

Investigations on the Biology and Control of *Glenea lefebueri*, a Noxious Longicorn Beetle of Cacao in West New Guinea.

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ABSTRACT.

In the years 1961 and 1962 the biology and methods of control of the noxious longicorn cacao borer, *Glenea lefebueri* Guer., were studied in the Vogelkop of West New Guinea. The larva first tunnels superficially in the bark of the stem and thicker branches of *Theobroma cacao*, and penetrates deeper into the bark as it matures, making galleries in the cambial layer. In this stage equal parts of wood and bark tissue are consumed. Finally, the larva makes a tunnel into the wood to pupate. The development from recently hatched egg to the adult stage takes approximately three months. Die-back of branches or death of the whole tree can be the result since branches and the stem are more or less ring-barked by the larvae.

The *Glenea* pest can be controlled by cutting out the larvae at intervals of three to four weeks. A more satisfactory control is obtained by spraying with Dieltrin in a concentration of 1 per cent. of an emulsifiable concentrate, containing 18 per cent. active ingredient, which product has also a long-lasting preventive action.

An ichneumon was found, *Xanthocryptus vesiculosus* (Brulle, 1846), which is most likely a parasite of the *Glenea* borer.

INTRODUCTION.

In 1961 and 1962 the stem and branch borer *Glenea lefebueri* Guer.¹ (Cerambycidae, Col.) was a very destructive pest in cacao plantations in the Vogelkop of West New Guinea (Manokwari and Ransiki). This longicorn beetle was not found elsewhere in West New Guinea, but does occur in the Territory of Papua and New Guinea, where cacao is also damaged by the species *Glenea aluensis* Gah. (Szent-Ivany, 1961.) A third species, *Glenea novemguttata* Cast., is found in Indonesia. (Kalshoven, 1951.)

Larvae of other longicorn beetles also attacked cacao trees in the Vogelkop, but actual damage was restricted to only a few trees. In some areas other cacao borers are more harmful, such as *Pansepta teleturga* Meyr. (Xylorictidae, Lep.) at Seroei and *Alcides australis* Boisd. (Curculionidae, Col.) at Ransiki. (Schreurs and Simon Thomas, 1961.)

DAMAGE.

In cacao plantings not properly maintained, large numbers of larvae were found in stem and branches. Once, 27 infections were counted in a stem of 70 cm. height and 23 cm. girth. The heaviest concentration of the borer is generally in the lower part of the stem, and relatively few larvae attack the branches. To determine the

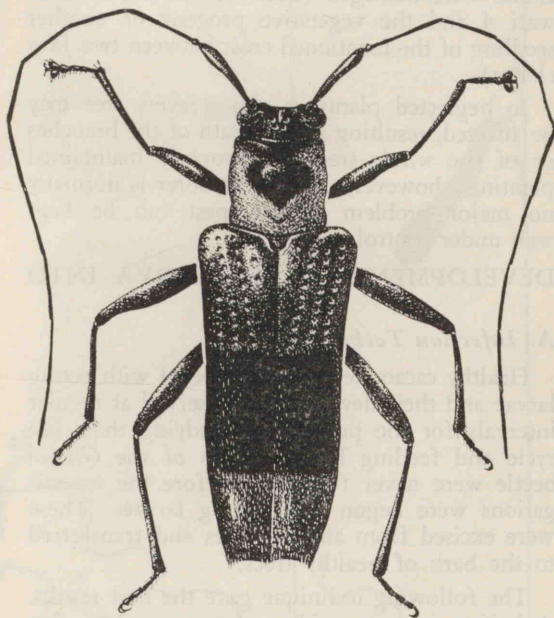


Plate I.—*Glenea lefebueri* Guer.

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¹ Identified by Dr. J. L. Gressitt, Bernice P. Bishop Museum, Honolulu, Hawaii.

area of greatest infestation, the stems of 30 trees were divided into ten equal parts, and the mean number of stem infections was calculated for each level. Measuring from the base to the top, the percentage of the total infections in each stem section was as follows :

15 per cent., 17 per cent., 14 per cent.,
9 per cent., 8 per cent., 6 per cent.,
8 per cent., 8 per cent., 9 per cent., and
6 per cent.

