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DESCRIPTIONS OF THE IMMATURE AND ADULT STAGES OF THE COCOA MIRID *HELOPELTIS CLAVIFER* (HETEROPTERA: MIRIDAE)

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Abstract: Descriptions, illustrations and measurements of the egg, the 5 nymphal instars and the adult stages of *Helopeltis clavifer,* a serious pest of cocoa (*Theobroma cacao*) on the mainland of Papua New Guinea, are presented. A key for the separation of the nymphal instars is provided.

The large and widely distributed genus *Helopeltis* (Heteroptera: Miridae) includes many species responsible for serious damage to a great variety of economic crops. *Helopeltis clavifer* (Walker) was first described as *Dulichius ? clavifer* by Walker (1871) (males only) and later, the same author described different color forms of this species as *H. braconiformis* (Walker 1873) and *H. niger* (Walker 1873), from specimens collected in other areas.

In 1954 *H. clavifer* was found damaging cultivated cocoa in the Central Province of Papua New Guinea (Dun 1954), and since that time it has become one of the most important pests of cocoa on the Papua New Guinea mainland. This mirid has been reported on cocoa in several areas of Irian Jaya (Simon Thomas 1962), and also in Sabah, Malaysia (Conway 1971), where the insect first appeared in 1957. The latter author also published some illustrations of the pest.

A brief account of the life history of *H. clavifer* has previously been given (Smith 1973), but detailed studies on its ecology have required identification of the immature stages.

This paper describes the various life history stages, redescribes the adults and provides a key for the separation of the nymphal instars.

MATERIALS AND METHODS

Specimens from each instar were collected alive and then measured, illustrated and described while immobilized by cold (following the placement of the insects in a refrigerator at −2 °C for 2 h). Immatures were reared in the laboratory by methods described in Smith (1973).

All measurements were taken using an ocular micrometer in a dissecting microscope and illustrations were done with the aid of a camera lucida attached to the same microscope.

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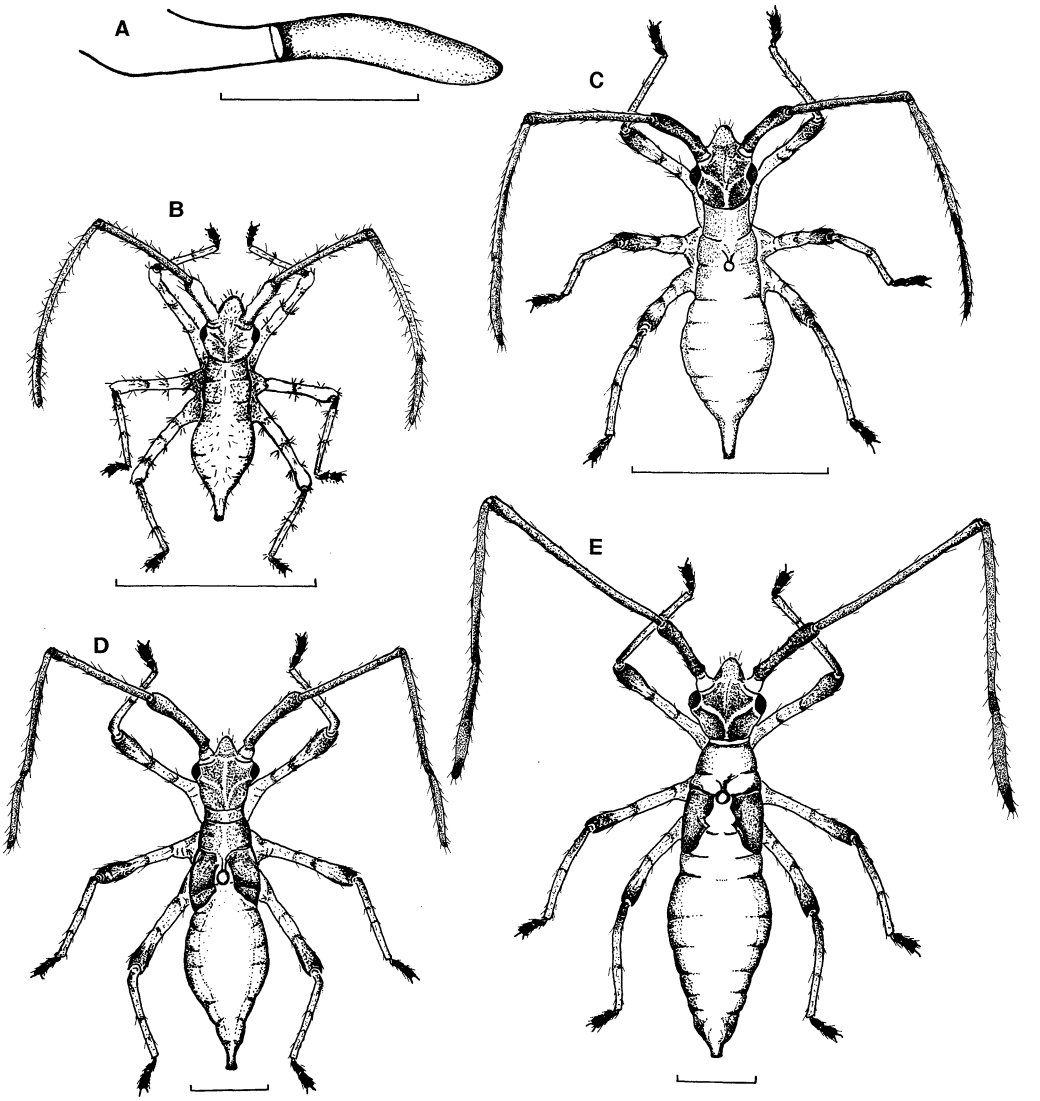

