of *Dysoxylum* sp., Wau, M. D., 30. VI. 1959 (J. S. Womersley). Alate at light, Wapenamanda, W. H. D., 21. III. 1960 (J. H. B.). From building, Mt. Hagen, W. H. D., III.

2. For each species Hill (1942) supplies descriptions, distribution data, biology and location of types.

1960 (M. Whiteman). In stem of *Coffea arabica*, Abauri Village, Biage Valley, N. D., 22. X. 1960 (V. Player). In stem of *Theobroma cacao*, Rooke Is., M. D., X. 1960 (E. J. Taanm). From log, Lae, M. D., 19. X. 1961. (J. H. Ardley). Lorengau, Manus I. D., 10. XI. 1961 (P. Herman). From *Theobroma cacao*, Madang, Madang D., 12. XI. 1961 (M. Brooke). From tree, Wewak Point, East Sepik D., 6. XII. 1961 (G. L. Hughes). In stem of *Eucalyptus deglupta*, Lae, M. D., V. 1962 (J. S. Colwell). In rotten stump, Ramu River N of Kainantu, E. H. D., 4. I. 1963 (A. E. Emerson & J. H. B.). Kerowagi, Chimbu D., I. 1963 (J. H. B.). In living *Terminalia* sp., Bulolo, M. D., 20. V. 1963 (L. Clifford). From log, Tari, S. H. D., IX. 1963 (M. Konecny). In house stump, Togaba, W. H. D., 17. III. 1964 (L. Smee). In live *Nothofagus grandis* at Central Nakanai Range, New Britain D., VII. 1965 (E. Hammermaster). In Leguminaceae sp., Lae, M. D., 1. X. 1965 (R. Curtis & K. Mallard).

#### Mastotermitidae

##### 37. *Mastotermes darwiniensis* Froggatt

COLLECTIONS: 1 alate, Lae, M. D., III. 1959 (J. H. Ardley). From an imported log of *Eucalyptus paniculata*, Lae, M. D., 1. VIII. 1961 (J. Beesley). From hardwood logs, Lae, M. D., 6. XI. 1961 (J. H. Ardley).

DISTRIBUTION AND BIOLOGY: The species occurs in Queensland and the Northern Territory of Australia. It was most probably introduced into the Territory from Australia during World War II. *M. darwiniensis* caused considerable localised damage to buildings in Lae. Efforts to eradicate the species by the D. A. S. F. show promise of being completely successful.

#### Rhinotermitidae

##### 38. *Coptotermes elisae* (Desneux)

COLLECTIONS: Gay (1963) recorded most known collections up to 1962. Nest in stem of live *Pometia pinnata*, Brown River, C. D., XII. 1958 (F. C.). Nest in root system of bud-grafted *Hevea brasiliensis*, Bisianumu, C. D., XII. 1964 & 3. VII. 1966 (A. J. H. van Haaren). Mambare River, N. D., collector and date unknown.

DISTRIBUTION AND BIOLOGY: *C. elisae* occurs in West Irian and possibly in the British Solomon Is. as well. J. H. Ardley made a brief study of the biology and control of the species in 1961. F. J. Gay, Division of Entomology, C. S. I. R. O., Canberra, visited Bulolo twice (1961 & 1965), to advise on the problem of *Coptotermes* spp. destroying *A. cunninghamii* and *hunsteinii* trees in the plantations.

The population of *C. elisae* nests can be enormous; large logs, up to 50 m long and 2-3 m in diameter, may be riddled with termites. Mature nests are mainly located in pine trees in the virgin forest. They are situated in a hollow in the taproot or between the roots. The main termitarium is normally found 30-60 cm beneath the ground; in one case, it was 4 m deep. It is oval shaped, usually 80-150 cm long and 35-60 cm wide, and normally in a vertical position in the old taproot. The galleries may extend many meters up the bole, often along an old crack or shake; in one instance, they ran more than 50 m up an *A. hunsteinii* stem.

Situated in the lower part of the nest is a large chamber or "haus queen". It is circular, 5-15 cm in diameter and 2-3 cm high, and flat bottomed with solid walls, 2-6 cm thick. There are often 2 or 3 additional queen chambers above the occupied one. The mature physogastric queen is 2-3 cm long. Winged adult reproductives reach maturity about October and swarm soon after.

It is the colonies left in the old stumps and logs, after logging, burning and clearing operations, that are responsible for the infestations in new plantation areas. Trees in all plantation age groups, from 3 to 18 years old (the oldest), may be attacked, but those 10 years or more may survive. No disease has been found associated with the damage. Two surveys, one completed in 1963 and the other in 1966, to assess the amount of damage are summarized in Table 3.