The trees become susceptible in the third year after planting. The borer attacks only living trees, although a few pupae or adults may be found in recently killed trees. Most likely, there are clonal differences in susceptibility to this pest. In a four to five year old cacao planting at Ransiki 23 per cent. of the trees of a clone were affected in 1962, being the vegetative progeny of a seedling, selected from the descendants of a cross between two Java clones, while only four to eight per cent. of the trees of the other clones were damaged (ICS 89, ICS 95, Manokwari 4 and the vegetative progeny of another seedling of the mentioned cross between two Java clones).

In neglected plantings almost every tree may be affected, resulting in the death of the branches or of the whole tree. In properly maintained plantings, however, the *Glenaea* borer is normally no major problem as this pest can be kept well under control.

DEVELOPMENT OF THE LARVA INTO ADULT.

A. Infection Technique.

Healthy cacao stems were infected with young larvae and their development observed at regular intervals for the purpose of studying their life cycle and feeding habits. Eggs of the *Glenaea* beetle were never found; therefore the investigations were begun with young larvae. These were excised from affected trees and transferred to the bark of healthy trees.

The following technique gave the best results. A half to one cm. wide and two cm. long flap of bark was lifted up with a knife, and a hole was drilled tangentially through the bark with a gimlet. The sap secreted from the freshly-made wound was drained off with a piece of absorbent cotton. Finally the larva was placed in the hole, the flap lowered and tightened with string. This method was successful in 40 per cent. of the

infections carried out. A total of 26 successful infections were obtained. The infected parts of the stem were covered with copper screen at the time the adults would be expected. During the course of the experiment a number of larvae was sacrificed for determination of their growth and for observation of the galleries.

B. Observations.

The tunnelling habits and development of the larva are discussed on the basis of *Figures 1* to 8.

A young natural infection is presented in *Figures 1* and 2. The bark of this cacao stem was 3.3 mm. thick. A newly hatched larva

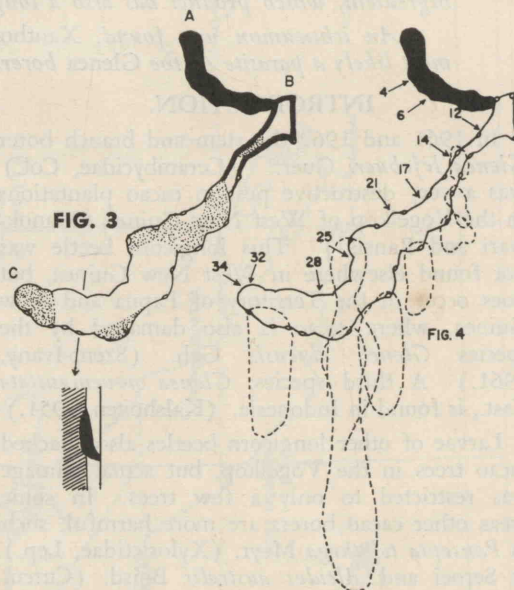
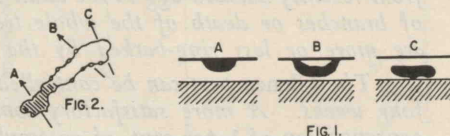


Figure 1.—Cross sections through spots A, B and C of the tunnel in *Figure 2*. The shadowed parts represent wood tissue. 2 x enlarged.

Figure 2.—Tunnel of young larva in the bark. Natural size.

Figure 3.—Tunnel in cambial layer. The cross section through the end of the tunnel is made at the spot where a "ventilating burrow" was gnawed. Natural size.