FIG. 1. Immature stages of *Helopeltis clavifer*: A, egg, lateral aspect; B, 1st instar, dorsal aspect; C, 2nd instar, dorsal aspect; D, 3rd instar, dorsal aspect; E, 4th instar, dorsal aspect. Scale = 1 mm.

DESCRIPTIONS

Helopeltis clavifer (Walker) FIG. 1–3

Dulichius ? clavifer Walker, 1871: 170.
Helopeltis braconiformis Walker, 1873: 165 (syn. by Waterhouse, 1886: 459).
Helopeltis niger Walker, 1873: 165 (syn. by Atkinson, 1890: 177).
Helopeltis clavifer: Distant, 1904: 108.

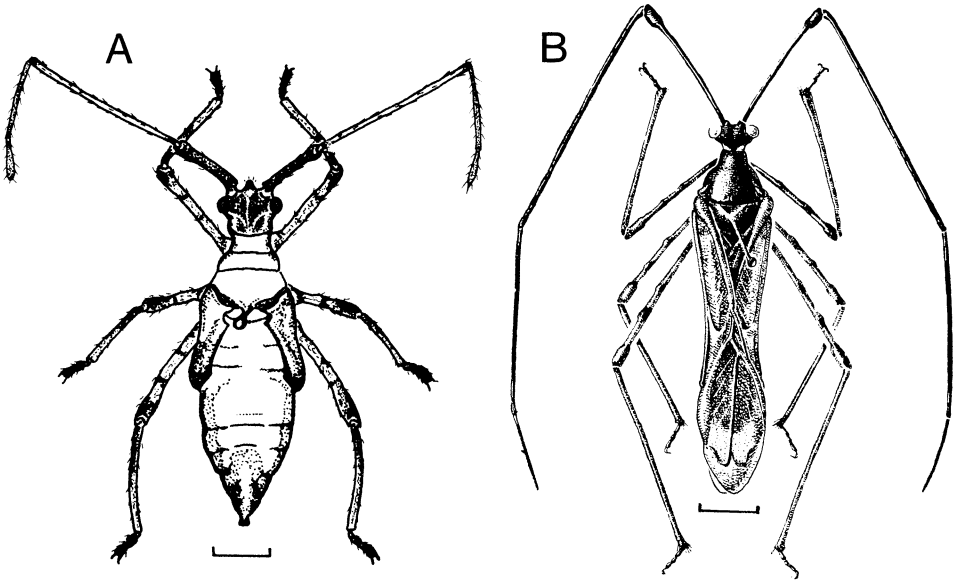

FIG. 2. *Helopeltis clavifer*: A, 5th instar, dorsal aspect; B, adult, dorsal aspect. Scale = 1 mm. Drawing of adult reprinted from Szent-Ivany (1961) with permission of the publisher.

Egg (FIG. 1A). Gray-white, glabrous, cylindrical, with the long axis slightly bent and slightly broader centrally; surface minutely reticulated; operculum situated between 2 slender chorionic processes of unequal length. Length approximately 4× longer than width, chorionic processes approximately $^3/_5$ and $^2/_5$ mean length of ovum (TABLE 1).

1st instar (FIG. 1B). Body elongate, abdomen narrowly pear-shaped. Head, thorax and abdomen (especially posteriorly) with erect setae, black and prominent. Head orange-yellow, thorax and legs yellow, banded with gray-black on setae. Head as broad as thorax; tylus and juga prominent. Antennal segment 1 ochreous, rest ferrugino-testaceous. Basal segment thicker than other segments. All antennal segments and legs bearing moderately long, erect setae. Eyes red; red lateral band on head extending posteriorly from eyes. Rostrum extending beyond 2nd abdominal (1st ventral) segment. Thorax mostly gray-black; abdomen yellow with anterior lateral bands. Last abdominal segment having elongated anal tube, blackened laterally and red posteriorly.

2nd instar (FIG. 1C). Body similar to preceding, but setae much less prominent. Head, thorax and legs orange with gray-black patches and bands. Head broader than thorax. Antennal segments ferruginous, basal segment thicker than others. Eyes red; red lateral band on head distinct; rostrum extending to margin of 2nd abdominal (1st ventral) segment. Scutellar spine on thorax short, cylindrical. Abdomen

TABLE 1. Dimensions of the egg stage of *Helopeltis clavifer* (measurements, in mm, are means of 10 specimens).

PARAMETER	MEAN	RANGE
Length (excluding chorionic processes)	1.23	1.1–1.3
Width	0.30	–
Length of longer chorionic process	0.73	0.6–0.8
Length of shorter chorionic process	0.49	0.4–0.5