Table 3. Percentage of termite infested trees in 2 sampled areas in the *Araucaria cunninghamii* plantation at Bulolo.

Area and year	No. of uninfested trees	No. of infested trees	Total counted	% infested
Sawmill Ck. L. A. 1963	24,861	1,791	26,652	7.2 %
Inakanda L.A. L. A. 1966	10,451	330	10,781	3.1 %

Initially, on plantation trees, external runways covered with mud become evident and there are few internal galleries. Subsequently, there is considerable tunnelling into the wood with galleries extending up the core, and mud packing is built around the base and lower trunk. Trees that succumb exhibit yellowing of the foliage and then a gradual browning off of all foliage and wilting. These trees are prone to wind throw and to secondary infestation by insect borers. Usually, a clump of trees is attacked and considerable pockets of dead trees may result.

**CONTROL:** Various control measures have been recommended and tried. Chemical treatments with arsenic dust or dieldrin failed owing to the difficulty in introducing them to the termites and to improper application. Also, the indigenous labor disregarded the safety precautions.

Present control measures consist of locating the main termitarium, grubbing it out and collecting the physogastric queen. The small satellite colonies die out once the queen has been removed. Previously all termite nests were dug up and over 70 men were employed at times; now, there are 2 part time crews of 5 men. The excavation of all nests was quite deleterious since many of the other species, *Schedorhinotermes* sp. and *S. dimorphus* ? *robustior* (Silvestri) for example, were of much benefit in hastening log decomposition and did not attack the living trees. To avoid this a reward system was introduced. Since *Coptotermes* spp. are easily recognized because the soliders emit a milky substance through their fontanelle, the reward system virtually eliminated the destruction of other species nests. The crews collect, on an average, 2 queens a day.

The eradication of infested stumps remaining in the plantation after logging has proved difficult. Gay recommended blasting of these. In a trial experiment, the explosive mix-

ture of ammonium nitrate-fuel oil was used. It was found very effective and to be economically feasible. However, the large infested logs remain a problem.

39. **Coptotermes grandiceps** Snyder

COLLECTIONS: In imported Oregon timber, Port Moresby, C. D., XI. 1954 (K. Whiteman).

DISTRIBUTION AND BIOLOGY: The species is confined to the Solomon Is. and the Territory. It is found in tree stumps in the jungle, and in construction timber in buildings (F. J. Gay, pers. comm., 1967).

40. **Coptotermes obiratus** Hill

COLLECTIONS: From building, Rabaul, New Britain D., XI. 1939 (Anon.). In house timbers, Port Moresby, C. D., IV. 1952 (Alexander). Attacking *Malus sylvestris*, Port Moresby, C. D., 21. X. 1958 (D. Shaw & Sz-I). In *Poinciana regea*, Konedobu, C. D., 9. II. 1959 (A. C.). *Acacia* sp., Oriomo River area, W. D., XI. 1961 (B. J. O'Hagan). On trunk of *Eucalyptus papuana*, Vanuamai, C. D., 24. IX. 1962 (P. C. Heyligers). In *Flindersia brachycarpa*, Oriomo River area, W. D., 6. XI. 1962 (B. J. O'Hagan). In *Octomeles sumatrana*, Konedobu, C. D., 19. XII. 1963 (J. S. Colewell). In *Tectona grandis*, Brown River, C. D., 5. XI. 1964 (L. T. Clifford).

DISTRIBUTION AND BIOLOGY: The species is confined to the Territory.

41. **Coptotermes pamuae** Snyder

COLLECTIONS: Attacking hardwood, Bulolo, M. D., VI. 1958 (C. E. Lane-Poole). In log of *Araucaria hunsteinii*, Bulolo, M. D., XI. 1958 (R. Halpin). From *Ar. cunninghamii*, Bulolo, M. D., 22. XI. 1961 (F. J. Gay). In rotten stump of *Leucaena* sp., Tavilo Plantation, Kerevat, New Britain D., 29. VI. 1966 (B. G. & E. Lamai). In stem and roots of *Pinus patula*, Bulolo, M. D., 9. I. 1967 (B. G. & N. Howcroft).

DISTRIBUTION AND BIOLOGY: *C. pamuae* has been found on the Solomon Is., San Cristobal and Banika Is. The *P. patula* tree was in a very moribund condition. Many of the roots were riddled with galleries, and external galleries were evident along the stem, but there was little penetration of the woody stem.