Figure 4.—Same gallery as presented in *Figure 3*. Special attention is paid to the secreted gum lumps and the progress of the larva in days after infection. Natural size.

feeds in the exterior bark, protected only by a very thin dead bark layer of 0.20 to 0.25 mm. thick (see shadowed part of tunnel in *Figure 2* and the cross section through A in *Figure 1*). Soon afterwards, possibly within a week after hatching, the larva penetrates deeper into the bark and feeds for some time in the middle layers (see Section B). Small holes are gnawed to the exterior at distances of a few millimetres; *Figure 1 B* shows a section through two of those holes. These burrows serve for secretion of various material and probably for ventilation as well. The larva had almost reached the cambial layer at spot C and was at that moment 7 mm. long. The larvae start tunnelling in the cambium when they have grown to 7-10 mm.

A bore tunnel in the cambial layer is presented in *Figure 3*. The stem of this tree was infected with a larva of 6 mm. at point A. The girth

of the stem was 17 cm. and the thickness of the bark 4.3 mm. The larva tunnelled first for eight to ten days exclusively in the bark (blackened part of tunnel) and then entered the cambium at point B. The tunnel was opened when the larva had reached point C, 34 days after infection. It had grown to 21 mm. In the cambial layer the larva eats equal parts of bark and wood tissue as is shown in the cross section through the gallery. Also in this stage small burrows are gnawed to the exterior; they are usually at the borders of the tunnel, only occasionally in the middle. When this tunnel was opened, the shadowed parts were compactly filled with fibrous chips. Bark renewal starts quite soon after the damage is done, about two and one-half weeks later. The area of these cambial activities is represented in *Figure 3* by thicker border lines from point B to the point reached 17 days after infection.

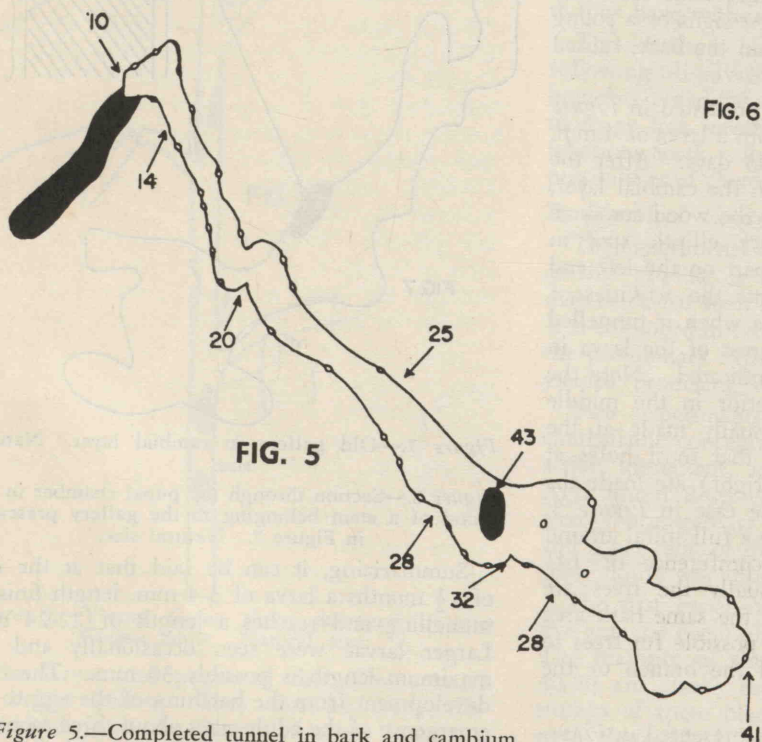
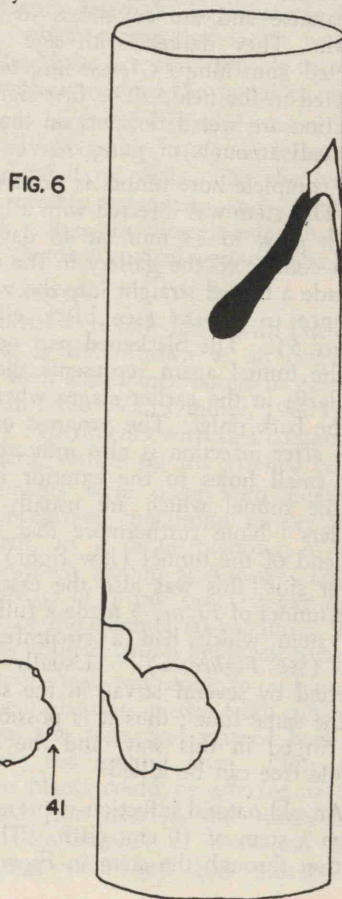


Figure 5.—Completed tunnel in bark and cambium. Natural size.