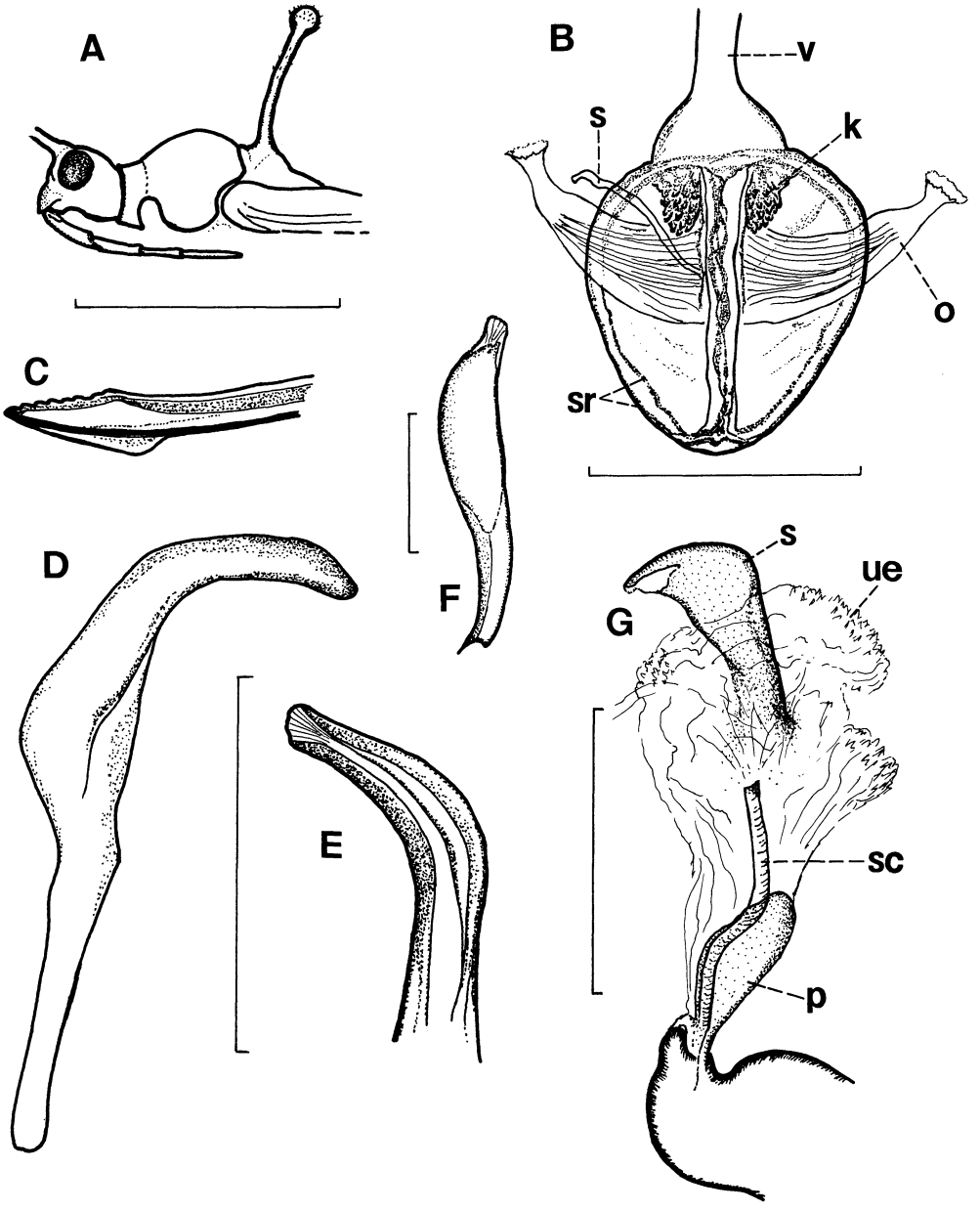

FIG. 3. *Helopeltis clavifer*: A, ♀, head, pronotum and scutellum, lateral aspect; B, ♀, genital apparatus, dorsal aspect (v, posterior valvifers; s, spermatheca; k, 'k' structure; o, oviduct; sr, sclerotized rings); C, ♀, apex of posterior valvifer; D, ♂, left paramere; E, ♂, apex of left paramere, enlarged; F, ♂, right paramere; G, ♂ genital apparatus, lateral aspect of specimen taken in copula (s, sclerite; ue, undifferentiated endophallus; sc, seminal canal; p, phallotheca). Scales: A = 2 mm; B, D, G = 0.5 mm; F = 0.1 mm.

yellow anteriorly, orange posteriorly, with red central dorsal band and posterior red lateral bands. Last abdominal segment similar to 1st instar.

3rd instar (FIG. 1D). Body elongate, abdomen narrowly pear-shaped. Head, thorax and legs yellow with black bands. Thorax broader than head. Tylus and juga on head still prominent. All antennal segments ferruginous, with segments 1 and 4 lighter in color and basal segment thicker. Eyes red; red lateral headband distinct; rostrum extending only to 2nd thoracic segment. Scutellar spine prominent, cylindrical, without swollen knob. Wing buds visible. Abdomen yellow anteriorly, orange posteriorly. Final abdominal segment elongated, blackened laterally, with red lateral bands, a red central dorsal band and red anus.