42. **Coptotermes** sp.

COLLECTIONS: In live stem of *Araucaria cunninghamii*, Bulolo, M. D., 15. X. 1966 (B. G.).

DISTRIBUTION AND BIOLOGY: To date, specimens of this species have only been collected in the Territory. The species is less common than *C. elisae* in the plantation. Control measures are the same as for *C. elisae*.

43. **Schedorhinotermes** spp.<sup>3</sup>

COLLECTIONS: Attacking bitumenised paper, Lae, M. D., VII. 1944 (H. F. C. Davis). From tree *Musaceae* sp., Lae, M. D., 8. VIII. 1944 (H. F. C. Davis). From rotting log, Lae, M. D.,

3. Gay, in pers. comm., 1967, comments "The position with this genus awaits clarification, and depends on Emerson's revision of the group. Only one definitely identified species is in our collection from New Guinea, and identified by Emerson himself as *S. dimorphus* ? *robustior* (Silvestri); collected from a sawdust heap, Omaura, E. Hlds. Dist., 6. v. 1958 (J. H. Barrett)."



3, IX, 1944 (H. C. F. Davis). Nadzab, M. D., X, 1944 (H. C. F. Davis). From stored paper, (locality unknown), 9. VII. 1950 (G. W. Tacln). From *Melia dupia*, Bulolo, M. D., 20. VII. 1958 (R. Evans). From timber of *Araucaria* sp., Bulolo, M. D., XII. 1958 (R. Halpin). Attacking house timbers, Bulolo, M. D., XII. 1958 (R. Halpin). Alates at light, Aiyura, E. H. D., 13. I. 1959 (J. H. B.). From stored yams, Aupik Village, East Sepik D., 20 and 22. VI. 1959 (Sz-I). In forest, Arau, E. H. D., 16. X. 1959 (J. H. B. & T. C. Maa). In refuse heap, Aiyura, E. H. D., 14. VI. 1960 (J. H. B. & K. van Horck). Alates only, Tage S. H. D., 16. X. 1960 (J. H. B.). From *Metroxylon* sp. in swamp, Oomsis, M. D., IV. 1961 (J. H. Ardley). From rotting log, Aiyura, E. H. D., 20 & 23. VII. 1962 (J. H. B.). From sawed timber, Aiyura, E. H. D., 6. IX. 1962 (J. H. B. & R. S. Carne). From hardwood stump, Bulolo, M. D., 12. VII. 1963 (L. T. Clifford). In hardwood timber, Nondugl, W. H. D., 23. X. 1964 (G. Dick). Attacking bushes of *Camellia sinensis* and timber in buildings, Garaina, M. D., VII. 1966 (A. F. Hutton). Nest in decaying log, Okasa pine forest, E. H. D., 18. V. 1967 (B. G.). In stump of *Araucaria cunninghamii*, Aiyura, E. H. D., 5. VI. 1967 (B. G.).

#### Termitidae

#### 44. *Microcerotermes biroi* (Desneux)

COLLECTIONS: From rotten log, Kaloi, Milne Bay D., VIII. 1944 (H. C. F. Davis). In *Cocos nucifera*, Sasul Plantation, Bainings, New Britain D., 26. V. 1955 (Sz-I); Aroa Plantation, C. D., 16. V. 1957 (J. H. B.). From branch of *Theobroma cacao*, Kerevat, New Britain D., 13. VI. 1957 (J. H. B.). On trunk of *Cocos nucifera*, Baubaugina Plantation near Abau, C. D., 11. V. 1959 (A. C.). Under bark of rotting tree, Konga, Bougainville D., III. 1961 (W. W. Brandt). From tree trunk, Manki Village near Bulolo, M. D., 30. V. 1961 (B. J. O'Hagan). In log of *Eucalyptus paniculata*, Lae, M. D., 1. VIII. 1961 (J. Beesley). On tree stump, Arehe Estate, N. D., 30. XI. 1961 (Sz-I & E. Kanjiri). On palm of *Cocos nucifera*, 1.6 km N of Kapa Kapa, C. D., 12. VII. 1962 (P. C. Heyligers). On trunk of *Alstonia* sp., 24 km N of Port Moresby, C. D., 27. VII. 1962 (P. C. Heyligers). On dead tree trunk, between Rouna and Sogeri, C. D., 29. VII. 1962 (P. C. Heyligers). Carton nest on stem of *Cocos nucifera*, Numa Numa Plantation, Bougainville D., 3. VIII. 1962 (A. C.). On *Glossampinus* sp., 8 km W of Kanosea Plantation, C. D., 12. VIII. 1962 (P. C. Heyligers). On *Mangifera indica*, 1.6 km N of Yokea, C. D., 29. IX. 1962 (P. C. Heyligers). In hardwood stump, Bulolo, M. D., 8. III. 1963 (L. T. Clifford). On *Hevea brasiliensis*, Hagita Plantation, Milne Bay D., 6. VI. 1963 (T. Martin). Infesting house, Kerevat, New Britain D., 29. I. 1964 (G. S. Dun). In root system of *Hevea brasiliensis*, Bisianumu, C. D., XII. 1964 (A. J. H. van Haaren). In stem of moribund *Tectona grandis*, Brown River, C. D., 27. XI. 1966 (A. White and B. G.).

