A REMARKABLE CASE OF ALARY DIMORPHISM IN THE ARADIDAE (HEMIPTERA) WITH A GENERIC SYNONYMY AND A NEW SPECIES

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Abstract

The genus *Zeugocoris* Usinger & Matsuda is sunk as a junior synonym of *Caecicoris* Kormilev since the respective type species, *Z. microcerus* (Walker) and *C. oviventris* Kormilev, are found to be dimorphic forms of the one species. The morphological changes associated with wing reduction in the micropterous morph are described and the taxonomic and biological implications of this dimorphism are discussed. Additional distributional and biological data for *C. microcerus* are presented and *C. latus* sp. n. is described from New Britain.

INTRODUCTION

While collecting in the Botanic Gardens in Lae, New Guinea in February, 1966, the writer took into alcohol a large series of aradids clustered together on the underside of a dead log. Later when cleaning and sorting this series preparatory to mounting there was found to be both sexes of three apparent species present, *viz Zeugocoris microcerus* (Walker) (macropterous), *Caecicoris oviventris* Kormilev (micropterous) and *Artabanellus mcnamarai* Kormilev (micropterous). Therefore it was with considerable surprise that among this same material was found a male of *C. oviventris* preserved firmly in copulation with a female of *Z. microcerus*. This pair was dissected apart and the aedeagus was found to be fully inflated (Fig. 6) which implied that this was a successful copulation. Microscope preparations were made of aedeagi and parameres of males of both nominal species and examination failed to reveal any differences. Also, disregarding thoracic reductions and fusions associated with wing reduction, the general facies of both forms is virtually identical. These observations together with the fact that on another occasion at Madang the two "species" were collected in association leaves no doubt in my mind that these two are merely the different morphs of a single dimorphic species, which must bear the name *Caecicoris microcerus* (Walker).

All measurements throughout this paper are in millimetres.

MEZIRINAE Oshanin, 1908

Caecicoris Kormilev, 1957

Caecicoris Kormilev, 1957, *Philipp. J. Sci.* **85**(3): 398.
Zeugocoris Usinger & Matsuda, 1959, *Class. Aradidae:* 310 *new synonymy*.

Since the type species of the two monotypic genera *Caecicoris* and *Zeugocoris* are, as shown above, merely different morphs of a single dimorphic species the two genera are synonyms and *Zeugocoris*, being the later name, must fall.

Caecicoris microcerus (Walker, 1873) **comb. n.**

Crimia microcera Walker, 1873, *Cat. Hemipt. Heteroptera*, Brit. Mus. **7:** 21.
Crimia microcera Lethierry & Severin, 1896, Catalogue général des Hémiptères **3:** 47 (incerti generis).
Caecicoris oviventris Kormilev, 1957, *Philipp. J. Sci.* **85**(3): 399 *new synonymy*.
Zeugocoris microcerus Usinger & Matsuda, 1959, *Class. Aradidae:* 311.

Material examined.—NEW GUINEA: 36 macropt. ♀♀, 3 micropt. ♀♀, 13 macropt. ♂♂, 2 micropt. ♂♂, Lae Botanic Gardens, 6.ii.1966, G. Monteith; 2 macropt. ♀♀, 1 micropt. ♀, 1 macropt. ♂, Madang, 17.ii.1966, G. Monteith; 1 micropt. ♀, Wau, 3-4.ii.1966, G. Monteith. All collected on the underside of logs in rainforest.

Since both forms were described and illustrated from females only and since there is also considerable sexual dimorphism in body form I give here short descriptions of the male morphs.

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Male macropter

Measurements—average of three specimens followed by similar figures for macropterous females in parentheses: length 5·45 (5·59); head length 1·10 (1·19); head width 0·90 (0·94); pronotal length 0·90 (0·92); pronotal width 1·80 (1·91); width of abdomen across posterior angles of connexiva IV 1·99 (2·83); antennal segments (I-IV) I 0·52 (0·54), II 0·33 (0·32), III 0·72 (0·79), IV 0·43 (0·42); prosternal length 0·47 (0·51); mesosternal length 0·58 (0·59); metasternal length 0·65 (0·68).