4th instar (FIG. 1E). Body similar to preceding instar. Body color orange, with black on legs and scutellar spine, gray-black on anterior section of head, wing buds and posterior part of abdomen. Thorax same width as head. First antennal segment black, others ferruginous, but segment 2 lighter than others; basal segment thicker than rest. Eyes dark red; head with red lateral band; rostrum extending to 2nd thoracic segment. Scutellar spine blackened on proximal ⅔ of length, and distal end orange, swelling visible. Wing buds prominent, gray-black. Abdomen yellow anteriorly.

5th instar (FIG. 2A). Body elongate. Head mostly gray-black; thorax orange; wing buds black; scutellar spine gray-black, and with distal swollen knob orange. Legs orange-yellow, banded with gray-black. Antennal segment 1 black, segment 2 yellow, segment 3 and 4 ferruginous, setaceous. Basal segment thicker than others. Eyes dark red-black; red lateral headband difficult to distinguish; rostrum extending between metathoracic legs. Abdomen yellow anteriorly, orange posteriorly; final abdominal segment elongated with anal tube clearly visible.

Adult (FIG. 2B, 3A–G). The adults are redescribed and genitalia illustrated from specimens examined from Popondetta, Northern Province (elev. 100 m), Garaina, Morobe Province (elev. 700 m) and Aiyura, Eastern Highlands Province (elev. 1500 m) in Papua New Guinea found on cocoa, tea and sweet potato, respectively.

♂. Body slender, nearly linear and generally piceous. Head short, shining black, minutely punctuated and with eyes prominent. Dorsal surface shining black, coronal suture distinct; infuscate areas posterior to eyes on ventrolateral surface of gula. Internal margins of antennal tubercles prominent; all antennal segments black, segment 1 distinctly clubbed at apex, segments 1 and 2 minutely tuberculate and setaceous, segments 3 and 4 with abundant short setae. Rostrum extending beyond mesothoracic segment, 1st segment pale, others mostly gray-black. Pronotum black, convex, with anterior lobe forming distinct collar; posterior angles rounded, pronotal line faint. Scutellum nearly semicircular, smooth, minutely punctured and with broad posterior apex; bearing long, filiform, capitate spine, minutely setaceous, feebly curved, proximally and distally piceous with central area testaceous. Legs: long, slender; femora strongly nodulated, sparsely tuberculate and banded with brown; tibia piceous proximally, testaceous distally; tarsi bearing large claws; tibia and tarsi densely setaceous. Hemelytra hyaline, infumate and extending well beyond abdomen. Posterior wing hyaline, lightly infumate distally, with dark venation. Cubital and postcubital reaching to edge of wing. Abdomen dorsally piceous in all segments, terminal 2 sternites piceous, with sternites 3–7 banded piceous along dorsal border.

♂ *Genitalia.* Described in general terms for the Indo-Malayan species of the genus by Schmitz (1968). Left and right parameres and genital apparatus as in FIG. 3D–G. The seminal canal opens at an unsclerotized area of the endophallus, which is an undifferentiated membranous sac having a large, terminal and somewhat sickle-shaped sclerite.

♀. Similar to the ♂, except larger and more robust and the terminal 3 segments of the abdomen completely piceous.

♀ *Genitalia.* Again, described in general terms by Schmitz (1968). The genital apparatus with the characteristic sclerotized rings and 'k' structures is illustrated in FIG. 3B and the apex of a posterior valvifer is shown in FIG. 3C.

Material examined. PNG: NEW GUINEA (NE): 10 ♂, 10 ♀, Northern Prov., Serovi Plantation, nr Popondetta, 9.I.1977, E. S. C. Smith; 5 ♂, 3 ♀, Morobe Prov., Garaina, 19.IV.1977, Smith; 10 ♂, 10 ♀, Eastern Highland Prov., Aiyura, Highlands Agric. Exper. Stn., 1550 m, 21.IV.1977, Smith. Specimens deposited in the Central Reference Collection, Department of Primary Industry, Konedobu, Papua New Guinea.