DISTRIBUTION AND BIOLOGY: The species also occurs in the Samoan Is. and Solomon Is. Commonly builds nests on tree trunks or stems of *C. nucifera*; occasionally attacks leaf stalks of the latter, and sometimes damages structural timber (F. J. Gay, pers. comm., 1967).

#### 45. *Nasutitermes novarumhebridarum* (N. & K. Holmgren)

COLLECTIONS: Nest on *Cocos nucifera*, Madang, Madang D., VII. 1944 (J. E. Cummins). In building, Kwato near Samarai, Milne Bay D., VIII. 1944 (H. F. C. Davis). In native

softwood, Kurakakaul Plantation, Rabaul, New Britain D., 5 & 11. V. 1952 (J. H. B.). Large "nigger-heads" and runways on *Cocos nucifera*, Arua Is., near Kieta, Bougainville D., 7. IX. 1954 (Sz-I). In branch of *Theobroma cacao*, Kerevat, New Britain D., 13 & 15. VI. 1957 (J. H. B.). On trunk of *Cocos nucifera*, Numa Numa Plantation, Bougainville D., 21. VI. 1957 (J. H. B.). On *Cocos nucifera*, Fead Is., New Ireland D., 7. X. 1959 (G. S. Dun). Under bark of rotting tree, Konga, Bougainville D., III. 1961 (W. W. Brandt). In butt *Hevea brasiliensis*, Hagita Plantation, Milne Bay D., 6. VI. 1963 (T. Martin). Nest on forest tree, Sineada Plantation, Milne Bay D., 13. VIII. 1963 (L. Smee). Gallery on tree, Garagos, M. D., 21. IX. 1963 (L. T. Clifford). On *Theobroma cacao*, Selau Cacao Development, Bougainville D., VII. 1964 (M. S. Mead). Attacking house timber, Rabaul, New Britain D., 8. IX. 1965 (F. J. Gay). Nest in *Leucaena* sp., Tavilo Plantation, New Britain D., 29. VI. 1966 (B. G. & E. Lamai).

**DISTRIBUTION AND BIOLOGY:** The species has been collected in the New Hebrides, Solomon Is. and Santa Cruz Archipelago. Commonly nests in tree in "nigger-head" nests; sometimes destroys construction timber (F. J. Gay, pers. comm., 1967).

#### 46. *Nasutitermes princeps* (Desneux)

**COLLECTIONS:** Bubia, M. D., 13. IX. 1961 (J. H. Ardley). Runways on tree, Lae, M. D., 20. IX. 1961 (F. J. Gay). Nest on *Theobroma cacao*, Matupit Plantation, Madang D., 6. IX. 1962 (Sz-I); Dagua, East Sepik D., 7-8. IV. 1964 (Sz-I & Pius Thamsen). On trunk of *Hevea brasiliensis*, Bisianumu, C. D., 3. VIII. 1966 (A. J. H. van Haaren).

**DISTRIBUTION AND BIOLOGY:** The species also occurs in West Irian, Graget I., Parando and Manokwari.

## E. LEPIDOPTERA

### Geometridae

#### 47. *Milionia isodoxa* Prout

**COLLECTIONS:** On *Araucaria cunninghamii*, Highlands Agric. Exp. Sta. Aiyura, E. H. D., 3. VIII. 1963 (J. H. B.). In flight, Bulolo, M. D., 20. VII. 1967 (F. R. Wylie). Large number of larvae on branchlets of *Araucaria cunninghamii*, Minj, W. H. D., 7. VIII. 1967 (B.G.). On *Eucalyptus robusta*, Korn Farm near Mt. Hagen, W. H. D., 27. VII. 1967 (J. Lowien).