Differing from female as follows:— Abdomen much narrower, parallel sided; postero-lateral angles of connexiva VI weakly angulate, those of connexiva VII strongly produced as triangular projections; mid lateral areas of tergal disc very narrow, almost completely covered by hemelytra in repose; tergum VII roundly elevated. Suture between sterna VI and VII markedly concave medially; sternum VI (Fig. 7) bearing medially a large glabrous, shining black, almost semicircular callosity; on each side of median

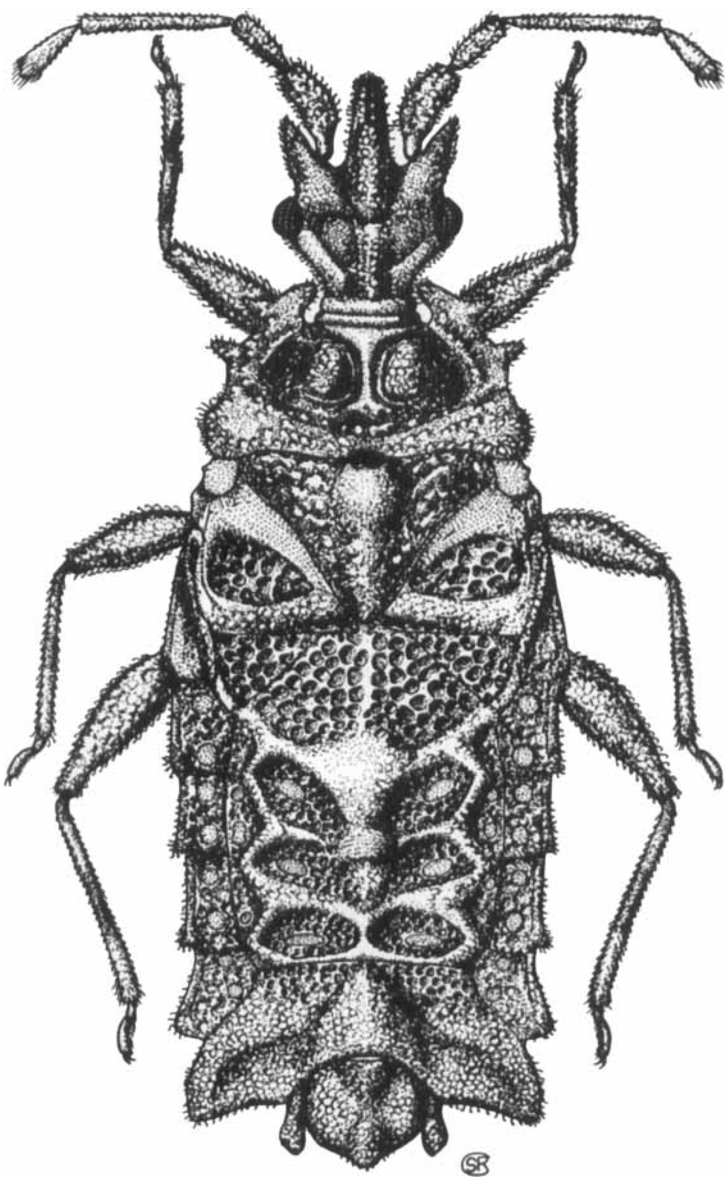


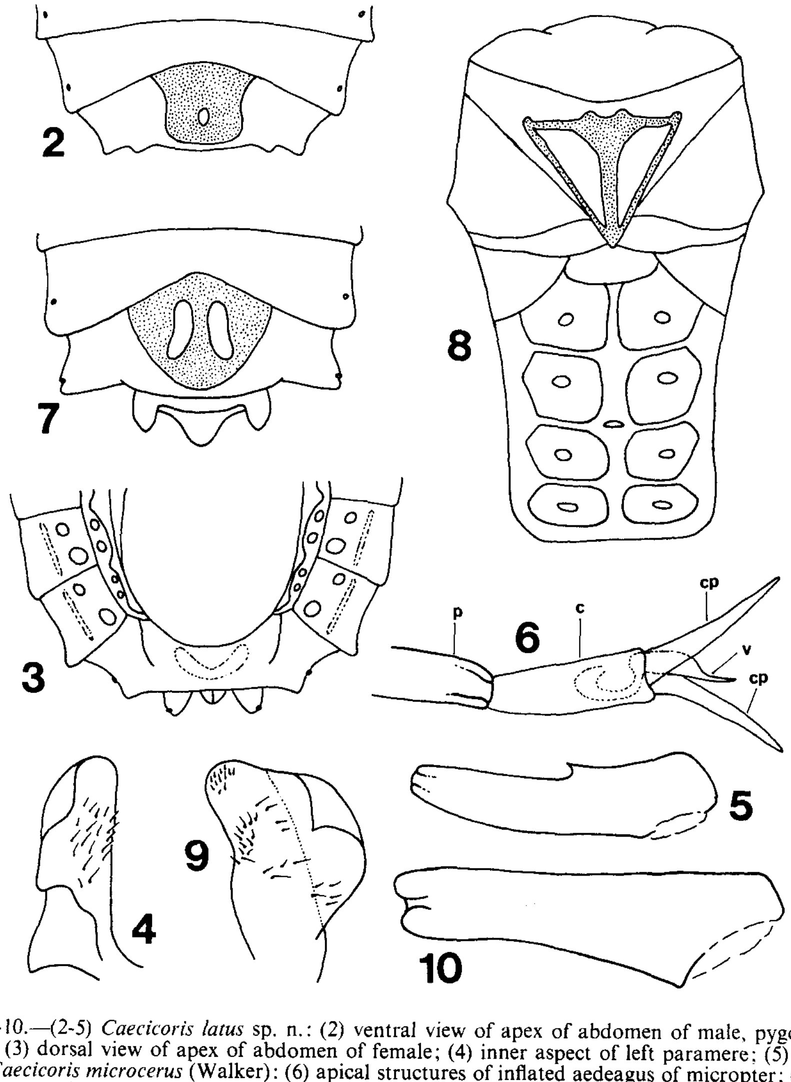
FIG. 1.—*Caecicoris microcerus* (Walker), micropterous male.

line of callosity is a pale, reniform, slightly raised area. Pygophore large, pointed posteriorly; aedeagus (Fig. 10); paramere (Fig. 9).

Male micropter (Figs. 1, 6)

Measurements of a single male followed in parentheses by the means of three micropterous females: length 5·07 (5·00); head length 1·00 (1·13); head width 0·91 (0·93); pronotal length 0·63 (0·60); pronotal width 1·53 (1·49); width of abdomen across posterior angles of connexiva IV 1·81 (2·46); antennal segments (I-IV): I 0·51 (0·53), II 0·31 (0·33), III 0·77 (0·77), IV 0·43 (0·41); prosternal length 0·48 (0·44); mesosternal length 0·31 (0·33); metasternal length 0·63 (0·64).

Hemelytra reduced to small oval, slightly mobile flaps 0·2 mm. long; hind wings absent; sides of abdomen weakly concave, abdomen being narrowest across segment V; postero-lateral angles of connexiva V, VI and VII all a little more prominent than in macropterous male; sternum VII with callosity as in macropter; an expanded aedeagus was obtained from the specimen taken in copulation (Fig. 6).