TABLE 2. Dimensions of immature stages and adults of *Helopeltis clavifer* (measurements, in mm, are means of 10 specimens).

	INSTAR					ADULT	
PARAMETER	1st	2nd	3rd	4th	5th	♂	♀
Body length	1.55	2.32	3.02	4.70	5.34	4.95	5.71
Antennal length							
Basal 1st segment	0.30	0.50	0.65	1.11	1.89	2.91	2.89
2nd segment	0.65	1.01	1.44	2.36	3.38	5.05	4.80
3rd segment	0.72	0.98	1.31	1.87	2.43	3.97	3.28
Distal 4th segment	0.50	0.60	0.79	1.03	1.26	1.74	1.34
Antennal ratios							
1:2	2.17	2.02	2.22	2.13	1.78	1.74	1.66
1:3	2.40	1.96	2.01	1.68	1.29	1.36	1.13
1:4	1.67	1.20	1.22	0.92	0.67	0.60	0.46
Head							
Width	0.30	0.44	0.50	0.75	0.99	1.12	1.14
Length	0.30	0.44	0.51	0.72	0.69	0.66	0.66
Rostrum length	0.70	0.77	1.02	1.32	1.65	1.97	2.05
Thorax							
Width						1.43	1.61
Length						1.81	1.95
Length scutellar spine	—	0.29	0.51	0.89	1.05	1.61	1.65
Diam. scutellar spine	—	—	—	—	0.19	0.25	0.27
Length of wings or buds	—	—	—	0.88	1.86	5.15	5.71
Legs							
Front femur	0.51	0.70	1.01	1.52	1.85	2.09	2.12
tibia	0.51	0.74	1.04	1.72	2.31	2.75	2.88
ratio	1.00	1.04	1.03	1.13	1.25	1.32	1.36
Middle femur	0.57	0.72	1.06	1.50	1.92	2.18	2.22
tibia	0.57	0.75	1.08	1.77	2.44	2.75	2.96
ratio	1.00	1.04	1.02	1.18	1.27	1.26	1.33
Hind femur	0.60	0.86	1.17	1.79	2.26	2.80	2.97
tibia	0.60	0.90	1.30	2.16	3.00	3.49	3.77
ratio	1.00	1.05	1.11	1.21	1.33	1.25	1.27

REMARKS

Subsequent to Walker's 1871 and 1873 descriptions of this species, Waterhouse (1886) and Atkinson (1890) supplied brief descriptions of *H. braconiformis* and *H. niger,* providing also an illustration of the scutellar spine. These authors recognized the synonymy between *D.* ? *clavifer* and *H. braconiformis* (Waterhouse 1886) and *D.* ? *clavifer* and *H. niger* (Atkinson 1890), but both failed to recognize the priority of the specific name *clavifer.* In addition, Distant (1904), who first proposed the combination *H. clavifer,* and Carvalho (1957: 135) both failed to note Atkinson's (1890) synonymy of *H. niger* and *D.* ? *clavifer.* Carvalho (pers. commun.) has indicated that Walker's *H. niger* specimen referred to the dark color variation of *H. clavifer.*

The measurement of length, over 8 mm, in Walker's original (1871) description is

much greater than that recorded in TABLE 2 and probably included the length of the wings beyond the body.

In regard to the color variations found in this species, I noted that both sexes, when newly molted into the adult form, had the posterior parts of the head, thorax and scutellar spinal knob orange and that these often darkened to a rich red color within a few hours. Some 3–4 days after attaining the adult form, the anterior pronotal collar, the posterior pronotal border and the posterior scutellar border became darker, and over 1–2 days the entire head and thorax darkened to piceous. This darkening process was not necessarily associated with sexual maturity, since females could mate while still in the red color form. It was also noted that when freshly killed, the abdomen was pale green in color but, within a few hours, the color generally faded to white.