**DISTRIBUTION AND BIOLOGY:** *M. isodoxa* is endemic to the Territory and is commonly called the "Araucaria Looper." Light to heavy infestations have occurred in the past few years at several localities - Bulolo, Goroka, Minj, Mt. Hagen and Wau. The outbreaks occur between July and October. Szent-Ivany & Stevens (1966) reported that larvae had not been observed in the Wau-Bulolo area; I observed light infestations of larvae in September 1966 in the Bulolo plantations.

The larvae eat the needles and outer tissue of the branchlets of *A. cunninghamii*. Very severe defoliation of planted trees, up to 20 m high, was observed in August 1967 at Minj and Korn Farm near Mt. Hagen. Some of these trees were dying. There was, significantly, very little defoliation of *A. hunsteinii* interplanted between the defoliated trees. The larvae fall to the ground and pupate beneath the host tree. Approximately 2 weeks later, the adults emerge (J. Lowien, pers. comm., 1967). Large numbers of adults were feeding off

the flowers of *E. robusta* and *Hibiscus* sp. near the defoliated trees at Korn Farm.

#### Lymantriidae

##### 48. *Euproctis* sp. near *fulvistiata* Swina

COLLECTIONS : Larvae feeding on *Eucalyptus deglupta*, Goroka, E.H.D., 19. III. 1960 (Sz-I).

#### Noctuidae

##### 49. *Hyblaea puera* Cramer

COLLECTIONS : Kerevat, New Britain D., 2. V. 1952 (G. S. Dun). On leaves of *Tectona grandis*, Brown River, C. D., 27.II.1956 (Sz-I). Reared ex pupa on *Tectona grandis*, Sawmill area, Lae, M.D., 14. III. 1957 (J. B. McAdam). On *Spathodea campanulata*, Kerevat, New Britain D., 18. VII. 1959 (L. Smee). Defoliating seedlings of *Tectona grandis*, Orimo Agric. Sta, W. D., 29 & 30. VII. 1960 (Sz-I). On *Tectona grandis*, Bubia, M. D., 29. VI. 1961 (J. H. Ardley); Vudal near Kerevat, New Britain D., VIII. 1964 (J. Clerk); Popondetta, N. D., 9. XII. 1965 (T. V. Bourke). Defoliating *Tectona grandis* in ornamental garden, Boroko, Port Moresby, C. D., 20. XII. 1965 (M. L. Szent-Ivany).

DISTRIBUTION AND BIOLOGY : *H. puera* has a wide distribution, ranging from the Himalayas to Ceylon, Japan, SE Asian countries and Northern Australia. Dun (1955) recorded damage to nursery seedlings at Kerevat and its control by a DDT and BHC preparation. Szent-Ivany & Womersley (1958) reported the occurrence of *H. puera* in the 2 major plantations of *T. grandis* at Brown River and Kerevat.

Initially, the larvae defoliated seedlings in the Dept. of Forests nurseries, but in recent years there has been considerable defoliation of young trees, 2-5 years old, in the plantations. A few trees have been found in a moribund condition in small areas; these were prone to attack by insect borers and dry rot. Otherwise, the recovery of the trees was good. A number of minor defoliators also contributed to the damage.

In India and Pakistan *H. puera* is regarded as a serious pest to *T. grandis*, and periodic outbreaks cause considerable loss in increment and quality (Chaudry 1964). In the Territory, periodic outbreaks occur with the larval populations at its maximum in March-April and September-October. The larvae pupate on the leaves by curling the leaf tips over their body.

CONTROL : Chaudry (1964) mentions that when the tops of young trees are killed, they are cut down to ground level to get a single leading shoot to grow into a good bole. In the Territory, the nurseries are dusted with 10 % BHC powder at short intervals during an outbreak. Szent-Ivany in 1955, and I in 1966, found several larvae destroyed by predators and parasites at Brown River. Chaudry (1964) reports that in Burma and Malaya, *H. puera* is not so serious a problem probably owing to biological control in the virgin forest.

#### Saturniidae

##### 50. *Synthereta janetta* White

COLLECTIONS : On *Eucalyptus deglupta*, Goroka, E. H. D., X.1954 (Sz-I). At lights, Wabag,

W. H. D., XI. 1962 (Sir A. H. Mann). In light trap, Mt. Hagen, W. H. D., 10. II. 1964 (Sz-I). On *Eucalyptus deglupta*, Mt. Hagen and Kandep, W. H. D., II 1964 (Sz-I & F. J. Simmonds). At lights, Bisi Plantation, N. D., 12. IV. 1964 (C. B. Mayoh). Large numbers on foliage of *Eucalyptus deglupta*, Popondetta, N. D., VI. 1965 (C. J. Choat).