FIGS. 2-10.—(2-5) *Caecicoris latus* sp. n.: (2) ventral view of apex of abdomen of male, pygophore removed; (3) dorsal view of apex of abdomen of female; (4) inner aspect of left paramere; (5) aedeagus. (6-10) *Caecicoris microcerus* (Walker): (6) apical structures of inflated aedeagus of micropter; (7) ventral view of apex of abdomen of macropterous male; (8) dorsal view of thorax and abdominal tergal disc, wings and pronotum removed; (9) inner aspect of right paramere; (10) aedeagus of macropter. Key to symbols: c, membranous conjunctiva; cp, membranous conjunctival processes; p, apex of phallotheca; v, sclerotised vesica.

Taxonomic implications of dimorphism in C. microcerus

There has been a strong tendency during the evolution of the Aradidae towards extreme wing reduction and, in many species, total wing loss. This reduction occurs in a little over 50% of all known genera (i.e. *c.* 85) and these are distributed in six of the eight recognized subfamilies. All these subfamilies also contain fully winged genera which are assumed to have given rise independently to the short winged genera in their respective subfamilies and it is fairly clear that in each of the two large subfamilies, Mezirinae and Carventinae, this has occurred several times. Of the two subfamilies which do not show extreme wing reduction, *viz* Calisiinae and Isoderminae, the Calisiinae has several species with reduced scutellum and somewhat shortened, probably functionless wings while adults of the Isoderminae all tend to shed the wing membranes leaving only the abbreviated coria. Thus it is apparent that throughout the family there is some basic need for, and an intrinsic capability to produce wing atrophy.

Alary polymorphism has previously been known only in a few species of *Aradus* (Aradinae) but here the extent of wing reduction is relatively minor, the wings never being shorter than the scutellum and only rarely is the membrane lost. Polymorphism in this genus usually takes the form of merely sexual dimorphism with the female always brachypterous and the male always macropterous. Rarer cases do occur where the female exists in both forms and one or two species are known where the male also is dimorphic. However the dominantly temperate climate Aradinae are rather remotely related to the more tropical Mezirinae and Carventinae which have the most pronounced tendency to wing reduction. Brachyptery in the Aradinae appears to be the common form seen in many other groups of insects in temperate and montane regions but in the Mezirinae and Carventinae an entirely different situation is seen. These are predominately tropical insects and where wing reduction occurs it is almost invariably extreme and usually no trace of wings remains. In addition these forms differ in many other details of thoracic and abdominal structure and are normally of bizarre appearance quite unlike their macropterous relatives and as a result they have usually been regarded as generically distinct. Of the 109 genera in the Mezirinae (to which *Caecicoris* belongs) 60 contain only macropterous species, 12 are all brachypterous or micropterous and 33 are completely apterous. Only in the remaining four genera have short winged species been included with macropters and in these the brachypterous species are without the other modifications usually associated with wing reduction in the family. No author has proposed an evolutionary sequence of species linking macropterous and apterous genera.

In *Caecicoris microcerus* we find a species in which both sexes are dimorphic, one morph being macropterous and the other an extreme micropter. I give below a summary of the non-alary characters by which the micropter differs from the macropter. Comparative thoracic measurements of the two male morphs are given in Table 1.

a. The hind lobe of the pronotum is reduced to a narrow transverse band which does not overlap the mesothorax.
b. The prothorax is immovably fused dorsally and ventrally with the mesothorax.
c. The meso- and metasterna, especially the former are reduced in length and, to a lesser extent, in breadth.
d. The scutellum is highly elevated in the middle, its apex is rounded, its median and lateral carinae are indistinct and its lateral edges are fused with the metanotum.
e. The punctured areas of the metanotum on either side of the scutellum are much more extensive.
f. The dorsum of the abdomen is on the whole more heavily rugose and punctured. The region of the scent gland scar is strongly elevated, the interstitial bands between the tergal plates are raised into rugose ridges and the mid-lateral region of the tergal disc is much wider (cf. Fig. 8 of macropter).