Figure 6.—Arrangement of tunnel of *Figure 5* around the stem. Natural size.



The same bore tunnel is presented in *Figure 4*. In this presentation, the advance of the larva is marked in days after infection. The larval progress could be observed without opening the tunnel as the freshly made burrows to the exterior indicate the spot where the larva is tunnelling. Through these holes particles of wood and bark tissue are secreted in a foamy gum lump, in which substance probably excrements are included. The gum lumps produced between 12 and 34 days after infection are drawn in *Figure 4* as they appear in the fresh state. In general, the lumps stay in this shape only for a few days. At the time the larva was cut out (34 days after infection), the gum lump made 28 days after infection may still have been there in this shape, while the older ones were washed off by rain or dried out. However, sometimes small strands of pure gum are secreted through older holes. The most common lumps have a clear, foamy appearance and are colourless to light reddish brown. They darken with age. Due to the secreted gum lumps *Glenea* infections are easily detected in the field. The first signs of a young infection are wet dark spots on the bark, caused by small amounts of gum.

A complete bore tunnel is presented in *Figure 5*. This stem was infected with a larva of 4 mm. which grew to 23 mm. in 43 days. After the larva completed the gallery in the cambial layer, it made a tunnel straight into the wood for some distance to pupate (see black elliptic spot in *Figure 5*). The blackened part on the left end of the tunnel again represents the activities of the larva in the earlier stages when it tunneled in the bark only. The progress of the larva in days after infection is also indicated. Note the two small holes to the exterior in the middle of the tunnel which are usually made at the borders. Note furthermore that most holes at the end of the tunnel (low right) are made the lower side, this was also the case in *Figure 3*. The tunnel of *Figure 5* made a full spiral around the stem which had a circumference of 14½ cm. (see *Figure 6*). Usually the trees are affected by several larvae in the same bark area at the same time; thus it is possible for trees to be ringed in this way, and the branch or the whole tree can be killed.

An old natural infection is presented in *Figure 7* on a stem of 10 cm. girth. The longitudinal section through the stem in *Figure 8* shows the

shape of the tunnel in the wood and of the pupal chamber. The shadowed parts of this chamber were compactly filled with chips of wood. The pupal chamber is made 1-2 cm. deep into the wood and always slants upwards in the stem. The opening of this tunnel is plugged with fibrous chips.

After the larva has made the pupal chamber, it takes about a month before it pupates. The pupal state lasts approximately one week. The adult remains a few days inside the pupal chamber before flying out.

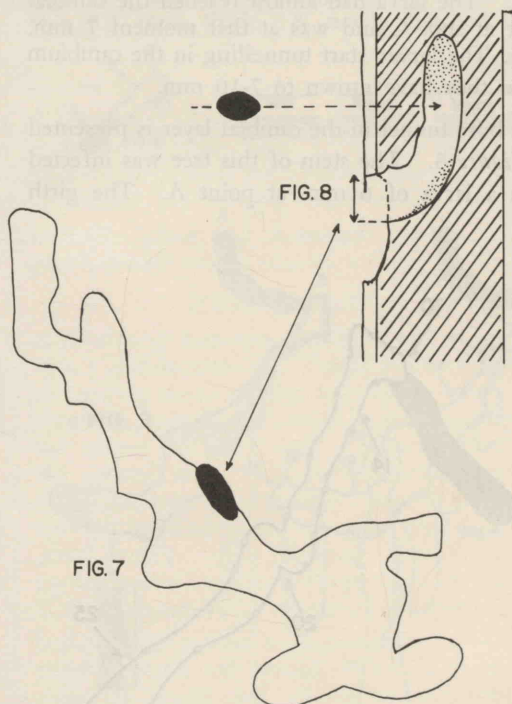


Figure 7.—Old gallery in cambial layer. Natural size.