In addition, in live or freshly killed specimens the apex of the scutellar spine was spherical, but several hours after the insect was killed, the membrane of the knob collapsed and it appeared in dry specimens as apically truncated. Much of the earlier taxonomic confusion may have been caused by these color forms and by the distortion of specimens upon drying.

KEY TO THE NYMPHAL INSTARS OF *Helopeltis clavifer*

1. Wing buds visible, rostrum not extending beyond thoracic segments 2
   Wing buds absent, rostrum extending well beyond thorax 4
2 (1). Wing buds extending onto 4th or 5th abdominal segment; scutellar spine with distal swollen knob distinct; indistinct red lateral band on head extending posteriorly from eyes .. 5th instar
   Wing buds extending at most to beginning of 3rd abdominal segment, scutellar spine without, or with an indistinct distal knob; red lateral band on head distinct 3
3 (2). First antennal segment black, others ferruginous, but segment 2 lighter in color; head same width as thorax; wing buds prominent; scutellar spine with distal swelling ..... 4th instar
   All antennal segments ferruginous, with segments 1 and 4 lighter in color, head narrower than thorax; wing buds indistinct; scutellar spine without distal swelling ..... 3rd instar
4 (1). Scutellar spine present, short and cylindrical; all antennal segments ferruginous; setae on body less prominent ..... 2nd instar
   Scutellar spine absent, not all antennal segments ferruginous; setae black, very prominent ... . 1st instar

Acknowledgments: I am grateful to Mrs B. Smith for the illustrations of the egg, nymphs and adult genitalia, and to the Publications Section, Department of Primary Industry, Konedobu, Papua New Guinea for permission to use the illustration of the adult previously drawn by Mrs M. L. Szent-Ivany, published in Szent-Ivany (1961). Permission to publish this paper was granted by the Secretary, Department of Primary Industry, Konedobu, Papua New Guinea.

LITERATURE CITED

Atkinson, E. T. 1890. *Indian Mus. Notes* **1**(4): 176–77.

Carvalho, J. C. M. 1957. Catalogue of the Miridae of the world. Part 1. *Arq. Mus. Nac., Rio de Janeiro* **44.** 158 p.

Conway, G. R. 1971. *Pests of cocoa in Sabah and their control.* Kementerian Pertanian Dan Perikanan, Sabah, Malaysia. 125 p.

Distant, W. L. 1904. Rhynchotal notes. XX. Heteroptera, Fam. Capsidae (Part 1). *Ann. Mag. Nat. Hist.* ser. 7, **13:** 103–14.

Dun, G. S. 1954. Notes on cacao capsids in New Guinea. *Papua New Guin. Agric. Gaz.* **8**(4): 7–11.

Schmitz, G. 1968. Monographie des espèces Africaines du genre *Helopeltis* Signoret (Heteroptera, Miridae). *Ann. Mus. R. Afr. Cent.* ser. 8 **168.** 247 p.

Simon Thomas, R. T. 1962. *The pests of some cultivated plants in Netherlands New Guinea.* Bull. Dep. Econ. Aff. (Agric. Ser.) 1962 No. 1. 126 p.

Smith, E. S. C. 1973. A laboratory rearing method for the cacao mirid *Helopeltis clavifer* (Walker) (Hemiptera; Miridae). *Papua New Guin. Agric. J.* **24**(2): 52–53.

Szent-Ivany, J. H. H. 1961. Insect pests of *Theobroma cacao* in the Territory of Papua New Guinea. *Papua New Guin. Agric. J.* **13**(4): 127–47.

Walker, F. 1871. *Cat. Heteropt. Br. Mus.* **4:** 170.

1873. *Cat. Heteropt. Br. Mus.* **6:** 165–66.

Waterhouse, C. O. 1886. Some observations on the tea bugs (*Helopeltis*) of India and Java. *Trans. Entomol. Soc. London* **1886**(4): 457–59.