TABLE 1

COMPARATIVE THORACIC MEASUREMENTS OF MALE MACROPTEROUS AND MICROPTEROUS *Caecicoris microcerus*

Caecicoris microcerus	Median lengths in millimetres				
	Prosternum	Mesosternum	Metasternum	Fore lobe of Prothorax	Hind lobe of Prothorax
♂ Macropter	0·43	0·48	0·63	0·37	0·43
♂ Micropter	0·43	0·29	0·51	0·37	0·17

Some of these characteristics, for example a, b and f, occur almost invariably in conjunction with aptery and microptery in the Aradidae and are commonly used as additional justification for segregating macropterous and short-winged species into separate genera. Also the number of short-winged genera has been multiplied in some cases by emphasising as diagnostic characters the relative amount of wing reduction and the degree of expression of some of these associated characters mentioned above. Confronted now with the fact that such a range of morphological diversity may be contained within the genetic repertoire of a single species it seems that a more critical appraisal should be made of some of the currently accepted genera and that future genera should be erected with some caution, especially when dealing with micropterous rather than apterous forms.

Caecicoris (New Guinea, New Britain) is related to a group of three flightless genera, *Mastigocoris* (Micronesia, Java, Sumatra, Malaya), *Artabanellus* (Micronesia, New Guinea) and *Phanocoris* (Fiji), with which it shares the characters of open rostral atrium, presence of wing vestiges and presence of a distinct scutellum. They are distinguished from each other primarily by degree of development of prothorax, scutellum and wing vestiges all of which differ grossly in the two morphs of *C. microcerus*. The validity of all three genera is therefore seriously in doubt and the whole group requires further study. The extensive inter-island distribution of this group is unprecedented among flightless aradids and is surely indicative of recent winged ancestors or possibly undiscovered macropterous morphs.

Biological implications of dimorphism in C. microcerus

The Aradidae with one or two poorly documented exceptions are mycetophagous, associated with fungal mycelia in and on dead wood. Macropterous forms are, in the main, subcortical in habits feeding on the fungus which grows in the moist situation beneath the lifting bark of recently dead logs and trees. This food source is comparatively short lived for as time passes the bark dries out, drops off and the breeding niche is lost. This then necessitates a dispersal flight to find and colonize a new log at a suitable state of decay. Flightless forms on the other hand have quite different requirements. They are inhabitants of the forest floor of wet tropical and subtropical rainforests. When dead logs and branches fall to the ground in rain forest they soon develop a luxuriant growth of mycelia on their undersurface in the dark, humid microclimate between the log and the leaf litter layer and this is the fungal food supply exploited by flightless species. Fungal activity is prolonged and enhanced by the continually moist conditions on the forest floor and this allows a long period of aradid activity at a single log. Such rotting logs abound in rainforest and are joined by an almost continuous supply of small decaying twigs throughout the intervening leaf litter layer. Thus the need for a dispersal flight to find a new food source as seen in subcortical species is lost, and, as is usual, once the function of an organ is lost so too is the organ itself.

The high incidence of wing atrophy in aradids of the forest floor indicates that there are intrinsic advantages in wing loss itself and I believe that one of these is camouflage. The secretive subcortical habitat of macropterous species requires no special camouflage mechanism but the flightless species which live exposed on the underside of logs on the ground are open to visually elicited attack by the many predators, for example carabid beetles, which share their environment. Aradid hemelytra have well developed membranes and abbreviated, sclerotised coria and these large, smooth membranes are quite conspicuous on the dorsum of macropters. Flimsy membranes do not lend themselves to elaboration into structures which blend with the rough, irregular surface of a decaying log and this surface elaboration has instead occurred on the dorsal surface of the abdomen of typical wingless species. This is a striking feature of the micropterous morph of *Caecicoris microcerus*. A rough surface also more easily traps and holds the layer of dirt and detritus with which many Mezirinae cover themselves thus adding to their cryptic appearance. It is of interest to note that some of the macropterous genera which frequent geophilic sites similar to those of flightless forms also coat their dorsal surface with dirt completely preventing flight, for example *Chinessa, Glochocoris* and *Chiastoplonia*.