Figure 8.—Section through the pupal chamber in the wood of a stem belonging to the gallery presented in *Figure 7*. Natural size.

Summarizing, it can be said that at the end of 1½ months a larva of 3-4 mm. length finishes tunnelling and reaches a length of 22-24 mm. Larger larvae were seen occasionally and the maximum length is possibly 30 mm. The total development from the hatching of the egg to the emergence of the adult takes about three months; this assumes that a recently hatched larva is 3-4 mm. long in one week's time, and allows

1½ months for further tunnelling activities, one month for the rest state of the larva and one week for the pupal state.

The adults were quite regularly seen in cacao plantings, resting on a leaf or on the bark, but seldom in large numbers. Only in one case 30-40 beetles were collected in a couple of hours. This was in a young planting of one year old, adjacent to an old neglected cacao planting, which was severely affected. It is likely that the beetles were feeding on the young green shoots, since in breeding cages the same type of damage to the shoots could be reproduced (see Figure 9).

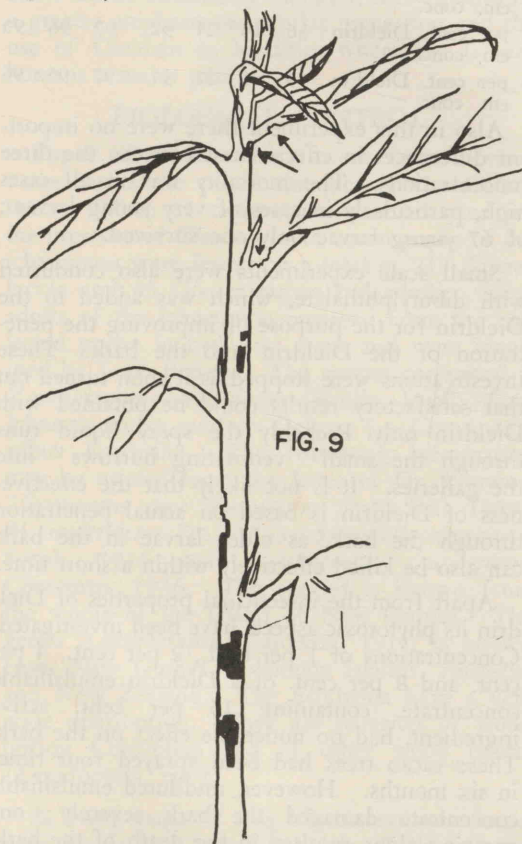


Figure 9.—Young Cacao shoot damaged by the *Glenea* adult. Natural size.

The larvae and pupae of this *Glenea* borer are bright yellow. They can be easily distinguished from the larvae of other longicorn borers by their colour as the others are usually greyish white and never bright yellow. The

pupae and adults of the *Glenea* borer are 12-14 mm. long. The males are somewhat more slender than the females. The elytra are steel blue and marked with a broad, darker-coloured cross band. The thorax and the head are yellow. The thorax is marked with a black to steel blue round spot.

CONTROL.

The *Glenea* pest can be controlled by excising the larvae or by application of insecticides. A parasite of the borer was found which means the borer is biologically controlled to a certain extent. Alternate hosts of the borer were not found. The different possibilities for control are discussed in the following.

A. Mechanical Control.

The pest can be kept under control if all the cacao trees are inspected every three to four weeks and the larvae are excised. When the inspections are made at longer intervals, larger larvae have to be excised, which means that larger wounds are made. The larvae are very difficult to reach if they have withdrawn into the pupal chamber.

This method of control has, however, the following disadvantages: (1) infections of branches are difficult to reach; (2) the tree is more or less severely wounded; and (3) it is laborious work. It is for these reasons that the possibilities of chemical control were investigated.

B. Chemical Control.

The experiments were only made with Dieldrin as this product is well known as an excellent insecticide for stem and branch borers in general. It is employed in cacao (Van Dinther, 1960) and the preliminary experiments with this compound yielded promising results on the *Glenea* borer.