DISTRIBUTION AND BIOLOGY: The species is also known from Australia (J. J. H. Szent-Ivany, pers. comm., 1967). The larvae eat the foliage of *E. deglupta*, but unless accompanied by the leaf-cutting bee *M. frontalis* little damage results. Szent-Ivany & Womersley (1958) describe the larva and pupa and mention, as does Szent-Ivany (1958), the rearing of a tachinid fly *Cuphocera varia sumatrensis* Tns. from the pupa.

#### Tineidae

##### 51. *Setomorpha rutella* Zeller

COLLECTIONS: In seed of *Araucaria hunsteinii*, Bulolo, M. D., VI. 1964 (J. L. R. Godlee).

DISTRIBUTION AND BIOLOGY: G. S. Dun reared adults from the seed collected by Mr Godlee. The larvae cause considerable damage to the seed.

#### F. ORTHOPTERA

##### Gryllotalpidae

##### 52. *Gryllotalpa* sp. (*G. africana* Beavois?)

DISTRIBUTION AND BIOLOGY: The species had damaged *T. grandis* seedlings at Kerevat. Dun (1955) mentions the use of chlordane to control it.

#### DISCUSSION

Much of the housing in the Territory consists of cheap native materials, such as bamboo, pit-pit (*Saccharum robusta*), South African tulip (*Spathodea campanulata*) and *Macaranga* spp., which are often readily available. However, with the ever increasing economic status of the indigenous population and the substantial post-war influx of Europeans, there has arisen a rapid and growing demand for timber and other building products in the Territory. In addition, large exports of logs and timber are likely within the next decade.

Associated with the commercial development of the timber industry has been a growing awareness of the damage caused by insect pests. Consequently, the Department of Forests has introduced preventive and control measures. They are the compulsory treatment of timbers used in the construction of administration buildings and furniture since July 1964, plus the establishment of timber treatment plants throughout the Territory and the establishment of an entomology section in 1966. Also, there is a growing interest in the use of pressure and other treatments of timber for external water and ground contact usage.

Nearly all the insects listed in the paper have been collected post-war. In the plantations, no insect was considered a serious pest until the 1960's. It is not possible to categorize the species in terms of their economic significance as pests, except for *H. araucariae* which is the major pest in the plantations. The apparent absence of any effective predator and parasite, the large food source available in pure stands and the short life cycle stress the

threat posed by *H. araucariae*. Browne (1961) warned that branchlet borers should be treated with respect as it is very difficult to implement control or preventive measures.

Other plantation insect pests—*C. elisae*, *H. puera* and *V. oberthuri*—kill a small number of trees. *C. elisae* and *Coptotermes* sp. become serious when left uncontrolled. *V. oberthuri* is considered relatively unimportant in the plantations and it may assist in thinning. However, in the Goroka and Kainantu areas, the species is serious in that it has killed a number of ornamentals.

*A. cunninghamii* appears to be more susceptible to insects than *A. hunsteinii*. Several species—*D. undata*, *H. araucariae*, *M. isodoxa* and *V. oberthuri*—attack and cause the death of the former species, but they hardly affect or do not attack *A. hunsteinii*. For this reason, the Department of Forests intends to plant much more *A. hunsteinii* in the future.

Timber borers such as the bostrychids, cerambycids, curculionids, scolytids and platypodids are rife in the Territory. Very little collecting has been carried out specifically for timber borers. The preceding paper by Dr K. E. Schedl represents the first paper principally on timber borers in the Territory. The paper gives descriptions of a number of new economic species and many collections made on forest trees by myself of Platypodidae and Scolytidae. These descriptions and collections have not been considered in this paper so as to avoid repetition. These timber boring groups will assume ever increasing significance particularly owing to their downgrading effect on logs and sawed timber destined for the export market.

Of the 52+ species listed as pests of forest trees and timber in the paper, approximately 20 of these have been recorded as pests of agricultural crops and plantation trees in the Territory. This overlap will most probably increase as the host plants and ecology of the species becomes better known.

**Summary:** Little attention has been paid to forest tree and timber insect pests in the Territory owing to the lack of trained staff and to the absence of any serious economic problem prior to the 1960's. Potentially serious problems were handled by entomologists of the D. A. S. F.