The two morphs of *C. microcerus*, one of typical macropterous facies and the other of typical camouflaged apterous facies, both inhabit the "wingless" niche in rainforest. Both morphs of males and females occur simultaneously in time and no intergrades are known which indicates that the dimorphism is likely to be controlled by a fairly simple genetic mechanism. This is probably a case of balanced polymorphism being maintained on the one hand by the advantages of aerial dispersal powers and on the other hand by the advantages of aptery—whatever they may be.

Caecicoris latus sp. n.
(Figs. 2-5, 11)

Types.—NEW BRITAIN: *Holotype* male, Kerevat, near Rabaul, 10.ii.1966, G. B. Monteith. Collected on underside of log in rainforest, 20 m. elev. In Bishop Museum, Honolulu, Hawaii.

Allotype and paratye females: Same data as holotype. In Department of Entomology, University of Queensland, Brisbane.

Holotype male

Macropterous. Body (Fig. 11) broadly sub-rectangular. Colour dull brown, somewhat reddish ventrally, femora and basal fifth of membranes pale. Dorsal surface, legs and basal two antennal segments with sparse, short, curled pubescence.

Length 4·85; width 2·13

Head.—A little longer than wide (1·04 : 0·97); postocular processes absent; antenniferous tubercles short, blunt, barely longer than length of eye; genae long, parallel, reaching just beyond apex of first antennal segment; eyes globular, exserted; lengths of antennal segments I-IV 0·43, 0·29, 0·54, 0·37.

Thorax.—Pronotum fully developed, length 0·83, width 1·87; for and hind lobes separated by a complete transverse furrow; fore lobe with a median longitudinal groove in posterior half and with a low tubercle on each side of groove; explanate edges of fore lobe narrow, extending from antero-lateral margins around to transverse furrow where they terminate abruptly, each with a notch just before posterior termination. Hind lobe slightly depressed in middle, its surface beset with scattered, shining granules.

Scutellum (length 0·77, width 1·18) with carinate edges on all three sides and with a median ridge tapering posteriorly. Hemelytra extending to hind margin of tergum VII; coria with basal margins strongly reflexed and two prominent longitudinal veins; membranes with apical four fifths dark, finely wrinkled, venation obscure.

Connexiva with weak sub-lateral, longitudinal ridges; posterior angles of connexiva V and VI weakly, and those of VII strongly, angulate. Mid-lateral region of tergal disc almost completely covered by the hemelytra and with the mid-lateral glabrous areas indistinct. Tergum VII roundly elevated in posterior half. Pygophore small, pointed posteriorly. Phallotheca of aedeagus (Fig. 5) elongate, cylindrical, slightly tapering towards apex and with a prominent dorsal notch at about half its length. Parameres as in Fig. 4.

Venter.—Prosternum considerably shorter than meso- or metasterna, their respective lengths being 0·37, 0·63, 0·57. Abdominal sterna III-VI medially each with the posterior half elevated into a broad, raised, transverse band which tapers to obliteration towards the lateral margins of the abdomen. Sternum VII (Fig. 2) with median callosity subquadrate, its lateral edges concave and with a small oval excavation just behind its centre. Median lengths of sterna II-VII respectively 0·35, 0·35, 0·31, 0·31, 0·22, 0·50. Spiracles all elevated on conical tubercles.

Allotype and Paratype Females

The two females available for description differ markedly in size and the smaller, being in the better condition, has been selected as the allotype.