Two experiments were done with Dieldrin emulsifiable concentrate, containing 18 per cent. active ingredient, in a cacao planting of the Agricultural Research Station at Ransiki. Tested were concentrations of 1 per cent., 2 per cent. and 3 per cent. of the commercial product. The spray liquid was applied with a knapsack sprayer.

The first experiment was done in a four to five year old cacao planting, grown from cuttings. The majority of the trees was pruned back to 30-40 cm above the ground level. Only the stumps of these plants could be affected as the new shoots had not reached the susceptible stage. A smaller number of trees was left unpruned at that time and had susceptible

branches. The planting consisted of five clones, each one represented by approximately the same number of trees, namely—ICS 89, ICS 95, Manokwari 4 and the vegetative progeny of two seedlings, selected from the descendants of a cross between two Java clones.

There were four treatments, the three concentrations mentioned above and one control. All susceptible parts were thoroughly sprayed. A pre-treatment count of the number of infections showed that 13 per cent. of the stumps and 27 per cent. of the unpruned trees were affected by one or more *Glenaea* larvae (trees with the characteristic gum lumps). One week after the application of Dieldrin all infections were opened to determine the mortality of the larvae.

The three concentrations yielded about the same, indicating that a concentration of 1 per cent. (0.18 per cent. active ingredient in the spray liquid) gives almost the best possible control; 93 per cent. of the larvae in the stumps were killed and at least 93 per cent. in the unpruned trees. In all the five clones a high mortality of larvae was obtained. All stages of the larvae were killed effectively with possibly the greatest effect on the youngest stages.

This experiment also showed that the residual action of Dieldrin lasted at least one month as is shown in Table 1.

Table 1.—Number of New Infections after treatment with Dieldrin after :

	10 days,	15 days,	23 days,	28 days,
on 327 treated stumps	0	0	0	1
on 80 untreated stumps	2	4	10	14

The second experiment was carried out in a five and one-half to six years old planting of Keravat bulk seedlings on 2nd May, 1962. Only the affected spots of the tree were sprayed in this experiment. A long spray boom was connected to the knapsack sprayer to facilitate spraying of infections in the higher branches. A quarter of a square foot was treated per affected spot. This is quite feasible with a knapsack sprayer provided the pressure is kept low. Per infection 30-40 ml. spray liquid was used. One week after the treatment the mortality of the larvae was determined. The experiment was

repeated twice on other trees in the same planting, namely on 9th May and 29th June, 1962. The results are presented in Table 2.

Table 2.

	Number treated infections in experiment of :			Per cent. mortality of larvae in experiment of :			Average mortality per cent.
	May 2.	May 9.	June 29.	May 2.	May 9.	June 29.	
1 per cent. Dieldrin em. conc.	26	14	23	89	100	91	93
2 per cent. Dieldrin em. conc.	36	18	24	92	97	96	95
3 per cent. Dieldrin em. conc.	53	20	22	97	97	95	96

Also in this experiment there were no important differences in effectiveness between the three concentrations. The mortality was in all cases high, particularly in cases of very young larvae; of 67 young larvae only one survived.

Small scale experiments were also conducted with dibutylphthalate, which was added to the Dieldrin for the purpose of improving the penetration of the Dieldrin into the bark. These investigations were stopped as it soon turned out that satisfactory results could be obtained with Dieldrin only. Probably the spray liquid runs through the small "ventilating burrows" into the galleries. It is not likely that the effectiveness of Dieldrin is based on actual penetration through the bark, as older larvae in the bark can also be killed effectively within a short time.

Apart from the insecticidal properties of Dieldrin its phytotoxic aspects have been investigated. Concentrations of 1 per cent., 2 per cent., 4 per cent. and 8 per cent. of a Dieldrin emulsifiable concentrate, containing 15 per cent. active ingredient, had no noticeable effect on the bark. These cacao trees had been sprayed four times in six months. However, undiluted emulsifiable concentrate damaged the bark severely; one spraying alone resulted in the death of the bark.