Most of the pests listed have been collected since 1955. Of the 52+ species listed: 21 belong to the Order Coleoptera; 8 in Hemiptera; 3 in Hymenoptera; 14+ in Isoptera; 5 in Lepidoptera and 1 in Orthoptera.

The most serious pest in the plantations is *H. araucariae* which infests *A. cunninghamii*. Several species—*C. elisae*, *Coptotermes*, *D. undata*, *M. isodoxa*, and *V. oberthuri*, kill living *A. cunninghamii* trees, but in relatively small numbers. Only *C. elisae* appears to be the only species capable of killing *A. hunsteinii*; however, control measures now used are quite successful in lessening the damage caused by the termite. Owing to the non-susceptibility of *A. hunsteinii* to serious attack by several serious pests of *A. cunninghamii*, much more of the former tree species will be planted in future. There are several important species of timber borers in the Territory.

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#### BIBLIOGRAPHY

The list includes known scientific papers recording collection data and discussing the distribution, biology and control of the insect pests listed in the paper, in relation to the Territory.

- Anon.** 1967. Timber resources in Papua and New Guinea. Department of Information and Extension Services, Port Moresby, T. P. N. G.
- Ardley, J. H., L. T. Clifford & F. J. Gay.** 1965. Termite damage to plantation grown Hoop Pine in New Guinea. *Proc. 12th Int. Congr. Ent.* London (Section 10: Forest Entomology), **10**: 680-81.
- Barrett, J. H.** 1965. The occurrence of termites in the New Guinea Highlands. *Papua N. Guin. Agr. J.* **17** (3): 95-98.
1966. Insect pests of *Coffea arabica* in the New Guinea Highlands. *Papua N. Guin. Agr. J.* **18** (3): 83-100.
- Brimblecombe, A. R.** 1953. An annotated list of the Scolytidae occurring in Australia. *Qld J. Agric. Sci.* **8**: 69-105.
- Browne, F. G.** 1961. *The Biology of Malayan Scolytidae and Platypodidae*. Malayan Forest Records No. 22. Government Printer, Kuala Lumpur.
- Chaudry, G.** 1964. A decade of forest entomology in Pakistan. *FAO/IUFRO Symposium on Internationally Dangerous Forest Diseases and Insects II/III*: 1-4.
- Dumbleton, L. J.** 1954. A list of insect pests recorded in South Pacific Territories. *S. Pacif. Comm. Tech. Pap.* **79**: 1-196.
- Dun, G. S.** 1954. Annual report of the Senior Entomologist, Department of Agriculture, Stock and Fisheries 1952-1953. *Papua N. Guin. Agr. J.* **8**(3): 18-27.
1955. Economic entomology in Papua and New Guinea 1948-1954. *Papua N. Guin. Agr. J.* **9** (3): 109-19, 4 fig.
- Froggatt, W. W.** 1925. Forest Insects, No. 13. The Island pinhole borer (*Xyleborus perforans* Wollaston). *Austral. For. J.* **8**: 232-34.
1927. *Forest Insects and Timber Borers*. Government Printer, Sydney.
- Gay, F. J.** 1963. The Synonymy, distribution and biology of *Coptotermes elisae* (Desneux). *Pacif. Insects* **5** (2): 421-23.
- Gray, B.** 1966. A review of forest entomology, collection of insects and future research in the Territory of Papua and New Guinea. Department of Forests, Konedobu, T. P. N. G.
- Gressitt, J. L.** 1959. Longicorn beetles from New Guinea (Cerambycidae). *Pacif. Insects* **1** (1): 59-171, 50 fig.
1963. Economic chrysomelid beetles from New Guinea, with new species. *Papua N. Guin. Agr. J.* **16** (2-3): 105-16, 11 fig.
1967. Chrysomelid beetles from the Papuan Subregion, 4 (Eumolpinae, 2). *Pacif. Insects* **9** (2): 295-340, 26 fig.
- Havel, J. J.** 1962. An investigation of problems of plantation establishment of Klinki Pine (*Araucaria klinkii*). Unpublished M. Sc. For. Thesis, University of Queensland.
- Hill, G. F.** 1942. *Termites (Isoptera) from the Australian Region*. C. S. I. R. O. Melbourne, 479 pp.