Measurements (allotype first): length 5·00, 5·66; maximum width 2·27, 3·01; head length 1·10, 1·07; head width 0·94, 1·13; prothorax width 1·87, 2·27; prothorax length 0·80, 0·91; antennal segments (I-IV) I 0·40, 0·51, II 0·29, 0·34, III 0·51, 0·57, IV 0·33, 0·34; prosternum length 0·37, 0·43; mesosternum length 0·57, 0·66; metasterum length 0·57, 0·63.

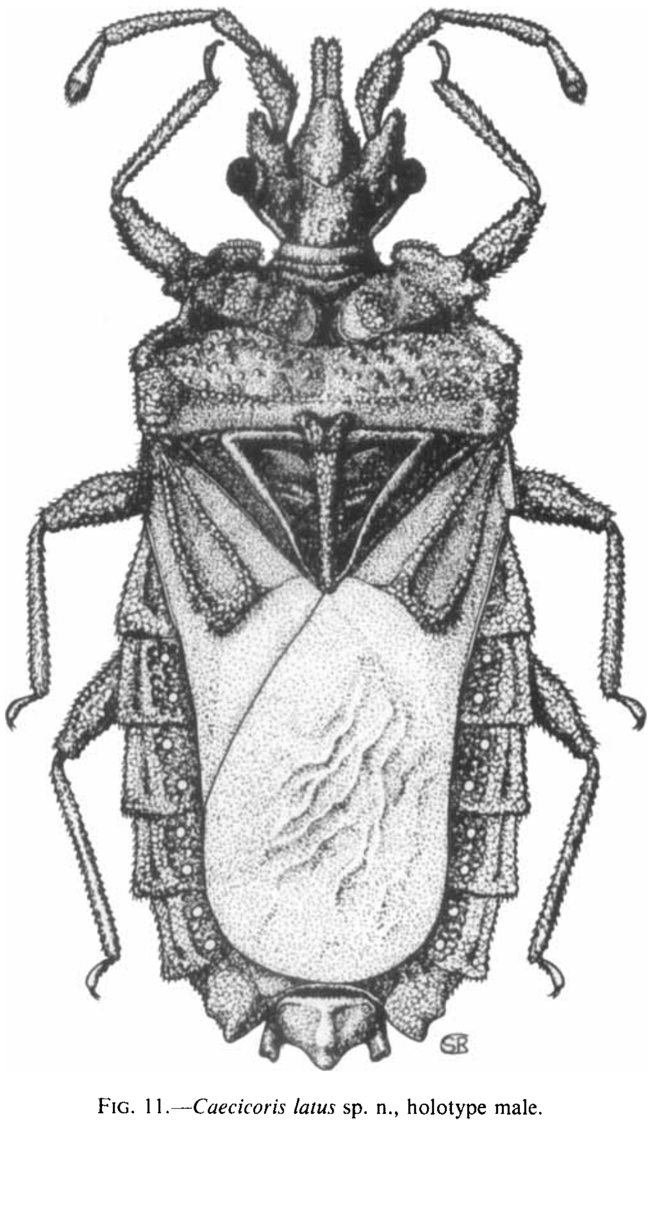


FIG. 11.—*Caecicoris latus* sp. n., holotype male.

Description.—As for male except: wings slightly shorter, extending to about middle of tergum VII; tergum VII with hind margin quite straight, its surface flatter than male and with a low crescentic, pubescent elevation; postero-lateral angles of connexivum V not angulate, those of VI and VII weakly so; hind margin of sternum VI concave medially. There is some variation in the length and shape of the genal processes, in the paratype they are much shorter than in the other two specimens and convergent rather than slightly divergent at their apices.

Comments

Caecicoris latus is known only from macropterous specimens. Only more collecting will reveal whether this species also is dimorphic. It is easily separated from *C. microcerus* by its broader form and the following characters: antennal segment III less than twice length of segment II; anterior lobe of prothorax broader and with differently shaped lateral margins; dorsum almost unicolorous, *C. microcerus* has coria, membranes and connexiva II and III contrastingly pale; aedeagus with a dorsal notch in the phallotheca.

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