All flowers and flower buds can be lost when sprayed with 4 per cent. of the Dieldrin emulsifiable concentrate. No notable damage was seen when concentrations up to 2 per cent. were employed. One month after spraying 4 per cent. of the emulsifiable concentrate new normal flowers were produced again.

As Dieldrin also may have an adverse effect on the beneficial insects, which play a part in the pollination of the cacao, it is recommended that only the affected spots of the tree be sprayed with a concentration of one per cent. (0.15 to 0.18 per cent. active ingredient in the spray liquid). Spraying of all susceptible parts of the tree is possibly justified in cases of severe attack. Perhaps the spray concentration can still be lowered more than 1 per cent., but it is not very likely but it is not very likely that the same high percentage mortality is obtained.

It may be concluded, since every tree of a plantation can be affected by this pest, there should be a greater emphasis on regular inspection and the use of Dieldrin in localities where the *Glenea* borer is a major pest.

BIOLOGICAL CONTROL.

Pupae of an ichneumon were found several times inside the pupal chamber of the *Glenea* borer. When 31 cacao stems were analysed for the presence of *Glenea* borers, seven pupae of the ichneumon were found on a total of 217 *Glenea* larvae and 33 *Glenea* pupae and adults. Some adults of the ichneumon emerged from the collected pupae in breeding cages and were identified by J. G. Betrem. The species concerned is *Xanthocryptus vesiculosus* (Brulle, 1846), fam. Ichneumonidae, subfam. Gelinae (= Cryptinae), tribus Echthrina. The following information may be quoted from the letter of Dr. Betrem: "Synonyms are: *Mesostenus pictus* Sm., 1859; *M. multipictus* Sm., 1863; *Stenarella nigritarsis* Szepi., 1916 and *Xanthocryptus monstratus* Cheesman, 1936. The species is known from the whole of the Island of New Guinea. The genus *Xanthocryptus* Cameron, 1911, is known from New Guinea, Solomons Islands, Australia and New Zealand. The Echthrina have a very wide distribution. They are parasites of wood boring Coleoptera and of other wood borers (Lepidoptera, etc.)."

A living pupa of this ichneumon was found once inside the pupal chamber of the *Glenea* borer together with a dead, shrivelled *Glenea* adult. The adult was caught only once.

In my opinion it can be assumed that *Xanthocryptus vesiculosus* is a parasite of the *Glenea* borer, however, this parasite seems to be of little practical importance as it was rarely found.

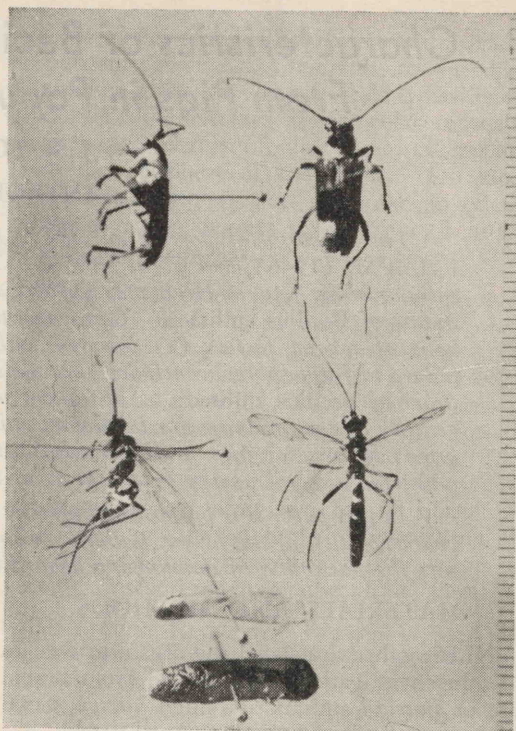


Plate II.—Top: *Glenea lefebueri* Guer. Bottom: *Xanthocryptus vesiculosus*.

ACKNOWLEDGEMENTS.

The author wishes to thank Mr. J. Ph. van Driest for his assistance in the investigations carried out at Manokwari, and Mr. E. B. Vreugdenburg for the execution of the experiments at Ransiki. (Received June, 1965.)

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