- Marshall, Sir Guy A. K.** 1956. The Otiiorhynchinae Curculionidae of the tribe Celeuthetini (Col.). Printed by order of the Trustees of the British Museum, London. 134 pp., 52 fig.
1957. Some injurious Curculionidae (Col.) from New Guinea. *Bull. Ent. Res.* **48**: 1-7, 3 fig.
1959. Two weevil pests of coffee in New Guinea. *Papua N. Guin. Agr. J.* **12** (1): 44-46, 3 fig.
- Michener, C. D.** 1965. A classification of the bees of the Australian and South Pacific Regions. *Bull. Amer. Mus. Nat. Hist.* **130**: 1-362, pl. 1-15, fig. 1-789.
- Michener, C. D. & J. J. H. Szent-Ivany.** 1960. Observations on the biology of a leaf-cutter bee "Megachile frontalis", in New Guinea. *Papua N. Guin. Agr. J.* **13** (1): 22-35, pl. 4, fig. 4.
- Pouillaude, I.** 1915. *Vanapa oberthüri* nouveau genre et nouvelle espèce de Curculionide (Col.). *Insecta Rennes* **5**: 101-5. Paris.
- Schedl, K. E.** 1958. Some more bark- and timber- beetles from Australia. *Proc. Linn. Soc. N. S. W.* **83**: 214-16.
1961. Scolytidae und Platypodidae Afrikas. Band **1** Familie Scolytidae. *Rev. Ent. Mocamb.* **2** (2): 357-422, 1959; **3** (1): 75-154, 1960; **4** (2): 335-742, 1961.
- 1962a. Scolytidae und Platypodidae Afrikas. Band **II** Familie Scolytidae. *Rev. Ent. Mocamb.* **5** (1): 1-594, 1962.
- 1962b. Scolytidae und Platypodidae Afrikas. Band **III** Familie Platypodidae. *Rev. Ent. Mocamb.* **5** (2): 1-11-595-1352, 1962.
- 1962c. Scolytidae und Platypodidae aus dem australisch-polynesischen Raum. *Ent. Arb. Mus. Frey* **13**: 72-78.
1964. On some Coleoptera of economic importance from New Guinea and Australia. *Pacif. Insects* **6** (1): 211-14.
- Snee, L.** 1964. Insect pests of *Hevea brasiliensis* in the Territory of Papua and New Guinea: their habits and control. *Papua N. Guin. Agr. J.* **17** (1): 21-28.
- Szent-Ivany, J. J. H.** 1956. New insect pests and host plant records in the Territory of Papua and New Guinea. *Papua and New Guinea Agr. J.* **11** (3): 82-87.
1958. Insects of cultivated plants in the Central Highlands of New Guinea. *Proc. 10th Int. Congr. Ent.* **3**: 427-37.
1959. Host plant and distribution records of some insects in New Guinea. *Pacif. Insects* **1**(4): 423-29.
1961. The zoogeographical factor in economic entomology in Pacific Islands with special reference to New Guinea. *Verh. XI. Int. Kongr. Ent. Wien* **1**: 534-37.
- 1964a. List of pests of *Theobroma cacao* L. in the Territory of Papua and New Guinea. *West African Cacao Res. Institute; Proc. Conf. on Mirids and other pests of Cacao* p.85-89.
- 1964b. Pacific Entomology. Report of the Standing Committee Chairman. Tenth Pacific Science Congress Series, University of Hawaii Press, Honolulu, p. 1-91, 1793 ref.
1965. Notes on the vertical distribution of some beetles in New Guinea with new locality data and host plant records of some high altitude species. *Papua N. Guin. Sci. Soc. Trans.* **6**: 20-36.
- Szent-Ivany, J. J. H. & A. Catley.** 1960a. Observations on the biology of the black leaf-footed bug *Leptoglossus australis* (F.) (Heteroptera: Coreidae) in the Territory of Papua and New Guinea. *Papua N. Guin. Agr. J.* **13** (2): 70-75.
- 1960b. Host plant and distribution records of some insects in New Guinea and adjacent Islands. *Pacif. Insects* **2** (3): 255-61.
- Szent-Ivany, J. J. H. & Rhonda M. Stevens.** 1966. Insects associated with *Coffea arabica* and some other crops in the Wau-Bulolo Area of New Guinea. *Papua N. Guin. Agr. J.* **18** (3): 101-119, pl. 1-12.
- Szent-Ivany, J. J. H. & J. Womersley.** 1958. Some insects of forest trees in New Guinea. *Proc. Xth Int. Congr. Ent.* **4**: 331-34.
- Waterhouse, D. F. & P. B. Carne.** 1964. Forest Entomology in Australia, Papua-New Guinea and the British Solomon Islands. *FAO/IUFRO Symposium on Internationally Dangerous Forest Diseases and Insects* II/III: 1-3.